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Influence of different organic sources on quality, uptake, soil microbial population and economics of summer clusterbean (*Cyamopsis tetragonoloba* L.) under organic farming

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Abstract
A field experiment was conducted during Summer season of 2020 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, to study the "Influence of different organic sources on quality, uptake, soil microbial population and economics of summer clusterbean (*Cyamopsis tetragonoloba* L.) under organic farming. The experiment comprised of nine treatments *viz.* T_1: 5.0 t/ha FYM, T_2: 1.0 t/ha castor cake, T_3: 2.5 t/ha FYM + 0.5 t/ha castor cake, T_4: 5.0 t/ha FYM + NPK consortium, T_5: 1.0 t/ha castor cake + NPK consortium, T_6: 2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium, T_7: 5.0 t/ha FYM + *Rhizobium* + PSB, T_8: 1.0 t/ha castor cake + *Rhizobium* + PSB, T_9: 2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB were evaluated in randomized block design replicating three times. Significantly higher protein content (26.73%) and protein yield (239.10 kg/ha) recorded over all other treatments. Total uptake of N and P by clusterbean, treatment T_9 (2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB) recorded significantly higher uptake of N and P. Significantly the higher *Rhizobium* (242.20 CFU × 10^4/g soil) and PSB (272.88 CFU × 10^4/g soil) count were recorded in treatment T_9. On an average maximum net realization (₹ 36463/ha) and benefit: cost ratio (BCR) (2.39) were obtained with treatment T_9 followed by treatment T_6.

Keywords: NPK consortium, *Rhizobium* + PSB, Clusterbean, Soil microbial population

1. Introduction
The clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] is an annual legume crop mostly grown under resource constrained conditions in arid and semi-arid regions. Clusterbean is a deep-rooted plant of Leguminosae family known for drought and high temperature tolerance (Kumar and Rodge, 2012) [8]. In India, next to cereals, pulses and legumes are the main constituent of diet. Gum obtained from cluster bean seeds is a choice of agrochemical in paper, food, mining, cosmetics, textile, oil and pharmaceutical industries across the world. In food industry Guar gum is used as Gelling, viscosifying, thickening, clouding, and binding agent. It is also used for stabilization, emulsification, preservation, water retention, enhancement of water-soluble fibre content etc. Clusterbean is grown especially in the arid regions of India (Rajasthan, Haryana, Gujarat and Punjab) for gum purpose, whereas it is grown for vegetable purpose in other parts of India. India is largest producer of clusterbean in the world with an annual production of 1.849 million tonnes and productivity of 451 kg/ha (DE&S 2018). Major clusterbean producing states in India are Rajasthan, Haryana, Gujarat, Uttar Pradesh, Punjab and Madhya Pradesh. India is the major exporter of guar gum to the world. It exports various forms of guar to a large number of countries. The country has exported 5.13 lakh tonnes of guar gum to the world for the worth of Rs. 4707.10 crores during the year 2018-19 (APEDA 2018-19) [2].

The organic farming of guar crop is important to get yield of good quality and to minimize harmful effects to soil fertility and texture. Being a leguminous crop, it has the capacity to fix atmospheric nitrogen up to 38 kg/ha through symbiosis and improves the fertility health of soil. It may also be used as green manure crop to improve fertility status of the soil. It also acts as cover crop, which reduces soil erosion and weed problem in mono as well as intercropping system. Application of organic manures combination with biofertilizer and NPK consortium found as effective components in organic farming for reliable and cheap supply of nutrients.

These combinations are eco-friendly, safe and improve soil fertility by improving physical, chemical and biological conditions of soil. Hence, the incorporation of organic manures such as farmyard manure and castor cake with liquid organic manures is undertaken in this experiment as it considered a good source of nutrients and low C: N ratio for quick decomposition.

2. Material and Methods

The field experiment was laid out on Plot No. B-4 during summer 2020 at Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (Gujarat). Geographically, Sardarkrushinagar is situated at 24º 19' North latitude and 72º 19' East longitude with an elevation of 154.52 metres above the mean sea level and situated in the North Gujarat Agro-climatic Zone. The climate of this region is subtropical monsoon type and falls under semi-arid region. In general, summer season (March-June) is generally hot and dry. Occurrence of storms and winds with very high velocity is very common during this season.

The experimental field had an even topography with a gentle slope having good drainage. The soil of the experimental plot was loamy sand in texture, low in organic carbon (0.29%), available nitrogen (137.56 kg/ha), medium in available P2O5 (32.10 kg/ha) and available K2O (250.50 kg/ha) with soil pH of 7.5. Electrical conductivity was very low showing that the soil was free from salinity hazard. The experiment comprised of nine treatments *viz*. T_1: 5.0 t/ha FYM, T_2: 1.0 t/ha castor cake, T_3: 2.5 t/ha FYM + 0.5 t/ha castor cake, T_4: 5.0 t/ha FYM + NPK consortium, T_5: 1.0 t/ha castor cake + NPK consortium, T_6: 2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium, T_7: 5.0 t/ha FYM + *Rhizobium* + PSB, T_8: 1.0 t/ha castor cake + *Rhizobium* + PSB, T_9: 2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB were evaluated in randomized block design replicating three times.

The clusterbean variety 'Gujarat Guar 2' was sown on march 4th, 2020 at 45 cm row to row spacing by using recommended seed rate of 18 kg/ha. The average gross and net plot size were 5.0 m × 3.6 m and 4.0 m × 2.7 m, respectively. All other agronomic practices were adopted as per need of the crop.

3. Results and Discussion

3.1 Effect on quality parameters

The result indicated (Table 1) that an application of 2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB (T_9) registered significantly higher protein content (26.73%) over all other treatments and it was at par with T_3 (25.32%), T_5 (24.01%), T_6 (26.32%), T_7 (24.19%), T_8 (24.99%). However minimum protein content (21.87%) was noted by 5.0 t/ha FYM (T_1) compared to other treatments. Significantly higher protein yield (239.10 kg/ha) was observed with treatment T_9 (2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB) which remained statistically at par with treatment T_6 (2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium) having (233.60 kg/ha) protein yield. Minimum protein yield was observed with treatment T_1 (5.0 t/ha FYM) having (160.30 kg/ha). Which remained statistically at par with treatments T_2 (1.0 t/ha castor cake) and T_4 (5.0 t/ha FYM + NPK consortium) having 167.00, 175.17 kg/ha, respectively. The quality parameters such as protein content and protein yield were increased might be due to application of castor cake along with FYM, PSB and *Rhizobium* increased availability of nutrients timely which accelerated crop growth there by emphasized yield and quality parameters of clusterbean. The results are in close vicinity with the findings of Singh *et al.* (2006) [15], Patel *et al.* (2010) [11], Prasad *et al.* (2016) [13], Manohar *et al.* (2018) [10].

3.2 Effect on nutrient uptake

3.2.1 Nitrogen uptake (kg/ha)

The mean data presented in Table 1 indicated that total uptake of nitrogen differed significantly due to different organic nutrient sources. An application (2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB) T_9 recorded significantly maximum uptake of nitrogen (68.89 kg/ha). Which remained statistically at par with T_3 (2.5 t/ha FYM + 0.5 t/ha castor cake) and T_6 (2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium) registered 67.49 and 68.48 kg/ha total nitrogen uptake. Reason behind nutrient accumulation in plants is a function of nutrient content and dry matter accumulation. The increase in supply of plant nutrients from organic manures like FYM and castor cake. Application of *Rhizobium* and PSB quick build up of soil micro flora and fauna (Yadav and Mowade, 2004) which has consequently increased the enzymatic activity and helped in mineralization, solubilization of native and applied nutrients and making them available for plant uptake. Similar findings have been reported by Malav *et al.* (2018) [9], Patel *et al.* (2018) [9], Rathore *et al.* (2007) [14], Patel *et al.* (2010) [11], Manohar *et al.* (2018) [10].

3.2.2 Phoshphorus uptake (kg/ha)

The data showed (Table 1) that total uptake of phosphorus differed significantly due to different organic nutrient sources. An application (2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB) T_9 recorded significantly maximum uptake of phosphorus (6.98 kg/ha). Which remained statistically at par with T_3 (2.5 t/ha FYM + 0.5 t/ha castor cake), T_6 (2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium) and T_8 (1.0 t/ha castor cake + *Rhizobium* + PSB) registered 6.84, 6.93 and 6.92 kg/ha total phosphorus uptake. Remarkable improvement in P uptake by crop with the application of organic source of nutrient *viz*., FYM and castor cake along with bio nutrient *viz.*, soil application of *Rhizobium* and PSB. The regulation of stomata favourably influenced by the bioactive substances produced by beneficial microorganisms present in bio nutrient, which also enhanced the uptake of nutrients of the clusterbean. Similar findings have been reported by Malav *et al.* (2018) [9], Patel *et al.* (2018) [9], Rathore *et al.* (2007) [14], Patel *et al.* (2010) [11], Manohar *et al.* (2018) [10].

3.3 Effect on soil microbial population

The microbial populations (Table 2) *viz*., *Rhizobium* and PSB were found significant by different organic sources. Significantly the higher *Rhizobium* (242.20 CFU × 10^4/g soil) and PSB (272.88 CFU × 10^4/g soil) count were recorded in treatment T_9 (2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB), respectively being at par with T_4, T_5, T_6, T_7 and T_8. Increasing microbial population of soil is attributed to the synergistic effect due to application of *Rhizobium* and PSB was observed as increased microbial population in soil. The soil application of *Rhizobium* and PSB enhanced microbial activity in the rhizosphere and the known and unknown constituent of *Rhizobium* and PSB might have influenced the rhizosphere through altered root exudation and

extension. These findings are in agreement with reported by Ashif *et al.* (2009) [4] and Gupta and Yadav (2009) [6].

3.4 Effect on economics

3.4.1 Economics

Economics was worked out from the seed and stover yields of clusterbean by taking into account the prevailing market selling prices. The data on economics of different treatments are presented in Table 3. A perusal of data revealed that the highest gross realization (₹62,628/ha) was incurred under treatment T_9 (2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB). The next better treatment in view of gross realization (₹ 61,775/ha) was T_6 (2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium). Highest net realization (₹ 36,463/ha) was incurred under treatment T_9 (2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB) with the benefit: cost ratio (BCR) value of 2.39.The results are well supported with those reported by Jatav *et al.* (2016) [7], Asha *et al.* (2017) [3], Anuradha *et al.* (2017) [1].

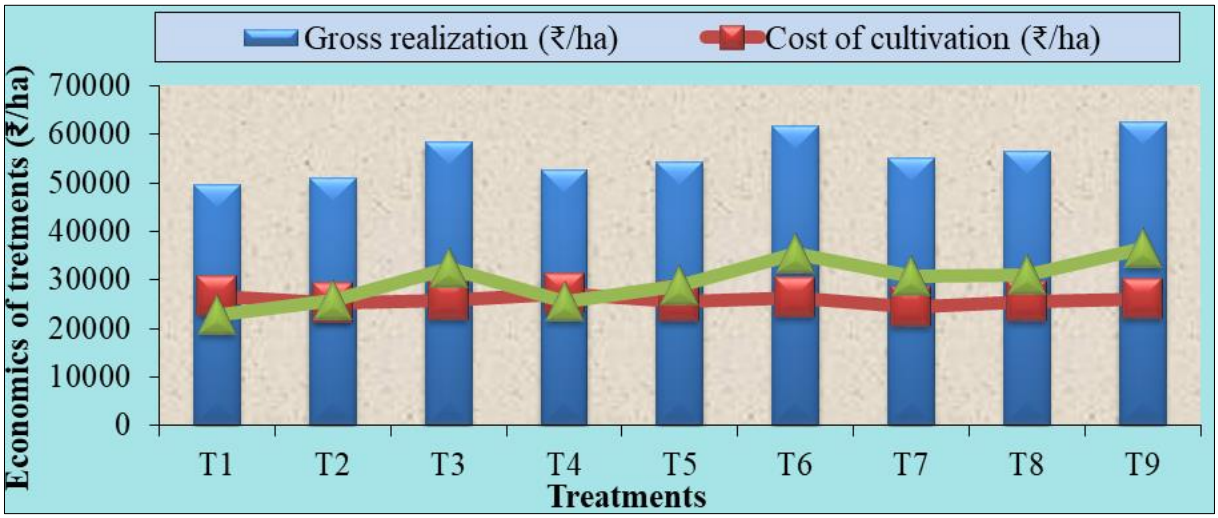

Fig 1: Economics of summer clusterbean as influenced by different organic sources

Table 1: Effect of different organic sources on quality parameters and nutrient uptake of summer clusterbean

Treatments	Total uptake (kg/ha)		Protein content (%)	Protein yield (kg/ha)
	Nitrogen	Phosphorus		
T_1: 5.0 t/ha FYM	50.34	5.45	21.87	160.30
T_2: 1.0 t/ha castor cake	56.15	5.67	22.75	167.00
T_3: 2.5 t/ha FYM + 0.5 t/ha castor cake	67.49	6.84	25.32	211.93
T_4: 5.0 t/ha FYM + NPK consortium	57.52	5.76	23.37	175.17
T_5: 1.0 t/ha castor cake + NPK consortium	58.17	5.98	24.01	185.27
T_6: 2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium	68.48	6.93	26.32	233.60
T_7: 5.0 t/ha FYM + *Rhizobium* + PSB	62.11	6.34	24.19	188.17
T_8: 1.0 t/ha castor cake + *Rhizobium* + PSB	63.64	6.92	24.99	195.30
T_9: 2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB	68.89	6.98	26.73	239.10
S.Em.±	1.62	0.17	0.99	9.01
C.D. (P = 0.05)	4.86	0.53	2.99	26.99
C.V.%	4.57	4.88	7.08	7.99

Table 2: Effect of different organic sources on soil microbial population of clusterbean

Treatments	Microbial population (CFU × 10^4/g soil)	
	Rhizobium	PSB
T_1: 5.0 t/ha FYM	192.00	220.10
T_2: 1.0 t/ha castor cake	198.22	228.20
T_3: 2.5 t/ha FYM + 0.5 t/ha castor cake	206.10	236.46
T_4: 5.0 t/ha FYM + NPK consortium	232.18	260.20
T_5: 1.0 t/ha castor cake + NPK consortium	238.46	265.00
T_6: 2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium	241.88	272.32
T_7: 5.0 t/ha FYM + *Rhizobium* + PSB	220.52	244.00
T_8: 1.0 t/ha castor cake + *Rhizobium* + PSB	228.32	252.66
T_9: 2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB	242.20	272.88
S.Em.±	10.72	11.75
C.D. (P = 0.05)	32.14	35.24
C.V.%	8.36	8.13

Table 3: Economics of clusterbean as influenced by different organic sources

Treatments	Gross returns (₹/ha	Total cost of cultivation (₹/ha)	Net returns (₹/ha)	B:C ratio
T_1: 5.0 t/ha FYM	49545	26675	22870	1.85
T_2: 1.0 t/ha castor cake	51023	25175	25848	2.02
T_3: 2.5 t/ha FYM + 0.5 t/ha castor cake	58375	25925	32450	2.25
T_4: 5.0 t/ha FYM + NPK consortium	52684	27075	25609	1.94
T_5: 1.0 t/ha castor cake + NPK consortium	54335	25575	28760	2.09
T_6: 2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium	61775	26325	35450	2.34
T_7: 5.0 t/ha FYM + *Rhizobium* + PSB	55051	24415	30636	2.25
T_8: 1.0 t/ha castor cake + *Rhizobium* + PSB	56360	25415	30945	2.21
T_9: 2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB	62628	26165	36463	2.39

Conclusion

From the results of one year experimentation, it is concluded that summer clusterbean should be fertilized with 2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB OR 2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium for obtaining higher seed yield and maintaining soil health under North Gujarat Agro-climatic condition.

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