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Research Communication

Effect of fertility levels and bioinoculants on productivity, profitability, quality and nutrient acquisition of clusterbean (*Cyamopsis tetragonoloba*)

ANIMESH SINGH[1], N.L. JAT[2], RAGHAVENDRA SINGH[3] AND SURESH PAL[4]

Sri Karna Narendra College of Agriculture, Jobner, Rajasthan 303 329

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ABSTRACT

A field experiment conducted during the rainy (*kharif*) season 2008 at Jobner, Rajasthan, to evaluate that effect of fertility and bioinoculants on productivity, nutrient uptake and quality of clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.]. The application of 75% recommended dose of fertilizer along with seed inoculation with *Rhizobium* significantly resulted in more number of effective nodules/plant (19.4), nodules dry weight/plant (17.8 mg), clusters/ plant (17.5), seed (1.10 t/ha) and stover yield (2.99 t/ha) and profitability over seed inoculation of PSB, *Rhizobium* and control. Nitrogen and phosphorus uptake by seed and stover were also significantly higher with 75% recommended dose of fertilizer along with *Rhizobium* over PSB, *Rhizobium* and control. Significantly higher protein content (27.81%) was recorded with application of 75% recommended dose of fertilizer along with *Rhizobium* over PSB, *Rhizobium* and control. Gum content (29.20%) was also higher with application of 75% recommended dose of fertilizer along with *Rhizobium*.

Key words : Crop productivity, Clusterbean, Gum yield, Nutrient uptake, PSB, *Rhizobium*

Clusterbean is a short-duration, drought-resistant legume crop of the rainy (*kharif*) season in arid and semi-arid regions of tropical India. Multiple uses of the clusterbean make it as an important component of cropping systems of the region. Of late, it has acquired the status of industrial crop because of high glactomanan content in the endosperm of its seed, which has multiple industrial uses and thus a main foreign exchange earner for the area (Rathore *et al*., 2007). Clusterbean seed is used as a concentrate for animals and for extraction of gum. Seeds of clusterbean contain 22–33% gum (Choudhary *et al.*, 2014). The gum has its use in several industries, viz. textiles, paper, petroleum, pharmaceuticals, food processing, cosmetics, mining explosives and oil drilling. Being its importance in the country, it has grown in all part of arid and semi-arid regions. The productivity is far low from its potential yield in many of the states due to improper nutrient management under limited moisture (Shubhra *et al*., 2004). Therefore, it has considered as major limiting factors for achieving higher productivity of clusterbean in semi-arid region. The nutrient management thus assumes as an important component to sustain its productivity. Due to poor socio-economic conditions of farmers coupled with low and erratic rainfall distribution, the intensive use of chemical fertilizers is a risky proposition in these regions. Hence low-cost nutrient supplementation through bioinoculants as integrated nutrient-supply system may be a better option to fulfill nutrient requirement of the crop and therefore the present study was under undertaken.

A field experiment was conducted during the rainy (*kharif*) season of 2008 at Agronomy farm of S.K.N. College of Agriculture, Jobner. This year the site received less than normal rainfall (220 mm) during July to October. The soil had 130.2 kg N/ha, 16.5 kg P_2O_5/ha, 151.9 kg K_2O/ha, 0.13% organic carbon and pH 8.1 (1:2.5 soil: water ratio). The experiment was laid out in randomized block design with 10 nutrient-management treatments, comprising control, *Rhizobium*, phosphate-solubilizing bacteria (PSB), 50% recommended dose of fertility (RDF), 75% RDF, 100% RDF, 50% RDF + *Rhizobium*, 50% RDF + PSB, 75% RDF + *Rhizobium* and 75% RDF + PSB and treatments were replicated 3 times. The clusterbean variety 'RGC 936' was sown with the help of hand-operated *desi*

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[1]**Corresponding author Email:** animeshsingh5@gmail.com
[1]Research Scholar, Department of Agronomy, IAS, BHU, Varanasi, Uttar Pradesh 220 005; [2]Ex-Associate Professor and Head, Department of Agronomy, RAU, Bikaner, Rajasthan 334 006; [3]Senior Scientist (Agronomy, ICAR (RC) NEH Region, Sikkim Center, Gangtok Sikkim 737 102; [4]Senior Technical Officer, Agricultural Scientists Recruitment Board, KAB I, Pusa, New Delhi 110 012

plough attached with *pora* at 30 cm rows on 17 July 2008 and harvested on 10 November 2008. The net plot size was 4.0 m × 3.0 m. The recommended dose of fertility (RDF) was 20 kg N + 40.0 kg P_2O_5/ha, applied basal through urea and single superphosphate as per the treatments. Bioinoculants (*Rhizobium* and PSB) were applied as seed inoculation 24 hr before sowing as per the treatments. Five random plants were selected from each plot, excluding the border row, for taking observations. The representative dry samples of shoots and seeds were analysed for ascertaining the nutrient (N and P) content. The N and P contents were analysed by colorimetric method (Linder, 1944) and Vanadomolydo phosphoric acid yellow-colour methods (Jackson, 1958) respectively. Total chlorophyll content of leaves at 40 days after sowing (DAS) was determined by using the method advocated by Arnon (1949) by taking 50 mg fresh leaf material. Samples were homogenized in 80% acetone and centrifuged for 10 minutes at 2,000 rpm and volume of supernatant was made to 10 ml. The resultant colour intensity was measured by spectrophotometer at 652 nm. Protein content in grain was calculated by multiplying nitrogen concentration in grain (%) with a factor of 6.25 (AOAC, 1960). The seed samples were analysed for per cent gum content by phenolsulphuric acid method (Das *et al*., 1977) and yield was computed by using the following formula:

$$\text{Gum yield (kg/ha)} = \frac{\text{Yield of seed (kg/ha)} \times \text{per cent gum content in seed}}{100}$$

The data pertaining to each of the characters of the experimental crops were tabulated and finally analysed statistically by applying the standard technique to draw a valid conclusion. Analysis of variance for randomized block design was worked out as per the standard procedure given by Cochran and Cox (1957) and the significance was tested by 'F' test. Treatment mean differences were separated and tested by Fisher's protected least significant difference (LSD) at a significance level of P=0.05.

Application of integrated use of fertilizers and bioinoculants significantly increased the growth attributes, yield attribute and yields of the cluster bean. The application of 75% RDF + *Rhizobium* which was statistically at par with *Rhizobium*, 50% RDF, 75% RDF, 100% RDF, 50% RDF + *Rhizobium*, 50% RDF + PSB and 75% RDF + PSB, but this treatment significantly enhanced the effective nodules, dry weight of nodules/plant and chlorophyll content (3.9 mg/g) over the PSB and the control (Table 1). The positive or synergistic effect of nitrogen and phosphorus supplied through combination with bioinoculants could be ascribed to its effectiveness in providing a balanced nutritional environment favourably both in rhizosphere and plant system. Greater availability of nutrients in general under the influence of nitrogen and phosphorus fertilization and their utilization by plants was evident from the significant improvement both in concentration and uptake of these nutrients by the crop (Table 1). Simultaneously, the inoculation of seed with *Rhizobium* increased the concentration of strain in the rhizosphere which in turn resulted in greater fixation of atmospheric nitrogen in soil for use by the plants (Yadav and Malik, 2005). Similarly, Sammauria *et al.* (2009) also reported that combined inoculation of *Rhizobium* and PSB along with nitrogen and phosphorus was more promising for productivity of clusterbean.

Highest number of clusters/plant, seed yield and stover yield were recorded with application of 75% RDF + *Rhizobium* (Table 1), being significantly higher over PSB, *Rhizobium* and control, but it remained statistically at par with 100% RDF and 75% RDF with PSB. This might be due to fact that *Rhizobium* inoculation increased the root development, nodulation, nutrient availability resulting in vigorous plant growth and dry-matter production which in turn resulted in better flowering, pod formation and ultimately seed yield. Since PSB might have helped in reducing phosphorus fixation by its chelating effect and also solubilized the fixed form phosphorus leading to more uptake of nutrients and reflected in better yield attributes. The synergistic effect of *Rhizobium* and PSB might have increased the yield attributes and yield owing to increased nitrogenase activity and available phosphorus status of soil. Our findings confirm the results of Shinde and Saraf (1994) and Meena (1997).

The highest crop productivity and profitability recorded with 75% RDF + *Rhizobium,* was at par with 100 % RDF and proved most remunerative than seed treatment with 75% RDF, 50% RDF, PSB, *Rhizobium* and control (Table 1). This might be owing to significant increase in seed and stover yield of clusterbean and low cost of treatments under 75% of recommended dose of fertilizer with *Rhizobium*/phosphate-solublizing bacteria.

Maximum nitrogen uptake of seed as well as stover were found under 75% RDF + *Rhizobium* which was statistically at par with 100% RDF and 75% RDF + PSB. The treatment 75% RDF + *Rhizobium* was significantly superior to PSB, *Rhizobium* and control (Table 2). Similarly, phosphorus uptake of seed as well as stover were also highest under 75% RDF + *Rhizobium* and the treatment was statistically at par with 100% RDF, 75% RDF + PSB, but was significantly superior to PSB, *Rhizobium* and control (Table 2). Application of nitrogen and phosphorus might have improved the nutritional environment in rhizosphere as well as in the plant system, leading to increased uptake and translocation of nutrients especially nitrogen and phosphorus in the reproductive structures resulting in higher uptake. These results are in close conformity with those of Pareek (1995). Application of nitrogen-fixing bioinoculants enhanced the soil nitrogen, and PSB produces the organic acids which may partly be responsible for quick release of nutrients, resulting in more content of nutrients. Seed inoculation with *Rhizobium* and PSB enhanced the nitrogen and phosphorus content in seed and straw and their uptake by crop. Seed inoculation with *Rhizobium* was probably owing to more nitrogen fixation resulting in better utilization of nutrients by plants, which led to more chlorophyll formation and ultimately nitrogen and phosphorus content in seed and straw and protein content in seed. The results confirm the findings of Tanwar *et al.* (2003) in black gram. Significant increase in total uptake of nitrogen and phosphorus by the crop was also observed with PSB inoculation. The PSB enhanced the availability of phosphorus to plants, which might have utilized by the crop in greater root development and nodulation that in turn resulted in higher N fixation. Thus, increased availability of nitrogen and phosphorus might have resulted in greater uptake by the plant for proper development and ultimately increased their contents in plant. Nagar and Meena (2004) also reported similar results in clusterbean. Combined application of chemical fertilizers and bioinoculants was more beneficial in increasing concentration of nitrogen and phosphorus in seed and marginally in stover, might be due to effective and well-developed root-system and the increased availability of these nutrients in the rhizosphere, and the increase in nitrogen and phosphorus uptake by the crop ap-

Table 1. Effect of fertility levels and bioinoculants on growth attributes, yield attributes, yield and profitability of clusterbean

Treatment	Effective nodules/ plant	Nodules dry weight (mg)	Chlorophyll content (mg/g fresh weight)	Clusters/ plant	Seed yield (t/ha)	Stover yield (t/ha)	Crop productivity (kg/ha/day)	Crop profitability (₹/ha/day)
Control	9.0	10.2	2.9	6.8	0.68	2.09	5.8	48.8
Rhizobium	13.5	12.3	3.2	10.0	0.84	2.43	7.2	79.1
PSB	12.1	12.0	3.0	9.6	0.89	2.40	7.6	86.9
50% RDF	12.5	13.4	3.5	13.2	0.91	2.51	7.8	81.2
75% RDF	13.0	13.5	3.4	14.0	0.98	2.62	8.4	94.3
100% RDF	14.4	16.1	3.7	15.9	1.07	2.91	9.2	109.4
50% RDF + *Rhizobium*	15.7	13.6	3.6	13.5	0.96	2.77	8.2	92.1
50% RDF + PSB	16.0	13.2	3.5	13.8	0.98	2.81	8.4	96.3
75% RDF + *Rhizobium*	19.4	17.8	3.9	17.5	1.10	2.99	9.4	116.5
75% RDF + PSB	18.9	17.3	3.4	16.1	1.06	2.90	9.1	108.7
SEm±	0.82	0.88	0.21	0.85	0.06	0.16	0.22	2.50
CD (P=0.05)	2.45	2.62	0.62	2.54	0.17	0.48	0.67	7.42

PSB, Phosphate-solubilizing bacteria; RDF, recommended dose of fertilizer

Table 2. Effect of fertility levels and bioinoculants on nutrient uptake and quality of clusterbean

Treatment	N uptake (kg/ha)		P uptake (kg/ha)		Protein content (%)	Gum content (%)
	Seed	Stover	Seed	Stover		
Control	20.6	16.3	1.71	3.55	19.00	23.14
Rhizobium	31.6	23.5	2.77	4.90	23.56	25.33
PSB	32.7	21.6	2.85	4.81	23.06	24.60
50% RDF	36.3	26.1	3.05	4.89	25.00	26.90
75% RDF	42.1	27.7	3.42	5.13	26.88	28.30
100% RDF	47.3	31.2	3.79	6.41	27.50	29.00
50% RDF + *Rhizobium*	39.5	29.1	3.29	5.81	25.69	27.50
50% RDF + PSB	39.1	29.2	3.35	5.79	24.88	27.10
75% RDF + *Rhizobium*	49.1	34.6	4.03	6.84	27.81	29.20
75% RDF + PSB	40.6	31.3	3.83	6.62	23.88	28.40
SEm±	2.5	1.7	0.20	0.35	1.33	1.65
CD (P=0.05)	7.5	5.1	0.61	1.03	4.06	NS

PSB, Phosphate-solubilizing bacteria; RDF, recommended dose of fertilizer pears owing to cumulative effect of increased seed and stover yield as well as their increased concentration.

Protein content was found maximum with application of 75% RDF (20 kg N and 40 kg P_2O_5/ha) + *Rhizobium.* This treatment was at par with 75% RDF, 100% RDF and was significantly superior to PSB, *Rhizobium* and control. Gum content was not significantly influenced by different treatments, but maximum gum content was recorded with 75% RDF (20 kg N and 40 kg P_2O_5/ha) + *Rhizobium,* followed by 100% RDF. These results are in conformity with those of Malik *et al*. (1981), who have reported increase in protein content and gum yield of clusterbean with the application of phosphorus.

Based on the 1 year experimentation, it is concluded that 75% recommended dose of fertilizer along with *Rhizobium* may be used for getting higher productivity and profitability of clusterbean in the region.

REFERENCES

AOAC, 1960. *Official Method of Analysis*, edn 18, Association of Official Agricultural Chemists, Washington.

Arnon, D.I. 1949. Copper enzymes in isolated chloroplasts I polyphenoloxidase in *Beta vulgaris*. *Plant Physiology* **24**(1): 1–15.

Choudhary, R.S., Yadav, R.S. and Amin, A. 2014. Productivity and economics of clusterbean (*Cyamopsis tetragonoloba*) as influenced by phosphorus fertilization and biofertilizers in western Rajasthan. *Annals of Agricultural Research New Series* **35**(1): 62–64.

Cochran, W.G. and Cox, G.M. 1957. *Experimental Designs*. John Willey & Sons, New York

Das, B., Arora, S.K. and Luthra, Y.P. 1977. A rapid method of determination of gum in guar. (In:) *Proceeding of first ICAR Guar Research Workshop*, CAZRI, Jodhpur, pp. 117–23.

Jackson, M.L. 1958. *Soil Chemical Analysis*, pp. 151–57. Prentice Hall Engle word Cliffs, N.J..

Linder, R.C. 1944. Rapid analytical method for some of the more common inorganic constituents of plant tissues. *Plant Physiology* **19**: 76–89.

Malik, A.C., Dahiya, D.R., Singh, D.P. and Malik, D.S. 1981. Yield and quality of two guar cultivar as influenced by inter row spacing and phosphorus application. *Journal Research, Haryana Agricultural University, Hisar* **11**(2): 198–01.

Meena, K.N. 1997. 'Response of chickpea (*Cicer arietinum* L.) to phosphorus and bioinoculants'. M.Sc. (Agriculture) Thesis, Rajasthan Agriculture University, Bikaner (Unpublished).

Nagar, K.C. and Meena, N.L. 2004. Effect of phosphorus solubilizing bacteria on yield components, yield and quality of cluster bean. *Legume Research* **27**(1): 27–31.

Pareek, R.G. 1995. Response of cluster bean to sulphur levels and sources, phosphorus and plant growth regulators and their residual effect on taramira. *Ph.D. Thesis,* Rajasthan Agricultural University, Bikaner (Unpublished).

Rathore, V.S., Singh, J.P., Soni, M.I., Yadava, N.D. and Beniwal, R.K. 2007. Productivity, quality and resource utilization by clusterbean (*Cyamopsis tetragonoloba*) as influenced by nutrient management. *Indian Journal of Agronomy* **52**(3): 243–46.

Sammauria, R., Yadav, R.S., and Nagar, K.C. 2009. Performance of clusterbean (*Cyamopsis tetragonoloba*) as influenced by nitrogen and phosphorus fertilization and biofertilizers in Western Rajasthan. *Indian Journal of Agronomy* **54**(3): 319–23.

Shinde, V.S. and Saraf, C.S. 1994. Pattern of dry matter accumulation and distribution in chickpea as influenced by phosphorus and sulphur. *Indian Journal of Pulses Research* **7**: 76-79.

Shubhra, Dayal, J., Goswami C.L. and Munjal, R., 2004. Influence of phosphorus application on water relations, biochemical parameters and gum content in clusterbean under water deficit. *Biologia plantarum* **48**(3): 445–48.

Tanwar, S.P.S., Sharma, G.L. and Chahar, M.S. 2003. Effect of P and bioinoculants on yield, nutrient content and uptake by black gram (*Vigna mungo*). *Legume Research* **26**(1): 39–49.

Yadav, R.D. and Malik, C.V.S. 2005. Effect of *Rhizobium* inoculation and various sources of nitrogen on growth and yield of cowpea. *Legume Research* **28**(1): 38–41.