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Effect of organic sources on growth, yield attributes and yield 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 "Effect of organic sources on growth, yield attributes and yield of summer clusterbean 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 plant height at 60 DAS and at harvest, Number of nodules per plant and dry weight of nodules per plant, number of pods per plant, seed yield per plant and seed index were recorded under treatment T_9 Which was found at par with T_6. In the case of Plant population at 30 DAS and at harvest, plant height at 30 DAS, Days to 50% flowering, Pod length, Number of seeds per pod treatments did not affected significantly. Significantly, higher seed yield (901 kg/ha) and stover yield (2709 kg/ha) were achieved with application of 2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB (T_9) which remained at par with treatment T_6.

Keywords: Clusterbean, NPK consortium, *Rhizobium* + PSB, Seed and Stover yield

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) [5]. 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) [1].

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 growth attributes

The data indicated that the plant population per net plot at 30 DAS and at harvest and days to 50% flowering were not significantly influenced due to different treatments which indicated that no effect of different organic sources of nutrients were observed on germination of clusterbean as well as on survival of clusterbean plants.

3.1.1 Plant height

The data indicated that plant height at 30 DAS was not significantly influenced by different organic sources, but significantly higher plant height of 77.20 cm at 60 DAS was recorded with treatment T_9 (2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB), which was remained at par with T_3 (2.5 t/ha FYM + 0.5 t/ha castor cake), 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) and T_8 (1.0 t/ha castor cake + *Rhizobium* + PSB) having 73.07, 68.70, 76.30, 70.03 and 71.40 cm plant height, respectively. Treatment T_1 (5 t/ha FYM) measured the lower plant height at 60 DAS (59.30 cm) which was at par with T_2 (1.0 t/ha castor cake) and T_4 (5.0 t/ha FYM + NPK consortium) having 63.73 and 65.60 cm plant height, respectively. These results are in accordance with the findings of Chaudhary (2008) [3], Singh *et al.* (2014) [17] reported that application of castor cake and *Rhizobium* + PSB solution recorded significantly higher plant height of summer clusterbean.

3.1.2 Number of nodules per plant

The mean data presented in Table 1 indicated that different organic sources significantly influenced the number of nodules per plant. Significantly higher number of nodules per plant (20.97) 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 treatments T_3 (2.5 t/ha FYM + 0.5 t/ha castor cake), 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) and T_8 (1.0 t/ha castor cake + *Rhizobium* + PSB) registered 19.93, 18.67, 20.37, 19.07 and 19.30 number of root nodules per plant, respectively. Minimum number of nodules per plant was observed with treatment T_1 (16.38); (5.0 t/ha FYM). These results are in accordance with the findings of Mishra (2003), Kumhar *et al.* (2012) [6], Lakshmipathy *et al.* (2017) [7], Patel *et al.* (2018) [13], Sharma *et al.* (2019) [16], Brahmbhatt *et al.* (2021) [2], reported that use of *Rhizobium* + PSB recorded higher number of root nodules per plant.

3.1.3 Dry weight of nodules per plant

The mean data presented in Table 1 indicated that different organic sources significantly influenced the dry weight of nodules per plant at harvest. Significantly higher number of dry weight of nodules per plant per plant at harvest (28.77 mg) 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 treatments T_3 (2.5 t/ha FYM + 0.5 t/ha castor cake), 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) and T_8 (1.0 t/ha castor cake + *Rhizobium* + PSB) having 27.50, 25.13, 28.23, 26.17 and 27.00 mg dry weight of nodules per plant, respectively. This might be due to use of *Rhizobium* + PSB bio fertilizer. These results are in accordance with the findings of Mishra (2003), Sharma *et al.* (2019) [16], Yadav *et al.* (2019) [16] observed that use of *Rhizobium* + PSB recorded higher dry weight of root nodules per plant. PSB (phosphate solubilizing bacteria) convert fix phosphorous in available form for plant, which is very essential during early growth stage of crop, and for root establishment. More absorption of nutrients including micronutrients favored in increasing total dry weight of nodule per plant (g) at harvest. These findings match with the findings of Mathivanan *et al.* (2014) [8], Singh *et al.* (2014) [17] and Patil and Udmale (2016) [14].

3.2 Effect on yield attributes and yield

The mean data presented in Table 2 revealed that number of seed per pod, pod length, was not affected significantly due to different organic sources. Eventhough numerically maximum values were found with application of 2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB.

3.2.1 Pods per plant

The mean data presented in Table 2 indicated that different organic sources significantly influenced the number of pods per plant. Significantly higher number of pods per plant

(37.37) 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 treatments 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), T_7 (5.0 t/ha FYM + *Rhizobium* + PSB) and T_8 (1.0 t/ha castor cake + *Rhizobium* + PSB) having 35.10, 37.03, 32.53 and 34.43 number of pods per plant respectively. Minimum number of pods per plant was observed with treatment T_1 (28.77); (5.0 t/ha FYM) which remained statistically at par with treatments T_2 (1.0 t/ha castor cake), T_4 (5.0 t/ha FYM + NPK consortium) and T_5 (1.0 t/ha castor cake + NPK consortium) having 30.37, 31.07 and 31.77 respectively. These results are in accordance with the findings of Singh and Kumar (2016), Patel *et al.* (2018) [13], Sharma *et al.* (2019) [16] reported that use of FYM, castor cake and *Rhizobium* + PSB recorded higher number of pods per plant.

3.2.2 Seed yield per plant

The mean data presented in Table 2 indicated that different organic sources significantly influenced the seed yield per plant. Significantly higher seed yield per plant (5.09 g) 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), T_7 (5.0 t/ha FYM + *Rhizobium* + PSB) and T_8 (1.0 t/ha castor cake + *Rhizobium* + PSB) registered 5.02, 4.46, 4.58 g seed yield per plant respectively. Minimum seed yield per plant was observed with treatment T_1 (5.0 t/ha FYM) having (4.01 g) which remained statistically at par with treatments T_2 (1.0 t/ha castor cake), T_4 (5.0 t/ha FYM + NPK consortium) and T_5 (1.0 t/ha castor cake + NPK consortium) having 4.13, 4.29 and 4.41 g, respectively. This result is in conformity with the findings Patel *et al.* (2018) [13] and Brahmbhatt *et al.* (2021) [2].

3.2.3. Seed index

An appraisal of data (Table 2) revealed that significantly higher seed index (4.73 g) was pronounced under treatment T_9 (2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB) which remained statistically at par with treatment 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) having corresponding values of (4.30 and 4.53 g) seed index, respectively. Minimum of seed index was observed with treatment T_1 (5.0 t/ha FYM) having (3.07 g). Results match with findings of Kumhar *et al.* (2012) [6], Mathivanan *et al.* (2014) [8] and Mavarkar *et al.* (2016) [9].

3.2.4. Seed yield

The mean data presented in Table 4.9 indicated that different organic sources significantly influenced the seed yield. Significantly higher seed yield (901 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_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), T_8 (1.0 t/ha castor cake + *Rhizobium* + PSB) having 840 kg/ha, 889 kg/ha, 811 kg/ha. Minimum of seed yield was observed with treatment T_1 (5.0 t/ha FYM) having (714 kg/ha) which remained statistically at par with treatments T_2 (1.0 t/ha castor cake), T_4 (5.0 t/ha FYM + NPK consortium) and T_5 (1.0 t/ha castor cake + NPK consortium). Seed yield was significantly higher with treatment T_9 might be due to the fact that combined application of organic manure and biofertilizer must have a produced excess of assimilates which are first stored in leaves and later translocated into seeds at the time of senescence, which might have ultimately led to higher seed yield. These results are in agreement with Patel *et al.* (2010), Chaudhari *et al.* (2018), Patel *et al.* (2018) [13], and Brahmbhatt *et al.* (2021) [2].

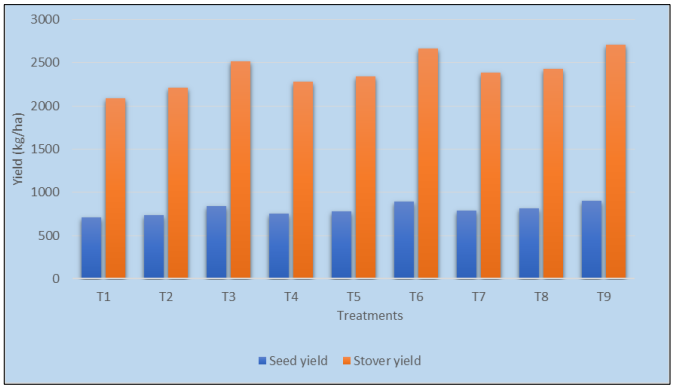

Fig 1: Seed and stover yield of summer clusterbean as influenced by different organic sources

3.2.5 Stover yield

An appraisal of data (Table 2) revealed that significantly higher stover yield (2709 kg/ha) was pronounced under treatment T_9 (2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB) which remained statistically at par with treatment 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), T_7 (5.0 t/ha FYM + *Rhizobium* + PSB) and T_8 (1.0 t/ha castor cake + *Rhizobium* + PSB) having 2517, 2660, 2381 and 2430 kg/ha stover yield, respectively. Minimum of stover yield was observed with treatment T_1 (5.0 t/ha FYM) having (2090 kg/ha). The higher stover yield under these treatments might be due to higher amount of atmospheric nitrogen fixation in soil with the use of *Rhizobium* coupled with FYM increase the availability of nitrogen and thereby increase the growth and development of plant leading to more transfer accumulation from source to sink. The trend of increases in stover yield obtained due to these treatments was exactly in accordance with the similar increases in the vegetative growth. The increases in yield-attributing characters and consequently the stover of summer clusterbean. These results are in close vicinity with the findings of Prajapati *et al.* (2017) [15].

Table 1: Effect of different organic sources on growth parameters of summer clusterbean

Treatments	Plant population (per metre row length)		Plant height (cm)			Days to 50% flowering	Number of nodules per plant	Dry weight of nodules per plant (mg)
	30 DAS	At harvest	30 DAS	60 DAS	At harvest			
T_1: 5.0 t/ha FYM	9.30	8.00	17.60	59.30	69.07	48.00	16.38	21.67
T_2: 1.0 t/ha castor cake	9.12	8.20	17.77	63.73	71.97	49.33	17.37	22.90
T_3: 2.5 t/ha FYM + 0.5 t/ha castor cake	9.60	8.83	18.37	73.07	86.87	52.67	19.93	27.50
T_4: 5.0 t/ha FYM + NPK consortium	8.84	8.67	17.13	65.60	75.33	50.67	18.30	24.27
T_5: 1.0 t/ha castor cake + NPK consortium	9.00	8.80	17.27	68.70	78.03	51.00	18.67	25.13
T_6: 2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium	9.33	8.87	19.00	76.30	89.03	53.33	20.37	28.23
T_7: 5.0 t/ha FYM + *Rhizobium* + PSB	8.98	8.60	17.17	70.03	82.80	52.33	19.07	26.17
T_8: 1.0 t/ha castor cake + *Rhizobium* + PSB	9.41	8.47	18.00	71.40	84.07	52.67	19.30	27.00
T_9: 2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB	9.68	8.90	19.90	77.20	89.83	54.67	20.97	28.77
S.Em.±	0.45	0.37	0.84	3.226	3.600	2.36	0.88	1.35
C.D. (P = 0.05)	NS	NS	NS	9.67	10.79	NS	2.60	4.01
C.V.%	8.38	7.48	8.04	8.04	7.72	7.91	8.05	9.10

Table 2: Effect of different organic sources on yield attributes and yield of summer clusterbean

Treatments	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Seed yield per plant (g)	Seed index (g)	Seed yield (kg/ha)	Stover yield (kg/ha)
T_1: 5.0 t/ha FYM	28.77	6.79	6.47	4.01	3.07	714	2090
T_2: 1.0 t/ha castor cake	30.37	6.84	6.56	4.13	3.21	734	2209
T_3: 2.5 t/ha FYM + 0.5 t/ha castor cake	35.10	7.37	7.64	4.75	4.30	840	2517
T_4: 5.0 t/ha FYM + NPK consortium	31.07	6.92	6.63	4.29	3.40	758	2276
T_5: 1.0 t/ha castor cake + NPK consortium	31.77	7.02	6.83	4.41	3.60	782	2337
T_6: 2.5 t/ha FYM + 0.5 t/ha castor cake + NPK consortium	37.03	7.87	7.80	5.02	4.53	889	2660
T_7: 5.0 t/ha FYM + *Rhizobium* + PSB	32.53	7.07	7.03	4.46	3.87	792	2381
T_8: 1.0 t/ha castor cake + *Rhizobium* + PSB	34.43	7.20	7.27	4.58	4.07	811	2430
T_9: 2.5 t/ha FYM + 0.5 t/ha castor cake + *Rhizobium* + PSB	37.37	8.02	7.90	5.09	4.73	901	2709
S.Em.±	1.71	0.32	0.35	0.22	0.25	35.84	114.39
C.D. (P = 0.05)	5.12	NS	NS	0.65	0.77	107.47	342.96
C.V.%	8.93	7.76	8.50	8.42	11.52	7.74	8.25

4. 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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