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Influence of Liquid Bio-fertilizers Along with Inorganic and Organic Sources of Nutrients on Quality Parameters of Cluster Bean [*Cyamopsis tetragonoloba* (L.) Taub.]

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ABSTRACT: Cluster bean is a legume crop, which requires minimum level of nitrogen but need to be supplemented with proper dose of nitrogen, phosphorus and potassium fertilizers for better growth and development. Being a drought tolerant crop, its cultivation in marginal lands with little or no inputs contribute to its poor productivity and quality. Thus, the present investigation was conducted to evaluate the effect of application of liquid bio-fertilizers [*Rhizobium*, phosphorus solubilizing bacteria (PSB) and potassium solubilizing bacteria (KSB)] in combination with three different levels of recommended dose of fertilizer (100%, 75% and 50%) and organic manures (FYM and Vermicompost) on quality of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.]. The study was carried out during 2022 in a Randomized Block Design (RBD) with 11 treatments in three replications. The quality attributes of cluster bean pods *viz.*, crude fibre, crude protein, shelf life and dry pod weight were found to be improved in plants treated with application of 75% RDF ha^{-1} + Vermicompost 5 t ha^{-1} + *Rhizobium,* PSB, KSB each at 20 ml kg^{-1} seeds + PPFM 1% at 30th and 60th DAS (T_{10}).

Keywords: Cluster bean, Quality parameters, Inorganic & Organic sources, Liquid Biofertilizers.

INTRODUCTION

Cluster bean, also known as Guar [*Cyamopsis tetragonoloba* (L.) Taub.] is an annual legume crop that occupies a substantial part of moisture deficient areas in our country. It is an erect annual growing plant, grow up to a height of 2 m with stiff erect branches, stems are angled, leaves trifoliate, ovate and serrate. The white or pink coloured flowers are small and borne on axillary raceme. Pods are compressed, linear, erect and clustered, double ridge on dorsal side, single ridge on ventral side, length 4-10 cm, 5-12 seeds per pod with white to grey or black in colour (Patel *et al*., 2018). Cluster bean can be used for multiple purposes (vegetable, cattle feed and green manure). Pods of cluster bean are rich in food value and each 100 g contains 10.8 g carbohydrate, 3.2 g protein, 1.4 g minerals, 316 IU vitamin-A, 47 mg Vitamin-C and Vitamin K. Cluster bean seed (endosperm) is a source of a natural hydrocolloid (galactomannan/guar gum). Recently, galactomannans are used in the water proof biocide film production (Selvaraj *et al*., 2014). The gum has unique abilities with multiple commercial applications like textile, printing, paper, cosmetics, mining, pharmaceutical, petroleum, natural gas, well drilling and oil industries (Bhatt *et al*., 2017). The efficient use of nutrients is one of the most important factors to achieve an economic increase in agricultural production. Use of inorganic fertilizers alone may not sustain the productivity in long run towards the increasing population and affects soil health. On the other hand, organic sources of nutrients are cheaper, eco-friendly, improve soil properties and can substitute nutrient requirement of crops partially. Organic sources of nutrients not only add the nutrients into the soil but also enhance the sustainability. Synergistic effect of bio fertilizers with crop increases the crop productivity and sustainability also (Brahmbhatt *et al*., 2021). Bio-fertilizers are the products containing one or more species of microorganisms which have the capacity to mobilize important elements from non-usable to usable form through biological processes such as nitrogen fixation, phosphate solubilization, excretion of plant growth promoting substances or cellulose and lignin biodegradation in soil, compost and other environments. They are totally harmless, pollution free and low-cost renewable agricultural inputs. They play a significant role in improving nutrient availability in plants. The use of microbial inoculants is of strategic interest for their potential to replace chemical fertilizers

and pesticides in agricultural systems and improve environmental sustainability (Cartivo *et al*., 2020). Hence, integrated use of inorganic fertilizers, organic manures and low-cost nutrient sources such as bio fertilizers is the better option for sustainable production and to maintain soil health (Parmar *et al*., 2019).

MATERIALS AND METHODS

The experiment was conducted during February (2022) – June (2022) in the horticulture farm, Department of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U.T. of Puducherry, situated at 11°01′N latitude and 79°59′E longitude and at an elevation of 4 m above mean sea level. The experiment was laid out in a randomized block design (RBD) with 11 treatments and three replications. The experiment was carried out using variety MDU-1, to evaluate the quality parameters like crude fibre, crude protein, shelf life and dry pod weight of cluster bean under different nutrient management practices to identify the best suited combination to improve the quality. Seeds were treated with liquid *Rhizobium* sp, PSB [*Bacillus megaterium* (Pb1)], KSB [*Bacillus mucilaginosus* (KRB9)] each at the rate of 20 ml kg^{-1} by soaking for about half an hour followed by air drying prior to sowing. Seeds were sown at a spacing of 45 cm x 15 cm, using recommended seed rate of 20 kg ha^{-1}. FYM (25 t ha^{-1}) and vermicompost (5 t ha^{-1}) were applied as basal after ploughing as per the treatment combinations fixed in the study. The crop was fertilized with nitrogen as urea, phosphorous as SSP and potassium as MOP $hectare^{-1}$. The level of nitrogen, phosphorus and potassium fertilizer application varied (100%, 75% and 50% of RDF) according to the treatments imposed. Foliar spray of 1% PPFM (Pink-Pigmented Facultative Methylotrophs) was done on 30th and 60th DAS.

(i) Crude fibre content was estimated from dried pod by the method suggested by Chopra and Kanwar (1976) and expressed in percentage.

(ii) Crude protein content of pod was estimated by Lowry's method (Sadasivam and Manickam 1996) from tender pod on wet weight basis and expressed in percentage.

(iii) The shelf life of freshly harvested pods were recorded in terms of per cent physiological loss in weight (PLW). Random number of freshly harvested tender pods weighing approximately 20 g were collected separately from the plants treated with 11 different nutrient combinations. The pods collected from each treatment combination with exact initial weight was labelled and stored separately under room condition. The percentage physiological loss in weight (or) the weight of the pods was measured on a daily basis until the pods remained fresh for consumption without loss in colour and glossiness. The maximum number of days the pods remained fresh without much reduction in PLW was recorded.

(iv) Weight of fully dried pods $plant^{-1}$ in all the tagged plants were recorded and expressed in grams. The observations recorded for quality characters were scrutinized statistically, as per the standard procedures using AGRES software. The treatment details are given in Table 1.

RESULT AND DISCUSSION

Effect on crude fibre and crude protein content of cluster bean. Crude fibre content in pod is one of the criteria to judge the quality of pods. Reduced levels of crude fibre and higher levels of protein content in pods are ideal quality characters and are achieved by application of organic form of nitrogen in combination with bio-fertilizers, which might be due to the easy availability of nitrogen leading to balanced C:N ratio, enhancing the vegetative growth resulting in high photosynthetic activity (Patel *et al.,* 2009). In the present study, it was observed that crude fibre content (Fig. 1) in pods were the lowest (14.34%) in plants that received 75% RDF ha^{-1} + Vermicompost 5 t ha^{-1} + *Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds + PPFM 1% at 30th and 60th DAS (T_{10}) while the highest value was recorded by absolute control (T_1). The result was in conformity with the findings of Reddy *et al.* (2014) in cluster bean. Protein content was higher (2.50%) in pods obtained from plants that received (T_{10}) 75% RDF ha^{-1} + Vermicompost 5 t ha^{-1} + *Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds + PPFM 1% at 30th and 60th DAS (Fig. 2). Similar finding was reported by Reddy, 2011 in cluster bean. Increase in protein content is attributed to favourable effect of organic manures on microbial activity which increases the supply of nitrogen throughout the growth period and resulted in higher protein content in pods (Baviskar *et al*., 2010).

Effect on shelf life of cluster bean: Fig. 3 furnishes the data with respect to shelf life of cluster bean pods as influenced by various treatments in the study. Maximum shelf life (5.66 days) under ambient condition was recorded in T_{10} [75% RDF ha^{-1} + Vermicompost 5 t ha^{-1} + *Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds + PPFM 1% at 30th and 60th DAS when compared with other treatment combinations and minimum shelf life was observed in pods (3.33 days) obtained from absolute control (T_1). This trend was in conformity with the observations of Chatterjee *et al.* (2012) in cabbage. The beneficial influence of shelf life might be attributed to vermicompost which increased the availability of sufficient amounts of plant nutrients throughout the growth period and especially at critical growth periods of crops resulting in better uptake, plant vigour and increased allocation of photosynthates towards the economic parts as well as hormonal balance in the plant system resulting in pods with superior shelf life. Incorporation of organic manures in combination with reduced inorganic fertilizers and bio-fertilizers might have reduced the respiration rate, which in turn resulted in higher storage life and reduction in PLW. The superiority of combined application of organic manures over sole inorganic fertilizer in reducing PLW of onion bulb has been reported by Sankar *et al*. (2009).

Effect on dry pod weight of cluster bean: Maximum dry pod weight (413.28 g) $plant^{-1}$ was observed in

plants that received 75% RDF ha^{-1} + Vermicompost 5 t ha^{-1} + *Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds + PPFM 1% at 30th and 60th DAS (T_{10}) than the plants that received other treatment combinations (Fig. 4). The result was in conformity with Panda *et al*. (2017) in cowpea. The amount of total dry pod produced is an indication of the overall efficiency of resource utilization. Increase in plant height, number of leaves, higher leaf area, clusters plant^{-1} and pod yield plant^{-1} have contributed to higher dry matter production. The increase in dry weight may also be attributed to higher uptake of essential nutrients and better utilization of these nutrients. The beneficial role of organic manures in improving soil physical, chemical and biological property is well known, which in turn helps in better nutrient absorption by plants (Prabhu *et al*., 2002).

Table 1. Different treatments and their combinations used.

Treatments	Treatment Details
T_1	Absolute control
T_2	(50:50:25) kg of NPK ha^{-1} + FYM 25 t ha^{-1}
T_3	(50:50:25) kg of NPK ha^{-1} + Vermicompost 5 tha^{-1}
T_4	*Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds + FYM 25 t ha^{-1} + PPFM1 % at 30th and 60th DAS.
T_5	*Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds + Vermicompost 5 t ha^{-1} + PPFM 1 % at 30th and 60th DAS.
T_6	50 % (25:25:12.5) kg of NPK ha^{-1} + FYM 25 t ha^{-1} + *Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds+ PPFM1 % at 30th and 60th DAS
T_7	75 % (37.5:37.5:18.75) kg of NPK ha^{-1} + FYM 25 t ha^{-1} + *Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds + PPFM 1 % at 30th and60th DAS
T_8	100 % (50:50:25) kg of NPK ha^{-1} + FYM 25 t ha^{-1} + *Rhizobium* at20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds+ PPFM 1 % at 30th and 60th DAS
T_9	50 % (25:25:12.5) kg of NPK ha^{-1}+ Vermicompost 5 t ha^{-1} + *Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds + PPFM 1 % at 30th and 60th DAS
T_{10}	75 % (37.5:37.5:18.75) kg of NPK ha^{-1} + Vermicompost 5 t ha^{-1} + *Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds + PPFM 1 % at 30th and 60th DAS
T_{11}	100 % (50:50:25) kg of NPK ha^{-1} + Vermicompost 5 t ha^{-1} + *Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds + PPFM 1 % at 30th and 60th DAS

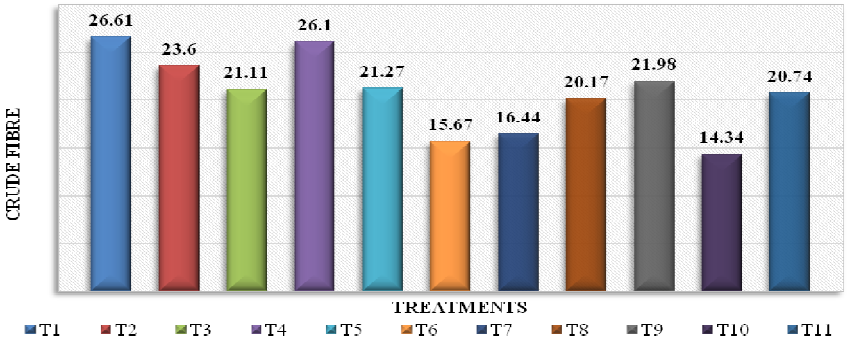

Fig. 1. Influence of liquid bio-fertilizers along with inorganic and organic sources of nutrients on crude fibre (%) of cluster bean.

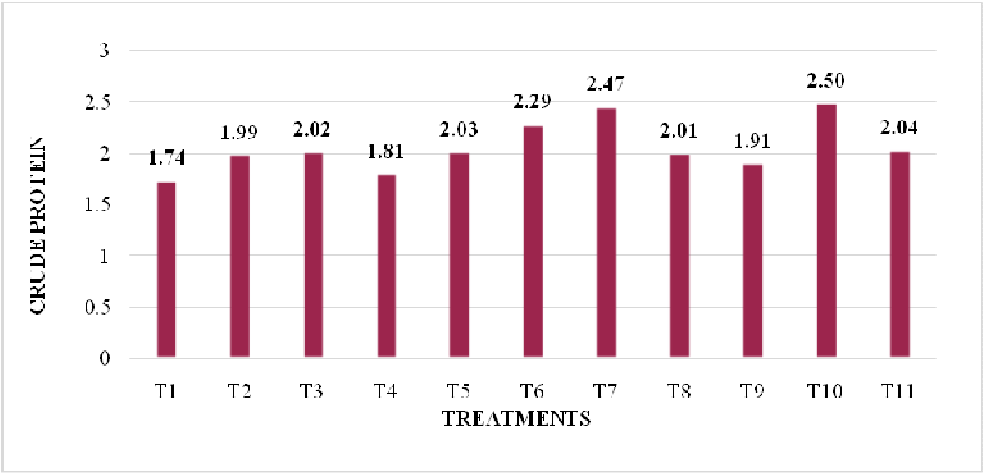

Fig. 2. Influence of liquid bio-fertilizers along with inorganic and organic sources of nutrients on crude protein (%) of cluster bean.

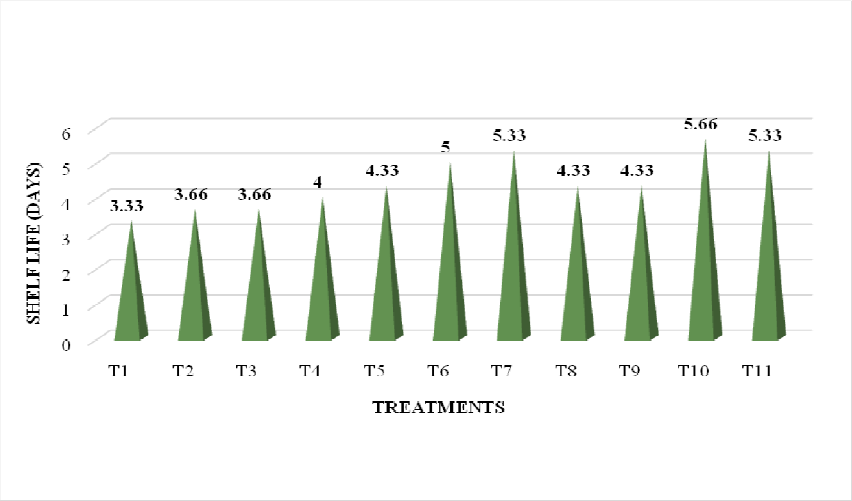

Fig. 3. Influence of liquid bio-fertilizers along with inorganic and organic sources of nutrients on shelf life (days) of cluster bean.

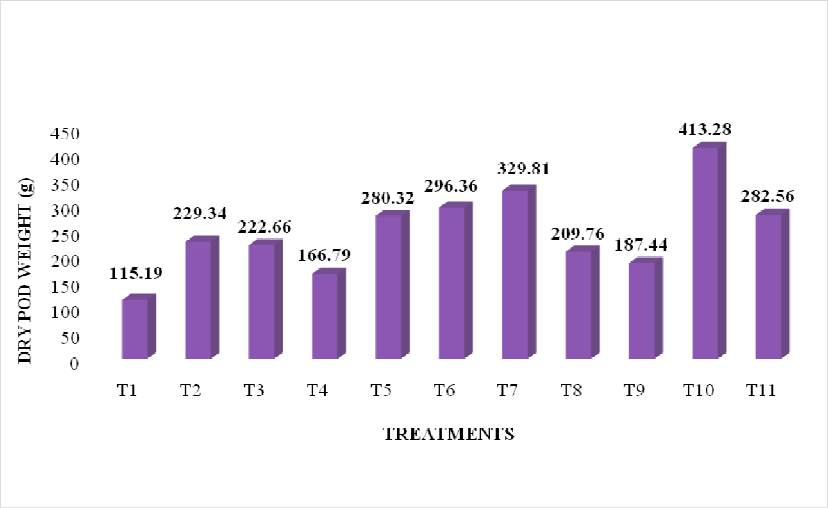

Fig. 4. Influence of liquid bio-fertilizers along with inorganic and organic sources of nutrients on dry pod weight (g) of cluster bean.

CONCLUSIONS

Crude protein, shelf life and dry pod weight were found to be higher with lesser crude fibre content in cluster bean pods when applied with 75% RDF ha^{-1} + Vermicompost 5 t ha^{-1} + *Rhizobium* at 20 ml kg^{-1} seeds + PSB at 20 ml kg^{-1} seeds + KSB at 20 ml kg^{-1} seeds + PPFM 1% at 30th and 60th DAS (T_{10}). Therefore, it could be concluded that treatment combination T_{10} could be adopted to improve the quality of cluster bean.

FUTURE SCOPE

Cluster bean is a legume crop, which requires minimum level of nutrients but need to be supplemented with proper dose of nitrogen, phosphorus and potassium fertilizers for better plant growth and development. Being a drought tolerant crop, its cultivation in marginal lands with little or no inputs contribute to its poor productivity. Soil health, sustainable productivity and quality of crops can be maintained only through balanced nutrient application. Hence, integrated use of liquid biofertilizers along with chemical fertilizers and organic manures could be considered as a better choice for sustaining productivity and improving the quality of crops.

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