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Effect of bio fertilizers, nitrogen and phosphorus on yield and economics of cluster bean [*Cyamopsis Tetragonoloba* (L.) Taub]

HIMANSHU KULDEEP[1*], PRADHUMAN SINGH MEENA[2], LALCHAND KUMAWAT[1], BISHAN SINGH[3] AND SIMRAN JAST[3]

[1]Department of Agronomy, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

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ABSTRACT

A field experiment entitled "Effect of Bio Fertilizers, Nitrogen and Phosphorus on Yield and Economics of Cluster bean [Cyamopsis tetragonoloba (L.) Taub]" was conducted at Research Farm, Vivekananda Global University, Jaipur during Kharif season of 2021. The experiment was laid out with 8 treatments comprising in a randomized block design with three replications. Results showed that application of bio fertilizers in combination with nitrogen and phosphorus levels brought an additive effect in increasing yield and economics of cluster bean. Maximum number of pods plant^{-1}, number of seeds pod^{-1}, length of pod, seed yield (1453 kg ha^{-1}), straw yield (3028 ha^{-1}), biological yield (4481 kg ha^{-1}), net returns (₹52602 ha^{-1}) and B: C ratio (2.54) of cluster bean was obtained by application of 100% RDF + Rhizobium + PSB (T_8) which was significantly higher over application of 75% RDF, 100% RDF, 75% RDF + Rhizobium and 75% RDF + PSB.

Key words: Biofertilizers, Cluster bean, Yield, Economics

INTRODUCTION

Cluster bean (*Cyamopsis tetragonoloba* L.) popularly known as "Guar" is an important legume crop mainly grown under rain fed conditions in arid and semi-regions of Rajasthan during *kharif* season and has been recognized as one of the best legume crop for the climatic situation of Rajasthan because of hardy and drought tolerant nature. It is a crop having deep tap root system which enables to utilize the available moisture more efficiently from deeper soil layers and offers to sustain production under rain fed situation (Ecocrop, 2010). Cluster bean grow well in hot and dry climate on medium to light textured sandy soils. It can also be grown successfully in soils of poor fertility as well as in areas of erratic rainfall.Cluster bean is a multi-purpose crop and the source of a natural hydrocolloid, which is cold water soluble and form thick solution at low concentrations. The cluster bean seed consists of three parts: the seed coat (14-17%), the endosperm (35-38%), and the germ (43-45%). The guar gum is the prime marketable product of the crop which is present in the spherical-shaped endosperm. The endosperm contains significant amounts of galactomannan gum (19 to 43% of the whole seed), which forms a viscous gel in cold water and is used as a thickener and stabilizer in foods such as, ice-cream and yoghurt. The gum and the water-soluble resin extracted from the seeds are also used in other industries, including paper manufacturing, cosmetics, mining and oil drilling. The sweet and tender young pods are consumed as a vegetable or snacks in north-western and southern India. Its fresh or dry pods are used as vegetable and as livestock feeds. The plant is also used as a green manure and cover crop. Cluster bean is a leguminous crop and can fix 37-196 kg N ha^{-1} per year. Use of biofertilizers can have a greater importance in increasing fertilizer use efficiency. The seed of legumes is inoculated with *Rhizobium* with an objective of increasing their number in the rhizosphere, so that there is substantial increase in the microbiologically fixed nitrogen for the plant growth. The association of *Rhizobium* and legume plants helps in improving fertility of soil and is a cost-effective method of nitrogen fertilization in legumes. Seeds of legume when inoculated with phosphate solubilizing bacteria (PSB) secret acetic substances and solubilize the unavailable soil phosphorus and make available to the crop. The inoculation with phosphate solubilizing bacteria biofertilizer may increase yield of crops by 10-30 per cent. Therefore, there may be a substantial saving of

Corresponding author email: kumawatlalchand522@gmail.com, [2]Vivekanada global university, Jaipur, Rajasthan, India, [3]Deapartment of Agronomy, CCS Haryana Agricultural University, Hisar (Haryana), India

applied nitrogen and phosphorus when seeds are inoculated with *Rhizobium* and phosphate solubilizing bacteria inoculants.

MATERIALS AND METHOD

The field experiment was carried out during *Kharif* season of 2021 at Research Farm, Vivekananda Global University, Jaipur. Geographically, the study area is located at 075°88'99" E longitude and 26°81'17" N latitude and this region falls under agro-climatic zone III A of Rajasthan (Semi-arid Eastern Plain Zone). The region's climate is classified as semi-arid with characterized by aridity of the atmosphere and extremity of temperature both in summer (45.5ºC) and winter (4ºC) with annual rainfall of 500-700 mm. The soil of experimental field was loamy sand in texture, slightly alkaline in reaction.The mean weekly meteorological observations have been depicted graphically in Fig.1.

The experiment was laid out in randomized block design with three replications and consistingeight treatment *viz.* 75% RDF (T_1), 100% RDF (T_2), 75% RDF + *Rhizobium* (T_3), 100% RDF + *Rhizobium* (T_4), 75% RDF + *PSB* (T_5), 100% RDF + *PSB* (T_6), 75% RDF + *Rhizobium* + *PSB* (T_7) and 100% RDF + *Rhizobium* + *PSB* (T_8).The gross plot size was 4.0 m x 3.6 m (14.4 m^2) and total experimental area was 388.8 m^2. The cluster bean variety 'RGC - 1002' was sown on 20th July 2021. On the basis of gross plot size, the required quantity of fertilizer as per treatments was calculated and weighted for different plots. Full recommended dose of 40 kg P_2O_5 ha^{-1} was applied uniformly as basal at the time of sowing. Recommended dose of nitrogen at 20 kg ha^{-1} and was applied half as basal and half as top dressing. The jaggery solution was prepared by boiling 30 g of jaggery in one and half liter water and then cooled; 600 g ha^{-1} of culture of each strain was mixed separately in the solution. The required quantity of seed for a hectare was thoroughly mixed with the paste of culture to inoculate them with *Rhizobium/PSB* and then the seeds were allowed to dry in shade.Five plants were selected randomly from net plot and tagged for measurement of number of pods $plant^{-1}$ and number of seeds pod^{-1}. Ten pods were selected from the observational plants in each plot and their length was measured with the help of meter scale from neck node to the tip and their average was computed and expressed as length of pod in centimeter. After threshing and winnowing of the seeds from each net plot were weighed in kg per plot and converted in kg ha^{-1} for seed yield. After complete drying, the harvested bundles of biomass were weighed and recorded plot wise. The straw yield in kg per plot was recorded after deduction of grain yield from total biomass from each plot and then converted in kg ha^{-1} and express as straw yield kg ha^{-1}.At maturity, dried biomass (pods and straw) from each net plot was harvested and weighed in kg per plot and computed for biological yield as kg ha^{-1}. To find out the most profitable treatment, economics of different treatments was worked out in terms of net returns (₹ ha^{-1}) on the basis of the prevailing market rates after deducting the cost of cultivation from the gross returns so that the most remunerative treatment could be recommended. While benefit: cost ratio for each treatment was calculated to ascertain economic viability of the treatment using the following formula:

$$\text{B: C ratio} = \frac{\text{Net returns (₹ ha}^{-1}\text{)}}{\text{Cost of cultivation (₹ ha}^{-1}\text{)}}$$

Statistical analysis: -Comprehensive statistical analysis (treatment mean, standard error mean, critical difference and range of variation) and test of significance test (F-test) were carried out for each quantitative and qualitative trait. For this, entire biometric data recorded during the course of investigation were compiled in proper tables and statistically analyzed by using the standard procedures of statistical analysis suggest by Fisher and Yats (1963).

RESULTS AND DISCUSSION

Effect of bio fertilizers, nitrogen and phosphorus on yield attributes

An examination of the data related to yield attributes of cluster bean revealed that the different treatments were significantly affected the number of pods $plant^{-1}$, number of seeds pod^{-1} and length of pod of cluster bean and the application of 100% RDF + *Rhizobium* + *PSB* (T_8) produced highest number of pods $plant^{-1}$, number of seeds pod^{-1} and length of pod of cluster bean which was significantly higher as compared to application of 75% RDF, 100% RDF, 75% RDF + *Rhizobium* and 75% RDF +

PSB. It was also observed from the data that application of 100% RDF + *Rhizobium* + *PSB* (T_8) were closely followed by application of 100% RDF + *Rhizobium* (T_4), 100% RDF + *PSB* (T_6) and 75% RDF + *Rhizobium* + *PSB* (T_7). Further examination of data revealed that different treatments had significant difference on seed yield, straw yield and biological yield of cluster bean and the highest seed yield, straw yield and biological yield of cluster bean was produced by the application of 100% RDF + *Rhizobium* + *PSB* (T_8) which was found significantly superior when compared with application of 75% RDF, 100% RDF, 75% RDF + *Rhizobium* and 75% RDF + *PSB* but found at par with application of 100% RDF + *Rhizobium* (T_4), 100% RDF + *PSB* (T_6) and 75% RDF + *Rhizobium* + *PSB* (T_7). However, the lowest seed yield, straw yield and biological yield of cluster bean was recorded with application of 75% RDF (T_1).The beneficial response of inorganic sources of nutrient and biofertilizers on yield attributes and yield of cluster bean might be due to the availability of sufficient amount of plant nutrients throughout the growth period of crop resulting in better uptake of nutrients, plant vigour and improved yield. The increase in pods plant^{-1} may be explained due to increase in number of branches under high fertility levels and biofertilizers inoculation. With the application of higher levels of fertility and biofertilizers, the tissue differentiations from the somatic to reproductive, meristematic activity and the development of floral primordial might have been enhanced causing greater production of flowers which latter developed to pods. Higher fertility level induced greater translocation of photosynthesis from leaves via stem to sink site i.e. pods and seeds and these resulted in longer pods and a greater number of seeds. The results are in conformity with that of Joshi *et al.* (2016), Nadeem *et al.* (2017), Verma *et al.* (2018) and Malek *et al.* (2021).

Further biofertilizers might have played an important role in making the unavailable forms of nutrients into available forms resulting in the better uptake of nutrients subsequently yield increases. The increase in yield with inoculation of *Rhizobium* may be an account of its direct role in nitrogen fixation, production of phytohormone like substances and increased uptake of nutrients such as nitrogen. The increase in yield may also be due to better uptake of nutrients from the soil which might have contributed to increased dry matter accumulation and number of branches per plant ultimately enhanced seed and straw yield of cluster bean. The plant emerging from biofertilizer inoculated seeds recorded significantly higher seed yield than plant emerging from biofertilizer uninoculated seeds. Similar findings were also reported by Kalegore *et al.* (2018), Manohar *et al.* (2018), Yadav *et al.* (2019), Aglawe *et al.* (2021), Parmar *et al.* (2021) and Yogi *et al.* (2021) in various legume crops.

Table 1: Effect of bio fertilizers in combination with nitrogen and phosphorus levels on yield attributes and economic of cluster bean

Treatments	Yield attributes				Yield (kg ha^{-1})			Harvest index (%)	B: C ratio
	No. of pods plant^{-1}	No. of seeds pod^{-1}	Length of pod (cm)	Test weight (g)	Seed	Straw	Biological		
75% RDF (N: P - 15: 30)	27.90	6.08	5.80	25.30	906	1964	2870	31.57	1.32
100% RDF (N: P - 20: 40)	35.47	7.91	7.31	26.31	1170	2518	3688	31.81	1.92
75% RDF + *Rhizobium*	34.97	7.78	7.21	25.93	1159	2493	3652	31.82	1.94
100% RDF + *Rhizobium*	42.25	9.57	8.74	27.48	1430	2997	4428	32.36	2.52
75% RDF + *PSB*	34.27	7.68	7.11	25.63	1151	2425	3575	32.24	1.91
100% RDF + *PSB*	42.08	9.48	8.66	27.35	1421	2968	4389	32.38	2.49
75% RDF + *Rhizobium* + PSB	41.62	9.41	8.54	27.05	1410	2948	4358	32.34	2.53
100% RDF + *Rhizobium* + PSB	42.66	9.67	8.90	27.69	1453	3028	4481	32.42	2.54
SEm±	1.63	0.43	0.38	1.15	61	143	183	1.31	0.14
CD (P = 0.05)	4.94	1.32	1.16	NS	187	435	555	NS	0.43

**NS= Non-significant*

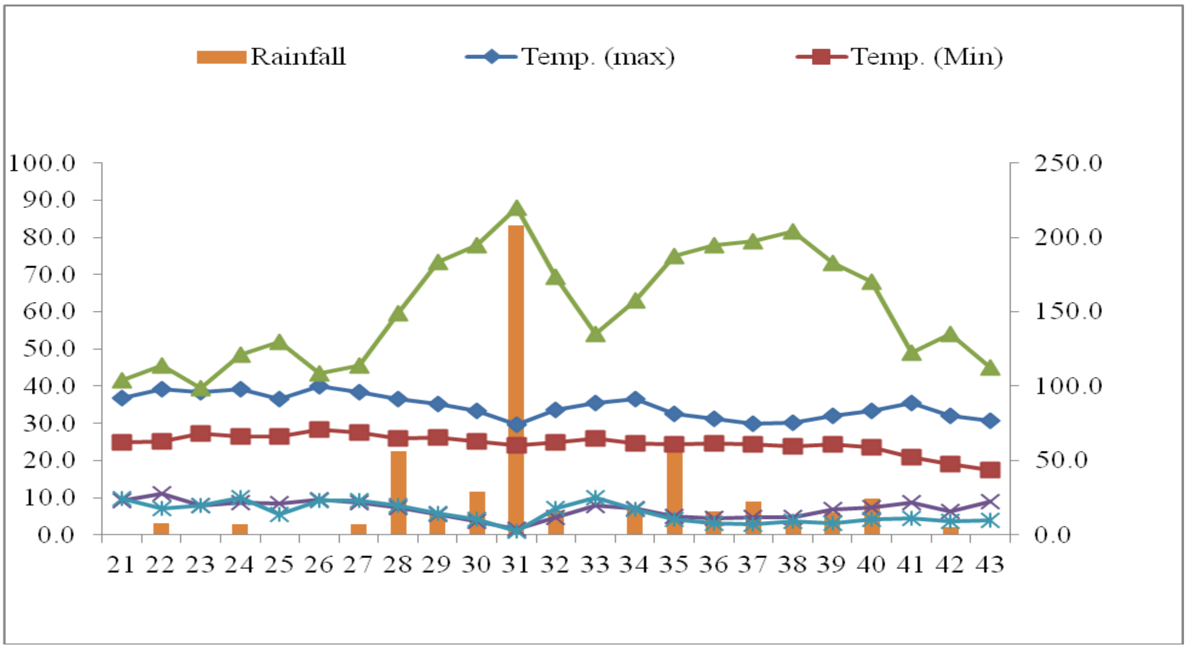

Fig. 1 Mean weekly weather parameters recorded during crop season (*Kharif*, 2021)

Effect of bio fertilizers, nitrogen and phosphorus on economics

A critical analysis of data revealed that the application of bio fertilizers in combination with nitrogen and phosphorus levels had significant difference on net returns and B: C ratio of cluster bean. The significantly maximum net return and B: C ratio was obtained with the application of 100% RDF + *Rhizobium* + *PSB* (T_8) which was closely followed by treatment application of 100% RDF + *Rhizobium*, 100% RDF + *PSB* and 75% RDF + *Rhizobium* + *PSB* and superior to all other treatments. The net returns and benefit: cost ratio was highest with the application of 100% RDF + *Rhizobium* + *PSB* (T_8). The application of inorganic fertilizers significantly enhanced the net returns and B: C ratio which was mainly due to increase in yield of cluster bean owing to enhanced nutritional environment of soil. The results are in close conformity to the findings of Meena *et al.* (2014), Chauhan *et al.* (2016), Jagadale *et al.* (2017), Verma *et al.* (2018) and Samant (2020).

CONCLUSION

Keeping in view the objectives framed for undertaking the study and the results obtained over the experimental period, it may be concluded that the application of bio fertilizers in combination with nitrogen and phosphorus levels significantly influenced yield attributes, yield and economics of cluster bean. Highest yield attributes, seed, straw and biological yield (1453, 3028 and 4481 kg ha^{-1}, respectively) and maximum net return along with highest B: C ratio were produced with the application of 100% RDF + *Rhizobium* + *PSB* (T_8). It was also inferred from the data that application of 75% RDF + *Rhizobium* + *PSB* (T_7) were also produced similar values of these parameters and remained statistically at par with treatment T_8.

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