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EFFECT OF LIQUID ORGANIC FORMULATIONS ON GROWTH, YIELD, NUTRIENT UPTAKE AND QUALITY OF CLUSTER BEAN (*Cymopsis tetragonaloba* L.)

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ABSTRACT

An experiment was conducted during year of 2023-24 at A.R.S. Sriganganagar, to study "Effect of organic-formulations on growth and quality of cluster bean (*Cymopsis tetragonoloba* L.)." The experiment was carried out in randomized block design with three replications and eleven treatments comprised of control, cow urine @ 10% at 30 DAS, cow urine @ 10% at 30 and 45 DAS, panchgavya @ 5% at 30 DAS, panchgavya @ 5% at 30 and 45 DAS, jeevamrut @ 10% at 30 DAS, jeevamrut @ 10% at 30 and 45 DAS, humic acid @ 10% at 30 DAS, humic acid @ 10% at 30 and 45 DAS, vermiwash @ 10% at 30 DAS and vermiwash @ 10% at 30 and 45 DAS. The results revealed that application of Panchagavya @ 5% at 30 and 45 DAS significantly increased the growth and yield attributes, quality parameters and economics of cluster bean *viz.* plant height, dry matter accumulation, number of branches/plant, crop growth rate and relative growth rate, leaf area index, number of cluster/plant, number of pods/cluster, seed yield (1485 kg/ha), straw yield (3538 kg/ha), biological yield (5023 kg/ha) and nitrogen, phosphorus and potassium content, and total uptake by seed and straw, protein content, gross returns (Rs 91195/ha^{-1}), net returns of (Rs 66225/ha^{-1}) and B:C ratio (3.65).

Key words: Cluster bean, Organic-formulations, Panchagavya, Jeevamrut, Growth, Yield and Economics,

Introduction

Cluster bean is a hardy and drought tolerant crop, which is especially suited for soil and climatic condition of Rajasthan. This crop is a rich source of nutrients and has been considered as protective supplementary food as it contains large quantities of minerals, vitamins and essential amino acids. The important minerals like calcium, phosphorous and iron, which are generally lacking in cereals while these are available in abundant quantities in this legume. The natural polysaccharide water-soluble polymer found in the endosperm and galactomannan gum, is the chief product used in many industries (Bhatt *et al*., 2015). Cluster bean cultivars with high gum content (>32%) is more preferred for export. Due to diversified uses of cluster bean gum in textile, paper, explosive and mining industries, pharmaceuticals, cosmetic goods and food stuffs, it has ever increasing demand in the international market. It can fix atmospheric nitrogen up to 37-196 kg ha^{-1} year^{-1} in soil. Sometimes, it is used in reclamation of saline and alkaline soils (Mahata *et al*., 2009). From India, cluster bean is mainly exported to USA, Germany, Netherlands, UK and Japan. It is cultivated mainly in Rajasthan, Gujarat, Punjab, Haryana, Uttar Pradesh and Maharashtra states and occupies an

area of 3.46 million ha with total production 2.91 million tonnes and productivity of 378 kg/ ha. In Rajasthan, cluster bean area, production and productivity is 2.39 lakh hectares, 1.9 lakh tonnes and 419 kg ha^{-1}, respectively (Rajasthan Agricultural Statistics at a Glance, 2021-22). In Sriganganagar district, it occupies 0.266 million ha cultivated area with 1.03 lakh tonnes production and productivity around 659 kg/ha. (Rajasthan Agricultural Statistics at a Glance, 2021-22).

Organic agriculture is now becoming the mainstream all over the world. During the last two decades, there has been a significant sensitization of the global community to looking into to environmental conservation and safe food. Among different organic liquid formulations, cow urine is a unique product of dairy which has huge property such as manure, antimicrobial agent, and disinfectant. It contains 95% water, 2.5% urea and remaining 2.5% contains minerals, salts, hormones and enzymes. Application of cow urine as liquid manure has been reported to have a favorable impact for enhancing productivity of different crops viz., mustard, maize, rice, etc. (Pradhan *et al*., 2018). Panchgavya and jeevamrut are other low cost and eco-friendly organic preparations made by cow products namely dung, urine, milk, curd and ghee. The panchgavya is an efficient plant growth stimulant that enhances the biological efficiency of crops while jeevamrut promotes immense biological activity in soil and makes the nutrients available to crop (Patel *et al*., 2021). Humic acid have lot of direct and indirect effects on plant growth like increasing photosynthesis, protein synthesis, nutrient availability, chelation of metal cations, improving soil structure, water holding capacity and cation exchange capacity of soil, therefore foliar application of humic acid reduces the nitrogen applications to the soil (Pettit, 2004).

Materials and Methods

The experiment was laid out at research farm of Agricultural Research Station, Sriganganagar, under Swami Keshwanand Rajasthan Agricultural University, Bikaner during *Kharif* season of 2022. According to "Agro-ecological region map" brought out by National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), Sriganganagar falls under Agro-ecological region No. 2 (M9E1) under Arid ecosystem (Hot Arid Eco-region), which is characterized by deep, sandy and coarse loamy, desert soils with low water holding capacity and hot arid climate. Annual PET in this region ranges between 1500-2000 mm. As per NARP classification of agro-climatic zones, Sriganganagar falls in Agro-climatic zone I b (Irrigated North Western Plain Zone). According to national Planning commission, Sriganganagar falls under Agro-climatic zone VI (Trans Gangetic Plains Zone) of India. The average annual rainfall is 326 mm, most of which is received through south-west monsoon during the period from June to September. During the crop growing season, the maximum and minimum temperature ranges lies between 30.14 to 40.57°C and 18.34 to 28.61°C, respectively. While, the minimum and maximum relative humidity ranges between 48.71 to 73.86 % and 44.71 to 84.29%, respectively. The soil of the experimental field was loamy sand in texture and slightly alkaline in reaction (pH 8.1), poor in organic carbon (0.19 %), low in available nitrogen (125.4 kg ha^{-1}) but medium in available phosphorus (33.5 kg ha^{-1}), potassium (333 kg ha^{-1}). HG 2-20' cultivar was sowed at spacing of…. with 12-15kg/ha seed rate. The experiment was carried out in randomized block design with three replications and eleven treatments *i.e.* Control, Cow urine @ 10% at 30 DAS, Cow urine @ 10% at 30 and 45 DAS, Panchgavya @ 5% at 30 DAS, Panchgavya @ 5% at 30 and 45 DAS, Jeevamrut @ 10% at 30 DAS, Jeevamrut @ 10% at 30 and 45 DAS, Humic acid @ 10% at 30 DAS, Humic acid @ 10% at 30 and 45 DAS, Vermiwash @ 10% at 30 DAS and Vermiwash @ 10% at 30 and 45 DAS.

Observations of different growth attributes was taken at different growth stages (30, 60, 90 DAS and at harvest) in crop. Estimation of nitrogen was done by colorimetric method using spectrophotometer after development of colour with Nessler's reagent (Snell and Snell, 1949). Nitrogen was calculated and expressed as percentage. Phosphorus content was estimated by digesting plant samples with tri-acid mixture (Vanadomolybdete phosphoric yellow colour method, Jackson, 1973) and expressed as percentage. Potassium content was estimated by digesting plant samples with tri-acid mixture and was determined by suitable aliquot of digested material with the help of flame photometer (Jackson, 1973)

The uptake of N, P and K by seed and straw was estimated by using the following formula:

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content in seed (\%)} \times \text{Seed yield (kg ha}^{-1}\text{)} + \text{Nutrient content in stover (\%)} \times \text{Stover yield (kg ha}^{-1}\text{)}}{100}$$

Protein per cent in seed was calculated by multiplying nitrogen concentration (per cent) in seed by a factor of 6.25 (A.O.A.C., 1960). Protein content in seed was estimated by using following expression.

$$\text{Protein content (\%)} = \text{N content in seed (\%)} \times 6.25$$

$$\text{Protein yield} = \frac{\text{Protein content (\%)} \times \text{Seed yield kg ha}^{-1}}{100}$$

Table 1: Effect of liquid organic formulations on plant height and DMA at 60 DAS and at harvest of cluster bean.

Treatment	Plant height (cm)		Dry matter accumulation (g/plant)	
	60 DAS	At harvest	60 DAS	At harvest
O_0	56.3	86.7	11.2	32.0
O_1	61.8	106.6	12.5	35.1
O_2	66.2	109.0	14.3	41.5
O_3	66.7	113.9	12.6	37.8
O_4	68.7	114.5	15.5	42.9
O_5	60.3	101.5	11.8	35.6
O_6	61.4	105.1	13.8	38.8
O_7	55.9	104.0	11.0	33.2
O_8	57.7	108.5	12.9	36.3
O_9	61.2	103.7	11.3	33.4
O_{10}	63.6	111.8	13.9	40.4
S.Em.±	1.1	5.0	0.39	1.09
C.D (P=0.05)	3.4	14.7	1.15	3.23
CV%				

O_0: Control; O_1: Cow urine @ 10% at 30DAS; O_2: Cow urine @ 10% at 30 and 45 DAS; O_3: Panchgavya @ 5% at 30DAS; O_4: Panchgavya @ 5% at 30 and 45 DAS; O_5: Jeevamrut @ 10% at 30 DAS; O_6: Jeevamrut @ 10% at 30 and 45 DAS; O_7: Humic acid @ 10% at 30 DAS; O_8: Humic acid @ 10% at 30 and 45 DAS; O_9: Vermiwash @ 10% at 30DAS; O_{10}: Vermiwash @ 10% at 30 and 45 DAS

Table 2: Effect of liquid organic formulations on leaf area index and branches per plant of cluster bean.

Treatment	Leaf area index		Branches /plant
	At 60 DAS	At 60 DAS	
O_0	3.5	4.1	5.3
O_1	3.9	4.6	5.6
O_2	4.1	4.8	6.1
O_3	4.1	4.8	5.8
O_4	4.2	4.9	6.1
O_5	3.9	4.5	5.4
O_6	3.9	4.6	5.6
O_7	3.7	4.3	5.4
O_8	3.8	4.4	5.6
O_9	3.9	4.6	5.9
O_{10}	4.0	4.6	6.0
S.Em.±	0.06	0.07	0.18
C.D (P=0.05)	0.17	0.20	0.52
CV%			

O_0: Control; O_1: Cow urine @ 10% at 30DAS; O_2: Cow urine @ 10% at 30 and 45 DAS; O_3: Panchgavya @ 5% at 30DAS; O_4: Panchgavya @ 5% at 30 and 45 DAS; O_5: Jeevamrut @ 10% at 30 DAS; O_6: Jeevamrut @ 10% at 30 and 45 DAS; O_7: Humic acid @ 10% at 30 DAS; O_8: Humic acid @ 10% at 30 and 45 DAS; O_9: Vermiwash @ 10% at 30DAS; O_{10}: Vermiwash @ 10% at 30 and 45 DAS

Results and Discussion

Growth parameters

The assessment of data (Table 1) indicates that maximum plant height (66.4 cm) recorded under treatment O_4 and was significantly higher than other treatments *viz.* O_0, O_1, O_5, O_6, O_7, O_8, O_9 and O_{10} and at 60 DAS by 21.90, 11.10, 14.00, 11.90, 22.80, 19.10, 12.20 and 8.04 percent. Whereas treatment O_4 found at par with treatment O_2 and O_3. However, plant height at 90 DAS and at harvest recorded superior over control by 32.80 & 32.09 percent respectively and found at par with remaining treatment, While dry matter accumulation was found maximum in treatment O_4 which was found superior over O_0, O_1, O_3, O_5, O_6, O_7, O_8, O_9 and O_{10} by 38.1, 24.3, 22.7, 31.1, 11.9, 40.9, 19.9, 37.5 and 11.3 percent and it found at par with O_2 at 60 DAS. However, at 90 DAS and harvest stage treatment O_4 found significantly superior over O_0, O_1, O_3, O_5, O_6, O_7, O_8 and O_9 by 29.9, 17.8, 16.5, 20.3, 11.2, 31.5, 19.4 and 30.5 percent and 31.1, 22.4, 13.5, 20.5, 10.6, 29.4, 18.2 and 28.4 percent. The increased plant growth in terms of plant height, dry matter accumulation of cluster bean with application of liquid organic formulation through foliar sprays might be due to the better availability of nutrients at the site of photosynthesis. Organics as panchagavya 71 and jeevamrut, possessed good amount of nutrients enriched with beneficial microorganism and growth promoting substances along with other enzymes (Gore and Sreenivasa, 2011). This might have created favorable environment in leaves and has resulted in better growth of plants which reflected in higher plant height, increased dry matter accumulation. The examination of data (Table 2) shows that maximum leaf area Index was recorded by treatment O_4 and become significantly superior over other treatment like O_0, O_1, O_5, O_6, O_7, O_8, O_9 and O_{10} by 21.3, 7.5, 8.1, 7.3, 13.8, 10.7, 7.7 and 5.9 percent at 60 DAS and 21, 7.4, 8, 7.2, 13.8, 10.6, 7.6 and 5.8 percent at 90 DAS. However, treatment O_4 found at par with treatment O_2 and O_3 at both stages. Also, treatment O_4 recorded maximum (8.52) branches per plant which was significantly superior by 14.5, 13.8 and 12.5 percent over treatment O_0, O_5 and O_7 respectively. Along with FYM, foliar application of panchagavya also contains essential plant nutrient such as nitrogen, which helps plant to produce more number of leaves and turns into higher LAI which increased availability of essential nutrients at both soil and foliage which helps plant to do more photosynthesis and cause rapid growth over rest of the treatments.Similar results were also observed in black gram by Suresh *et al*., (2011), in chickpea by Patil *et al*., (2012) and in cowpea by Patel *et al*., (2013).

Table 3: Effect of organic formulations on test weight, seed yield, straw yield, biological yield and harvest index of cluster bean.

Treatment	Seed yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
O_1	1059	2542	3601	29.5
O_2	1156	2954	4110	28.2
O_3	1259	3271	4530	27.8
O_4	1375	3045	4420	31.2
O_5	1485	3538	5023	29.6
O_6	1098	3069	4167	26.4
O_7	1136	3234	4370	26.0
O_8	1091	2758	3849	28.4
O_9	1173	2912	4084	28.7
O_{10}	1114	3144	4258	26.2
S.Em±	1217	3335	4552	26.7
C.D (P=0.05)	32.4	94.9	101.1	0.8
CV%	95.5	280.1	298.2	2.5

O_0: Control; O_1: Cow urine @ 10% at 30DAS; O_2: Cow urine @ 10% at 30 and 45 DAS; O_3: Panchgavya @ 5% at 30DAS; O_4: Panchgavya @ 5% at 30 and 45 DAS; O_5: Jeevamrut @ 10% at 30 DAS; O_6: Jeevamrut @ 10% at 30 and 45 DAS; O_7: Humic acid @ 10% at 30 DAS; O_8: Humic acid @ 10% at 30 and 45 DAS; O_9: Vermiwash @ 10% at 30DAS; O_{10}: Vermiwash @ 10% at 30 and 45 DAS

Yield parameters

In Table 3 showed that application of liquid organic formulations found to have significant favorable effect on seed and straw yield of cluster bean. Foliar application of treatment O4 significantly increase the seed yield over treatment O_0, O_1, O_2, O_3, O_5, O_6, O_7, O_8, O_9 and O_{10} by 40.2, 28.4, 17.9, 8.0, 35.3, 30.8, 36.1, 26.6, 33.3 and 22.1 percent respectively. Treatment O_4 recorded highest straw yield in comparison to treatment O_0, O_1, O_3, O_5, O_7, O_8 and O9 by 39.2, 19.8, 16.2, 15.3, 9.4, 28.3, 21.5 and 12.5 percent and found at par with treatment O_2 and O_{10}. Data (Table 3) shows that grain yield (1485 kg/ha), straw yield (3538 kg/ha) and biological yield (5023 kg/ha) was recorded significantly higher by O_4 treatment over rest all treatments. Since grain yield is a cumulative effect of yield attributes and correlated with cluster/plant (r = 0.814), pod/plant (r = 0.662), seed/pod (r = 0.708), pod length (r = 0.808) and test weight (r = 0.755). Thus significantly improvement in yield attributes like cluster/plant, pod/cluster, seed/pod and pod length due to above treatment led to increased grain yield. The present trend of increase in seed yield with application of organic formulations is in close conformity with the findings of Shariff *et al*., (2017) in green gram. Straw yield also increased significantly. It might be due to its direct and positive influence on plant height and DMA as discussed in preceding paragraphs. Straw yield (Table 3) is strongly correlated with DMA at harvest (r = 0.873). This was further substantiated by regression analysis wherein a unit increase in DMA at harvest increases straw yield 67.56 kg/ha. Whenever liquid manures are applied at regular intervals (1-2 times), they act as a stimulating agent in the plant system and in turn, increase the production of growth regulators in cell system. Further data (table 3) revealed that foliar application of treatment O_4 recorded maximum biological yield and found significantly superior over treatment O_0, O_1, O_2, O_3, O_5, O_6, O_7, O_8, O_9 and O_{10} by 39.5, 22.2, 10.9, 13.6, 20.5, 14.9, 30.5, 23.0, 18.0 and 10.3 percent respectively. From Table 3 it seems to be clear that there is significant variation observed in harvest index and treatment O_3 found significant superior over treatment O_5, O_6, O_9 and O_{10}, by 18.2, 20, 18.8, and 16.7 percent. It was also found at par with treatment O_0, O_1, O_2, O_4, O_7 and O_8 respectively. Biological yield and harvest index (Table 3) have direct correlation with grain and straw yield. The results of the present study are in close agreement with those of in cowpea by Patel *et al*., (2013) who also reported improvement in straw yield due to application of organics and fertilizers.

Nutrient content and uptake

Data presented in Table 4 clearly showed treatment O_3 were found to improve the nitrogen content in seed over treatment O_0 by 15.5 percent and found at par with rest of the treatments. Data further reveal that foliar application of treatment O_3 found significant superior and increased nitrogen content in straw by 6.9, 4.3, 3.5, 3.6, 4.6 and 3.8 percent over treatment O_0, O_1, O_3, O_7, O_9 and O_{10} and found at par with treatment O_2, O_4, O_5, O_6 and O_8 respectively. Phosphorus content by the application of treatment O_4 found significantly superior over treatment O_0 (control) by 42.7 and 63.64 percent in both seed & straw. However, it found at par with the rest of treatment respectively. Potassium content in seed improved by application of treatment O_4 by 15.1 percent over treatment O_0 and found at par with rest of the treatment. In straw also treatment O_4 found superior over O_0, O_5 and O_9 by 5.4, 2.4 and 2.4 percent and found at par with treatment O_1, O_2, O_3, O_6, O_7, O_8 and O_{10} respectively. The positive influence of panchgavya @ 5% at 30 DAS treatment on nitrogen and panchgavya @ 5% at 30 and 45 DAS on phosphorus and potassium contents in crop appears due to effective utilization of nutrients by photosynthesis system. Increased availability of these nutrients is also due to well-developed root system which leads to absorption of more and more nutrients

Table 4: Effect of organic formulation on protein and nutrient content in grain and straw of cluster bean.

Treatment	N content (%)		P content (%)		K content (%)		Protein content (%)
	Seed	Straw	Seed	Straw	Seed	Straw	
(O_0) Control	3.22	1.07	0.24	0.11	0.73	1.10	20.75
(O_1) Cow urine @ 10% at 30DAS	3.60	1.09	0.32	0.14	0.81	1.14	22.48
(O_2) Cow urine @ 10% at 30 and 45 DAS	3.67	1.11	0.33	0.15	0.79	1.14	22.94
(O_3) Panchgavya @ 5% at 30DAS	3.62	1.10	0.33	0.17	0.83	1.14	22.60
(O_4) Panchgavya @ 5% at 30 and 45 DAS	3.68	1.12	0.35	0.18	0.84	1.16	22.98
(O_5) Jeevamrut @ 10% at 30 DAS	3.66	1.13	0.32	0.14	0.81	1.13	22.88
(O_6) Jeevamrut @ 10% at 30 and 45 DAS	3.72	1.14	0.33	0.16	0.82	1.14	23.25
(O_7) Humic acid @ 10% at 30 DAS	3.61	1.10	0.31	0.138	0.79	1.14	22.56
(O_8) Humic acid @ 10% at 30 and 45 DAS	3.67	1.11	0.32	0.151	0.81	1.137	22.94
(O_9) Vermiwash @ 10% at 30DAS	3.63	1.09	0.31	0.138	0.80	1.133	22.69
(O_{10}) Vermiwash @ 10% at 30 and 45 DAS	3.69	1.098	0.32	0.153	0.83	1.140	23.06
S.Em.±	0.09	0.01	0.02	0.01	0.02	0.01	0.55
C.D (P=0.05)	0.26	0.03	0.05	0.03	0.06	0.02	1.62
CV%							

from soil as compared to control. Significant improvement in nutrient contents and their uptake due to application of organics and fertilizers were also observed by Gore and Sreenivasa, (2011) and Patel *et al*., (2012). Table 5 reveals thatthe nitrogen uptake by seeds & straw was recorded maximum under the application of treatment O_4 significantly Increase nitrogen uptake to the tune of 53.8, 27.3, 14.1, 13.0, 25.9, 19.0, 35.0, 24.8, 25.8 and 15.5 percent over treatment O_0, O_1, O_2, O_3, O_5, O_6, O_7, O_8, O_9 and O_{10} respectively. Phosphorus uptake was increased by foliar application of O_4 treatment and it found significantly superior over O_0 (Control), O_1, O_2, O_3, O_5, O_6, O_7, O_8, O_9 and O_{10} by 113.2, 44.3, 26.7, 16.7, 43.9, 26.2, 57.8, 40.4, 46.9 and 26.4 percent respectively. Treatment O_4 was found significantly superior in respect to the potassium uptake by seed & straw over treatment O_0, O_1, O_2, O_3, O_5, O_6, O_7, O_8, O_9 and O_{10} by 49.8, 24.5, 13.3, 16.3, 22.5, 15.9, 33.5, 25.6, 20.3 and 11.2 percent and found at par with treatment O_2 and O_{10} respectively. Nutrient uptake is simply multiplication of nutrient content in plant and yield of grain and straw. Both content and yield simultaneously influenced by various methods of jeevamrut application therefore huge increase was recorded in nutrient uptake by application of O_4 treatment. Significant improvement in nutrient contents and their uptake due to application of organics and fertilizers were also observed by Gore and Sreenivasa, 2011 and Patel *et al*., 2012.

Table 5: Effect of liquid organic formulations on nutrient uptake by grain and straw in cluster bean.

Treatment	Nitrogen uptake (kg/ha)	Phosphorus uptake (kg/ha)	Potassium uptake (kg/ha)
O_0	61.2	5.3	35.7
O_1	73.9	7.9	43.0
O_2	82.4	9.0	47.2
O_3	83.3	9.8	46.0
O_4	94.1	11.4	53.5
O_5	74.7	7.9	43.7
O_6	79.1	9.0	46.2
O_7	69.7	7.2	40.1
O_8	75.4	8.1	42.6
O_9	74.8	7.8	44.5
O_{10}	81.5	9.0	48.1
S.Em.±	1.36	0.41	1.19
C.D (P=0.05)	4.01	1.20	3.51
CV%			

O_0: Control; O_1: Cow urine @ 10% at 30DAS; O_2: Cow urine @ 10% at 30 and 45 DAS; O_3: Panchgavya @ 5% at 30DAS; O_4: Panchgavya @ 5% at 30 and 45 DAS; O_5: Jeevamrut @ 10% at 30 DAS; O_6: Jeevamrut @ 10% at 30 and 45 DAS; O_7: Humic acid @ 10% at 30 DAS; O_8: Humic acid @ 10% at 30 and 45 DAS; O_9: Vermiwash @ 10% at 30DAS; O_{10}: Vermiwash @ 10% at 30 and 45 DAS

Protein Content

Data (Table 4) showed that application of liquid organic formulations had significant effect of protein content in seed. Maximum protein content (23.25) was recorded under treatment O_6 and found significantly superior over O_0 (Control) by 10.88 percent and found at par with rest of the treatment. The improvement in quality parameters such protein content (%) with application of panchagavya might be due to optimum dose of panchgavya as foliar application (10%) which provide more macro nutrients especially nitrogen which helps grain to synthesize more nucleic acid and in turns of protein content.

Conclusion

On the basis of experimentation, it was concluded that foliar application of panchagavya @ 5% at 30 and 45 DAS found to be effective in improving growth parameters, yield attributes, yields, quality parameters and economics of cluster bean. Application of panchagavya @ 5% at 30 and 45 DAS recorded significantly higher seed yield (1485 kg/ha), gross return (Rs 91195/ha), net returns (Rs 66225/ha) and B.C ratio (3.65) over control. These results are based on one year experimentation, and hence, only indicative and further experimentation is required to arrive at more consistent and definite conclusion for recommendation to the farmers.

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