Original Research Article

EFFECT OF ORGANICS ON GROWTH, YIELD AND QUALITY OF CLUSTERBEAN (*Cyamopsis tetragonoloba* L.)

ABSTRACT

A field experiment was conducted during the *kharif* season of the year 2021 at Agronomy Instructional Farm, Department of Agronomy, CPCA, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the "Effect of organics and on growth, yield and quality of clusterbean (*Cyamopsis tetragonoloba* L.)" under loamy sand soil. The experiment was laid out in randomized block design with three replications. Thirteen treatments comprises different organic sources *viz.*, T_1: 100% RDF through chemical fertilizers, T_2: 100% RDN through castor cake (CC), T_3: 100% RDN through poultry manure (PM), T_4: 100% RDN through neem cake (NC), T_5: 75% RDN through CC + biofertilizers (NPK), T_6: 75% RDN through PM + biofertilizers (NPK), T_7: 75% RDN through NC + biofertilizers (NPK), T_8: 75% RDN through CC + 5% cow urine, T_9: 75% RDN through PM + 5% cow urine, T_{10}: 75% RDN through NC + 5% cow urine, T_{11}: 75% RDN through CC + biofertilizers (NPK) + 5% cow urine, T_{12}: 75% RDN through PM + biofertilizers (NPK) + 5% cow urine and T_{13}: 75% RDN through NC + biofertilizers (NPK) + 5% cow urine. The results revealed that an application of 75% RDN through PM + biofertilizers (NPK) + 5% cow urine (T_{12}) recorded significantly higher plant height, number of branches per plant, number of pods per plant, seed index, seed yield, stover yield and crude protein content in seed. However, gum content in seed was recorded significantly higher in treatment T_{13}. Therefore, the application of different organic sources of nutrients treatment application significantly influenced the growth, yield and quality of clusterbean.

KEYWORDS: Poultry manure, Castor cake, Neem cake, Cow urine, Biofertilizers

1. INTRODUCTION

Clusterbean popularly known as *guar* belongs to the family *leguminoseae* and sub-family *papilonaceae*. Clusterbean is also known as one of the most important commercial crops of arid and semi-arid region. The seed of clusterbean contains about 30 to 33 per cent gum in endosperm (Lee *et al.,* 2004). It is an important drought resistant crop suited to dry farming areas and cannot withstand under excessive moisture or water logging conditions. It is bushy annual herb have deep rooted system, is a hard-wearing and drought resilient crop grown under sandy soils of arid and semi-arid regions. It has been established as high-valued cash crop in the arid and semi-arid regions due to its drought hardiness and large amount of usage and has occupied a special place in the commercial scene because of its gum.

Clusterbean is mainly grown in tropical Asia, Africa and America. The major clusterbean producers are India, Pakistan and United States of America, with smaller acreages in Australia and Africa (Patel *et al.,* 2018). In India, clusterbean is mostly grown in Rajasthan, Haryana, Gujarat, Punjab, Uttar Pradesh and Madhya Pradesh. Rajasthan occupies first position in India both in area and production, whereas Haryana and Gujarat have second and third position, respectively. In Gujarat, it is mainly grown in Banaskantha, Mehsana, Ahmedabad, Anand, Kheda, Gandhinagar and Kachchh districts. The cultivated area under *guar* in Gujarat was 134.1 thousand hectares with the production of 75,365 M.T. and productivity 562 kg ha^{-1} in 2018-2019 (Anonymous, 2020).

In India, next to cereals, pulses and legumes are the main constituent of diet. Green and tender pods of clusterbean are used as favourite vegetable in many parts of the country. It is used for cattle feed, green manuring, medicinal and industrial purpose as well as for increasing soil fertility. Green matter of clusterbean is also used as forage and it contains 82.5 per cent water, 9.9 per cent carbohydrates, 3.7 per cent protein, 0.2 per cent fats, 2.3 per fiber and 1.4 per cent mineral matter (Deore *et al.*, 2004). Moreover, it contains Vitamin-A 330 I. U. and Vitamin-C 49 mg 100 g^{-1}.

Organic farming strategy is one of the ways towards soil sustainability, human health and environment also. Poultry manure is an important source of nutrients which plays direct role in plant

growth. Besides major nutrients, poultry manure also contains traces of micronutrients which are generally not supplied by the commercial fertilizers but essential for plant growth. It is established that it is an excellent source of organic manure which increases nutrient uptake of the plants.

Cow urine is the liquid manure contains essential nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, uric acid, amino acids enzymes, cytokinins, *etc*. (Bhadauria, 2002). The application of cow urine through foliar spray helps to correct the nutrient deficiency and improves the plant growth. The uric acid present in the urine acts as fertilizer and hormone. It has antibacterial, antiviral and antifungal properties.

Caster cake is not used as animal feed as it contains a toxic alkaloids ricinine and ricin. It widely used as concentrated organic manure. Castor cake contains 5.5 to 5.8 per cent N, 1.8 to 1.9 per cent P_2O_5 and 1.0 to 1.1 per cent K_2O (Kolay, 2007). Nutrient present in castor cake is make easily available to crop. Castor cake has good manurial value which favoured to modify the growth and yield attributes resulted into significant positive correlation with yield of crop (Sujathamma *et al*., 2003). Castor cake also supply micronutrients, improve physical properties of soil, immobilize toxic elements like Al and promote Mo activity (Lima *et al.*, 2011). Neem cake is the by-product obtained in the process of cold pressing of neem tree fruits and kernels. Neem cake protects plant roots from nematodes, soil grubs and white ants probably due to its residual limonoid content. Neem cake also reduce alkalinity in soil, as it produces organic acids on decomposition. Being totally natural, it is compatible with soil microbes, improves the rhizophere microflora and hence ensures fertility of the soil. Neem cake improves the organic matter content of soil, soil texture, water holding capacity and soil aeration for better root development.

Biofertilizers play a significant role in fixing atmospheric nitrogen, production of growth promoting substances and make phosphorus and potassium available to the plants. Inoculation of seed with *Rhizobium* increase yield due to more nitrogen fixation and better utilization by plants. Several strains of phosphate solubilizing bacteria and fungi as well as potassium solubilizing microorganisms are isolated. The mechanism of these microorganisms involves in secretion of organic acids which lower the pH and increase the availability of sparingly soluble phosphorus sources and also solubilize the fixed potassium in soil. Biofertilizers have shown positive interaction with organic manures in legume crops. Organic manures in conjunction with biofertilizers sustain and maintained the productivity of soil.

Evaluation of the role of organic manures, cow urine and biofertilizers to harness their effect in enhancing crop yield. Manures and biofertilizers have become an essential because of increasing cost of chemical fertilizer, sustain soil fertility and overcome adverse effect of chemical fertilizers on the soil health, ecology and environment.

2. MATERIALS AND METHODS

A field experiment was conducted at Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. Geographically, this university is situated at 24˚19' North latitude and 72˚19' East longitude with an elevation of 154.5 meter above the mean sea level. It is situated in the North Gujarat Agro-climatic Zone IV of the Gujarat state.

The experiment entitled, Effect of organics and on growth, yield and quality of clusterbean (*Cyamopsis tetragonoloba* L.) was conducted during *kharif* season of the year 2021-22 using total thirteen treatments *viz*., T_1: 100% RDF through chemical fertilizers, T_2: 100% RDN through castor cake (CC), T_3: 100% RDN through poultry manure (PM), T_4: 100% RDN through neem cake (NC), T_5: 75% RDN through CC + biofertilizers (NPK), T_6: 75% RDN through PM + biofertilizers (NPK), T_7: 75% RDN through NC + biofertilizers (NPK), T_8: 75% RDN through CC + 5% cow urine, T_9: 75% RDN through PM + 5% cow urine, T_{10}: 75% RDN through NC + 5% cow urine, T_{11}: 75% RDN through CC + biofertilizers (NPK) + 5% cow urine, T_{12}: 75% RDN through PM + biofertilizers (NPK) + 5% cow urine and T_{13}: 75% RDN through NC + biofertilizers (NPK) + 5% cow urine. Clusterbean variety Gujarat Guar 2 was taken using spacing 45 cm × 10 cm under investigation and conducted experiment in randomized block design with three replications.

For all the growth and development studies during the crop growth period, five plants were selected randomly from net plot and tagged in each plot for recording plant height, number of branches per plant, number of pods per plant, number of grains per pod, pod length, 100 seeds weight were randomly taken from the bulk produce of each net plot and were counted and weighed. The data on seed and stover yield were recorded from net plot and converted on hectare basis. The crude protein content in seed was computed by multiplying the nitrogen content with 6.25 for each treatment. The gum content was determined as per the method suggested by Dubois *et al*. (1956). Data were statistically analyzed by the procedure suggested by Panse and Sukhatme (1985).

The soil samples were collected 0-15 cm depth with the help of *khurpi* and spade before sowing and after harvest of crop and processed for further analysis. The air dry and sieved soil samples were analyzed by standard methods *viz*., alkaline $KMnO_4$ method, Olsen's method and flame photometric method for available nitrogen, phosphorus and potassium, respectively. The experimental plot soil was loamy sand in texture with mildly alkaline in reaction (pH 7.53) and free from any kind of salinity hazard (EC 0.14 dSm^{-1}). The soil was low in organic carbon (0.29%) and available nitrogen (148.36 kg ha^{-1}) and medium in available phosphorus (45.38 kg P_2O_5 ha^{-1}) and potassium (251.49 kg K_2O ha^{-1}) status.

The recommended dose of NPK 20:40:00 kg ha^{-1} were used for treatment application. Organic manures were applied as per treatments as basal application. Chemical fertilizers urea and superphosphate were used for N and P, respectively and applied as basal application in treatment T_1. Biofertilizers *viz*., *Rhizobium* was applied as seed treatment @ 20 ml kg^{-1} seed, whereas PSB and KSM each were applied as soil application @2.5 L ha^{-1}. Foliar spray of 5 per cent cow urine was applied as per treatment at 30 and 50 DAS. Quantity of organic manures (castor cake, neem cake and poultry manure) were calculated on the basis of nitrogen content in them (Waranke and Barber, 1974). They were subjected to chemical analysis of nitrogen content before the commencement of experiment as per the standard methods of analysis.

3. RESULTS AND DISCUSSION

3.1 Effect on Growth Attributes

The data pertaining to the plant height and number of branches per plant of clusterbean as influenced by organics are presented in Table 1.

3.1.1 Plant height

A perusal of data showed that application of 75% RDN through PM + biofertilizers + 5% cow urine (T_{12}) recorded significantly maximum plant height of 51.07 and 94.01 cm at 50 DAS and at harvest, respectively. However, it was remained statistically at par with treatments T_{13} (75% RDN through NC + biofertilizers + 5% cow urine), T_{11} (75% RDN through CC + biofertilizers + 5% cow urine), T_6 (75% RDN through PM + biofertilizers), T_7 (75% RDN through NC + biofertilizers), T_1 (100% RDF through chemical fertilizers), T_3 (100% RDN through poultry manure)and T_5 (75% RDN through CC + biofertilizers) at 50 DAS, similarly at harvest it was recorded at par with the treatments T_{13}, T_{11}, T_6, T_7, T_5, T_3 and T_1.Whereas,minimum plant height of 41.23 and 74.02 cm were recorded at 50 DAS and at harvest, respectively with treatment T_8 (75% RDN through CC +5% cow urine). It might be due to application of poultry manure that stimulated activities of microorganisms and synchronized release of nitrogen, which might have encouraged the cellular activity, useful for the process of cell division. It might be due to the synergistic effect of organic manures and biofertilizers. It may fix atmospheric nitrogen, convert nutrient from insoluble to soluble form, scavenge phosphorus from soil, help in mineralization process and due to the biosynthesis of growth-promoting substances like auxin. The application of cow urine through foliar spray also helps to correct the nutrient deficiency and improves the plant growth. These results are in accordance with the findings of Menon *et al.* (2010) in cowpea; Patil *et al*. (2012) in chickpea; Singh *et al.* (2015) in greengram; Brahmbhatt *et al.* (2021) and Choudhary *et al.* (2021) in clusterbean.

3.1.2 Number of branches per plant

The statistically analyzed data indicated that application of 75% RDN through PM + biofertilizers + 5% cow urine (T_{12}) were recorded significantly maximum number of branches per plant of 4.36, 6.79 and 10.01 cm at 30 DAS, 50 DAS and at harvest, respectively. However, it was remained statistically at

par with treatments T_6 (75% RDN through PM + biofertilizers), T_{11} (75% RDN through CC + biofertilizers + 5% cow urine), T_7 (75% RDN through NC + biofertilizers), T_1 (100% RDF through chemical fertilizers), T_5 (75% RDN through CC + biofertilizers), T_{13} (75% RDN through NC + biofertilizers + 5% cow urine), T_3 (100% RDN through poultry manure) and T_4 (100% RDN through neem cake)with respect to number of branches at 30 DAS and treatments T_{13}, T_{11}, T_6, T_7 T_5 and T_1at 50 DAS. Similarly, it was also found at par with treatments T_6 (75% RDN through PM + biofertilizers), T_3 (100% RDN through poultry manure) and T_1 (100% RDF through chemical fertilizers) with respect to number of branches at harvest. While, minimum number of branches per plant of 3.09 and 4.91 were recorded at 30 and 50 DAS, respectively with treatment T_8 (75% RDN through CC + 5% cow urine) and at harvest 7.59 with treatment T_{10} (75% RDN through NC + 5% cow urine). It might be due to pronounced influence of organic manures and biofertilizers might have exerted their strong influences like improving soil biological activity, fixing atmospheric nitrogen by *Rhizobium* besides production of phyto hormones and converting insoluble phosphates into soluble forms by PSB in the rhizosphere and supplied the required nutrients to plant at optimum levels constantly from the soil solution at all stages of crop growth. These finding are in agreement with the previous research work of Kumhar *et al.* (2012), Reddy *et al.* (2014), Singh *et al.* (2014) and Singh and Kumar (2016) in clusterbean.

3.2 Effect on Yield Attributes and Yield

The data pertaining to the yield attributes and yield of clusterbean as influenced by organics are presented in Table 2.

3.2.1 Number of pods per plant

A perusal of data showed that significantly maximum number of pods per plant (61.87) was noted under treatment T_{12} (75% RDN through PM + biofertilizers + 5% cow urine). However, it was remained statistically at par with treatmentsT_6 (75%RDN through PM + biofertilizers), T_3 (100% RDN through poultry manure) and T_1 (100% RDF through chemical fertilizers). Application of 75% RDN through CC + 5% cow urine (T_8) resulted in production of minimum number of pods per plant (38.10). This might be due to the facts that combined effect of *Rhizobium,* PSB and KSM with organic sources of nutrients. It may be increased the availability of nutrients to the plant from different organic sources and plays an important role in increase the solubility of micro-nutrients in root rhizosphere, essentially required for the formation and development of the pods. Thus, it increased the number of pods per plant may be influenced in yield parameters. Similar observations were also recorded by Rathore *et al.* (2007), Reddy *et. al*. (2014) and Patel *et al.* (2018) in clusterbean and Pargi *et. al.* (2018) in cowpea.

3.2.2 Number of grains per pod

The data indicated that different organic sources did not exhibit their significant influence on number of grains per pod but numerically higher value of number of grains per pod (6.58) was noted under the treatment T_{12} (75% RDN through PM + biofertilizers (NPK) + 5% cow urine).

3.2.3 Pod length

A cursory glance over data indicated that different treatments did not reach to the level of significance but numerically higher value of pod length (7.01 cm) was observed with the application of 75% RDN through PM + biofertilizers (NPK) + 5% cow urine (T_{12}).

3.2.4 Seed index

Data pertained that significant and maximum seed index (3.47 g) was recorded with the application of 75% RDN through PM + biofertilizers + 5% cow urine (T_{12}), which was remained statistically at par with treatments T_6 (75% RDN through PM + biofertilizers), T_3 (100% RDN through poultry manure) and T_1 (100% RDF through chemical fertilizers). Whereas, minimum seed index (2.65 g) was recorded with treatment T_8 (75% RDN through CC + 5% cow urine). The higher increase in seed index have been reported to be associated with the release of macro and micronutrients during the course of microbial decomposition. The beneficial response of poultry manure to yield attributes might also be attributed to the availability of sufficient amounts of easily utilizable form of plant nutrients throughout the growth period and specially at critical growth periods of crop resulting in better uptake, plant vigour and superior yield attributes. *Rhizobium* has the capacity to fix atmospheric nitrogen and

PSB may be attributed to several mechanisms especially production of growth hormones, improving the efficiency of roots and increasing phosphorus availability for seed development in clusterbean and influence on seed index These results are in accordance with the research findings reported by Rathore *et al.* (2007) and Kumhar *et al*. (2012) in clusterbean; Singh *et al.* (2015) in greengram; Umadevi *et al.* (2019) in cowpea; Brahmbhatt *et al.* (2021) and Choudhary *et al.* (2021) in clusterbean.

3.2.5 Seed and stover yield

It is clearly evident from the results that differences in seed yield due to different organic sources were found significant. Maximum seed yield of clusterbean (1060 kg ha^{-1}) was recorded with the application of 75% RDN through PM + biofertilizers + 5% cow urine (T_{12}). While, it was remained statistically at par with treatmentsT_6 (75% RDN through PM + biofertilizers), T_3 (100% RDN through poultry manure) and T_1 (100% RDF through chemical fertilizers). However, minimum seed yield (767 kg ha^{-1}) was recorded with treatment T_8 (75% RDN through CC + 5% cow urine).

An examination of data indicated that significantly higher stover yield (2872 $kgha^{-1}$) of clusterbean was obtained with the application of 75% RDN through PM + biofertilizers + 5% cow urine (T_{12}) and it was remained statistically at par with treatmentsT_6 (75% RDN through PM + biofertilizers), T_3 (100% RDN through poultry manure) and T_1 (100% RDF through chemical fertilizers). Whereas, minimum stover yield (2130 kg ha^{-1}) were recorded with treatment T_8 (100% RDN through CC + 5% cow urine).

The increase in seed and stover yield with the application of 75% RDN through PM + biofertilizers + 5% cow urine (T_{12}) which might be due to the synergistic effect of organic manures and biofertilizers. Biofertilizers may fix atmospheric nitrogen, convert nutrients from insoluble to soluble form, scavenge phosphorus from soil, help in mineralization process and improve yield. It plays an important role in increase the solubility of micro nutrients in the rhizosphere, essentially required for the formation and development of the pods. Thus, it increased the seed yield. It influenced the rate of photosynthesis, protein synthesis and more absorbance capacity of nutrients from root zone. It may be mentioned that no single source of nutrient supply be it biofertilizer is in position to meet the increasing nutrient demand for biological yield. Use of organic manure improves the soil aeration, nutrient status and biological properties. Similar results were also obtained by Kumhar *et al*. (2012) in clusterbean; Birla *et al.* (2018) and Umadevi *et al.* (2019) in cowpea; Brahmbhatt *et al.* (2021) and Choudhary *et al.* (2021) in clusterbean.

3.3 Effect on Quality Parameters

The data pertaining to the crude protein content and gum content in seed of clusterbean as influenced by organics are presented in Table 3.

3.3.1 Crude protein content in seed

The statistically analyzed data indicated that treatments of different organic sources have significant effect on crude protein content in seed. Maximum protein content (25.63 %) was recorded with the application of 75% RDN through PM + biofertilizers + 5% cow urine (T_{12}), while it was remained statistically at par with treatments T_{13} (75% RDN through NC + biofertilizers + 5% cow urine), T_6 (75% RDN through PM + biofertilizers), T_7 (75% RDN through NC + biofertilizers), T_{11} (75% RDN through CC + biofertilizers + 5% cow urine), T_5 (75% RDN through CC + biofertilizers) and T_1 (100% RDF through chemical fertilizers). However, minimum crude protein content in seed (18.85%) was noted with the application of 75% RDN through CC + 5% cow urine (T_8). It might be due to higher nitrogen in seed is directly responsible for higher protein because it is a primary component of amino acids which constitute the basis of protein. The influence of applied nitrogen and phosphorus and higher N-fixation in the root nodules, the availability of these nutrients in soil increased and consequently resulted to higher uptake by plants. Higher levels of protein content in pods are ideal quality characters and are achieved by application of organic form of nitrogen in combination with biofertilizers might be due to the easy availability of nitrogen leading to balanced C:N ratio, enhancing the vegetative growth resulting in high photosynthetic activity. Similar findings were also reported by Reddy *et al.* (2014) in clusterbean; Birla *et al.* (2018) in cowpea and Manohar *et al.* (2018) in clusterbean.

3.3.2 Gum content in seed

An examination of data showed that significantly maximum gum content (27.66%) was recorded with treatment T_{13} (75% RDN through NC + biofertilizers + 5% cow urine) and it was remained statistically at par with treatments T_6 (75% RDN through PM + biofertilizers), T_{11} (75% RDN through CC + biofertilizers + 5% cow urine), T_{12} (75% RDN through PM + biofertilizers + 5% cow urine), T_5(75% RDN through CC + biofertilizers), T_3 (100% RDN through poultry manure) and T_1 (100% RDF through chemical fertilizers). The significant increase in gum content in seed with the application of 75% RDN through NC + biofertilizers + 5% cow urine might be due to cumulative effect of organic manures and biofertilizers for enhancement of nutrient availability in soil. Gum content increased due to the fact that improvement in carbohydrates synthesis of phospholipids and nucleic acids. This was in accordance with the results of Meena *et al*. (2006) and Sharma *et al*. (2019).

Table 1: Effect of organics on growth attributes of clusterbean

Treatments	Plant height (cm)			Number of branches per plant		
	30 DAS	50 DAS	At harvest	30 DAS	50 DAS	At harvest
T_1	21.82	46.32	81.61	3.91	5.81	9.36
T_2	19.12	41.79	78.36	3.40	5.42	8.22
T_3	20.08	46.16	83.23	3.85	5.65	9.56
T_4	19.48	42.80	81.23	3.68	5.49	8.17
T_5	20.01	45.91	84.15	3.89	6.03	8.48
T_6	20.97	48.63	87.40	4.27	6.31	9.63
T_7	20.24	47.67	86.20	3.95	6.17	8.46
T_8	18.49	41.23	74.02	3.09	4.91	7.81
T_9	19.61	44.76	77.31	3.22	5.19	8.09
T_{10}	18.89	43.11	75.44	3.16	5.02	7.59
T_{11}	22.06	49.22	91.18	4.02	6.58	8.34
T_{12}	22.68	51.07	94.01	4.36	6.79	10.01
T_{13}	22.13	50.74	93.11	3.87	6.75	8.51
S.Em.±	0.99	2.14	4.36	0.28	0.39	0.47
C.D. (P = 0.05)	NS	6.24	12.72	0.81	1.13	1.37

Table 2: Effect of organics yield attributes and yield of clusterbean

Treatments	Number of pods per plant	Number of grains per pod	Pod length (cm)	Seed index (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1	52.55	5.56	6.48	3.12	942	2590
T_2	43.43	5.43	6.10	2.72	863	2278
T_3	54.70	5.50	6.41	3.28	996	2650
T_4	42.62	5.46	6.30	2.79	870	2312
T_5	45.76	5.69	6.42	2.91	890	2246
T_6	57.34	5.80	6.64	3.36	1017	2774
T_7	48.75	5.75	6.54	2.86	876	2413
T_8	38.10	5.30	5.90	2.65	767	2130
T_9	42.58	5.41	6.03	2.70	837	2262
T_{10}	40.72	5.37	5.98	2.67	785	2184
T_{11}	49.15	6.12	6.73	2.90	883	2352
T_{12}	61.87	6.58	7.01	3.47	1060	2872
T_{13}	49.07	6.26	6.87	2.80	880	2394
S.Em.±	3.76	0.27	0.30	0.18	54.35	142.25
C.D. (P = 0.05)	10.99	NS	NS	0.53	158.64	415.21

Table 3: Effect of organics quality parameters of clusterbean

Treatments	Crude protein content in seed (%)	Gum content in seed (%)
T_1	22.98	26.69
T_2	21.35	25.99
T_3	22.56	26.96
T_4	21.63	25.78
T_5	23.63	27.02
T_6	24.73	27.44
T_7	24.48	26.26
T_8	18.85	25.58

T_9	20.23	26.05
T_{10}	19.42	25.79
T_{11}	24.17	27.20
T_{12}	25.63	27.06
T_{13}	25.23	27.66
S.Em.±	0.97	0.40
C.D. (P = 0.05)	2.84	1.17

4. CONCLUSION

It can be concluded that for harnessing maximum seed and stover yield with better seed quality of clusterbean by the application of 75% RDN through PM + biofertilizers (NPK) + 5% cow urine is beneficial.

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