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Effect of varying fertility levels and different liquid biofertilizers on the gum content and protein content in the seed of cluster bean [*Cyamopsis tetragonoloba* (L.) *Taub*]

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Abstract
A field experiment was conducted at research farm, RARI, Durgapura during two consecutive *kharif* seasons 2018 and 2019 to study the Effect of different liquid biofertilizers and varying fertility levels on growth, yield and quality of cluster bean [*Cyamopsis tetragonoloba* (L.) *Tau*b]. The experiment consists of twenty four treatment combinations consisting of three fertility levels (100% RDF, 75% RDF and 50% RDF) and eight liquid biofertilizers combination (control, Rhizobium, PSB, KMB, SSB, Rhizobium+PSB, Rhizobium+ PSB+ KMB and Rhizobium+ PSB+ KMB+ SSB), thereby making twenty four treatment combinations were replicated three times in randomized block design. Result showed that application of 100% NPKS proved significantly superior over 75% RDF and 50% RDF with respect to all quality parameters (gum content and protein content). Significantly higher gum content and protein content in seed were obtained in the combination of 100% NPKS with application of Rhizobium + PSB + KMB+SSB.

Keywords: Biofertilizers, maize, nitrogen, phosphorus, potassium

Introduction
Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] or Guar is a drought tolerant legume of family Fabaceae (Leguminaseae). It is an important cash crop, grown in semi-arid and arid regions of Rajasthan, Haryana and Gujarat during rainy (*Kharif*) season. Raw mature clusterbean seeds contain 23% protein. 1.7% fat, 6% carbohydrate and traces of vitamins and minerals. Besides, guar pods are very good source of vitamin A, calcium, iron, phosphorus and ascorbic acid (Vijaylaxmi and Singh, 2011). It contains many important nutrients, phytochemicals such as saponin and flavonoids. It is well-known traditional plant used in folklore medicine. India contributes 80% to the global production of guar seed where it is grown on an area of 3.93 m ha, 1.62 m tonnes with a very low productivity of 413 kg/ha (NRAA, 2020) [3]. India is the leading exporter of guar seeds and guar gum. Today, this crop become the significant foreign exchange earners of our country. The gum has its use in almost all types of industries *viz.*, textiles, paper, paint, petroleum, pharmaceuticals, food processing, cosmetics, confectionary, beverages, dairy products, photography, mining explosives, oil drilling etc. The by product from gum extraction process is a high value protein feed for cattle as it contains about 40% protein. Newly, galactomannans is used in the water proof biocide films production (Selvaraj and Prasanna, 2012) [5].

Biofertilizers helps in the maintenance or adjustment of plant nutrient supply to an optimum level for sustaining desired crop productivity and soil fertility (Anonymous, 2018) [2]. Biofertilizers are the products containing one or more species of microorganisms which have the capacity to mobilize nutritionally 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. Liquid biofertilizers are liquid formulations have the dormant form of desirable micro-organisms and their nutrients together with the substances that encourage formation of resting spores or cysts for longer shelf life and tolerance to unfovourable conditions.

The merits of liquid biofertilizers over conventional carrier based biofertilizers are: (1) longer shelf life (12- 24 months), (2) high temperature tolerance, (3) nil contamination chances, (4) no loss of properties due to storage at high temperature up to 45° C. (5) Higher populations can be maintained more than 109 cells and stored up to 12 to 24 months (6) easy to handle by the farmers (7) higher export potential (8) dosages are ten times less than carrier-based inoculants and quality control protocols are quick and very easy.

Biofertlizers are applied as seed treatment or applied the soil. Biofertilizers in lquid formulaton are easy to handle and applied @3-5 ml/kg seed just before sowing. Soil applied biofertiizers are mixed in compost or farm yard manure and kept it for over night and then incorporated in soil just befoe sowing. Now a days in addition to N, P and K fixing biofertilizer, liquid bifertilizers for sulphur, zinc and manganese are also available. These liquid biofertilizers are easy to handle and cost effective (Kumar *et al*. 2017) In India, biofertilizers are available for almost all crops. Hence, total consumption of biofertilizer is expected to increase too many fold in coming years. Various Agricultural State Universities and non Government Organizations were engaged in mass production of biofertilizers (Bhattaacharyya and Kumar 2002). Largest producing states are Madhya Pradesh, Maharashtra, Karnataka and Tamil Nadu.

Materials and Methods

The field experiment entitled "Effect of different liquid biofertilizers and varying fertility levels on growth, yield and quality of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub]" was conducted during *Kharif* seasons of 2018 and 2019, at research farm of Rajasthan agricultural research institute, Durgapura (Jaipur). The details of experimental techniques adopted and criteria used for treatment evaluation during the entire course of investigation are described in this chapter. The experiment was conducted on farm of Rajasthan Agricultural Research Institute (RARI), Durgapura, Jaipur (Raj.). The test crops were raised on field during *kharif*-2018 and *kharif*-2019 respectively. Geographically this place is situated at 75º47 East longitudes, at 26º51 North latitude and at altitude of 390 m above mean sea level in Jaipur district of Rajasthan. According to NARP, this region falls under Agro-climatic zone IIIa (Semi-arid eastern plain zone) of Rajasthan. India occupies top position in the world trade of guar gum. Seeds of cluster bean contain 28-33% gum (presence of Galactomannan). The crude gum content, protein content and protein yield calculated by these formulas.

Crude protein content and protein yield

The per cent crude protein in seed and straw was computed by multiplying the nitrogen content in seed and straw with a constant factor of 6.25 (A.O.A.C., 1960) [1].

$$\text{Crude protein yield (kgha}^{-1}\text{)} = \frac{\text{Crude protein content in seed (\%) x Seed yield (kgha}^{-1}\text{)}}{100}$$

Gum content

The guar gum or galactomanon have been isolated and purified by wet processing method at laboratory scale. The mature seeds of cluster bean were cleaned and boiled in 2% alkali solution i. e. NaOH at 100°C for 5-10 min to remove husk or hull portion. This was followed by washed the seed in running water, neutralized with dilute acid (HCl) and again washing with water. Husk was removed and dried for night over. The seeds were then pulverized to get gum splits. The splits were converted into powder known as crude gum. The crude gum was suspended in aqueous solution of iso-propanol and resultant precipitate was centrifuged at 5000 x for 15 min. The purified gum was vaccum dried and pulverized to 200-mesh size (Rodge *et al*, 2006) [4].

Result and Discussion

Crude gum content in seed

Fertility levels: Data given in table 4.17 indicate that various RDF levels caused positive influence in the crude gum content (%) in seed during individual years as well as in pooled mean. In the pooled mean, the highest crude gum content of 31.57% was observed with 100% RDF which was 20.18 and 4.77 per cent higher than 50 and 75% RDF levels, each level being significantly higher than the preceding level.

Liquid biofertilizers: Application of different liquid biofertilizers significantly influenced the crude gum content in seed of cluster bean (Table 4.17). The highest crude gum content (32.36%) was recorded with *Rhizobium* + PSB + KMB + SSB in the pooled mean. This was at par with *Rhizobium* + PSB (31.75%) and *Rhizobium* + PSB + KMB (32.07%). The increase in the mean crude gum content due to application of *Rhizobium* + PSB + KMB + SSB was 24.99, 8.55, 15.90, 15.94, 20.30 per cent higher over control, *Rhizobium*, PSB, KMB and SSB, respectively.

Crude protein content in seed

Fertility levels: Data (Table 4.17) indicate that increasing levels of RDF caused positive influence in the crude protein content (%) in seed during individual years as well as in pooled mean. In the pooled mean, the highest crude protein content of 20.52% was observed with 100% RDF which was 16.26 and 4.21 per cent higher than 50 and 75% RDF levels, each level being significantly higher than the preceding level.

Liquid biofertilizers: It is apparent from the data (Table 1) that the application of different liquid biofertilizers significantly influenced the crude protein content in seed of cluster bean. The highest crude protein content (21.25%) was recorded with *Rhizobium* + PSB + KMB + SSB in the pooled mean. This was at par with *Rhizobium* + PSB (20.72%) and *Rhizobium* + PSB + KMB (21.09%). The increase in the mean crude protein content due to application of *Rhizobium* + PSB + KMB + SSB was 22.97, 10.56, 13.51, 16.06, 19.92 per cent higher over control, *Rhizobium*, PSB, KMB and SSB, respectively.

Table 1: Effect of different liquid biofertilizers and varying fertility levels on crude gum content and protein content in seed of cluster bean

Treatments	Crude gum content in seed (%)			Crude protein content in seed (%)		
	2018	2019	Pooled	2018	2019	Pooled
Fertility levels						
100% RDF	31.08	32.05	31.57	19.86	21.18	20.52
75% RDF	29.72	30.55	30.13	18.85	20.54	19.69

50% RDF	25.66	26.89	26.27	17.05	18.26	17.65
SEm +	0.37	0.43	0.28	0.21	0.23	0.15
CD (P = 0.05)	1.04	1.21	0.79	0.60	0.64	0.43
Liquid biofertilizers						
Control	25.52	26.26	25.89	16.56	18.00	17.28
Rhizobium	29.26	30.35	29.81	18.50	19.94	19.22
PSB	27.48	28.36	27.92	17.75	19.69	18.72
KMB	27.46	28.35	27.91	17.56	19.06	18.31
SSB	26.15	27.65	26.90	17.00	18.44	17.72
Rhizobium + PSB	31.15	32.35	31.75	20.13	21.31	20.72
Rhizobium + PSB+ KMB	31.65	32.49	32.07	20.50	21.69	21.09
Rhizobium + PSB+ KMB + SSB	31.90	32.82	32.36	20.69	21.81	21.25
SEm +	0.60	0.69	0.46	0.35	0.37	0.25
CD (P = 0.05)	1.70	1.98	1.29	0.98	1.05	0.71
CV (%)	6.21	6.98	6.62	5.57	5.53	5.55

Conclusion

In all, the highest gum content and protein content were recorded with the treatment combination of 100% RDF along with Rhizobium + PSB + KMB+SSB applied, which showed the similar influence with 75% RDF along with Rhizobium + PSB + KMB+SSB. Therefore, the combination of 75% RDF along with Rhizobium + PSB + KMB+SSB was emerged out the best treatment for attaining the higher gum content and protein content in semi arid eastern plain zone (IIIa) of Rajasthan.

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