



## Effect of Fertility Levels and Bio-fertilizers Application on Yield, Yield Attributes, and Economics of Chickpea (*Cicer arietinum* L.)

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### Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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### ABSTRACT

The experiment was conducted during Rabi season of 2017–18 at the Students' Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh to evaluate the effect of different fertility levels and bio-fertilizers application on yield, yield attributes, and quality of late sown chickpea (*Cicer arietinum* L.). The experiment comprised of 12 treatment combinations in split plot design which comprised 4 treatments [F<sub>1</sub> (control), F<sub>2</sub> (RDF 100%), F<sub>3</sub> (75% RDF), F<sub>4</sub> (50% RDF)] in main plot and 3 treatments [B<sub>1</sub> (*Rhizobium* + PSB), B<sub>2</sub> (*Rhizobium* + PGPR) and B<sub>3</sub> (*Rhizobium* + PSB + PGPR)] in sub plots with three replications. Results showed that among the different fertility levels, application of 100% RDF significantly enhanced yield and yield attributes over other treatment. Among the different bio-fertilizers treatments application of *Rhizobium* + PSB + PGPR had significantly improved yield attributes and seed yield as compared

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to *Rhizobium* + PGPR. The combined application of 100% RDF with *Rhizobium* + PSB + PGPR resulted in significantly higher seed yield of late sown chickpea during winter (*Rabi*). Higher values of economics viz., gross return, net return and B:C ratio in chickpea were observed with the application of 100% RDF + (*Rhizobium* + PSB + PGPR) treatments except cost of cultivation.

**Keywords:** Bio-fertilizers; chickpea; rhizobium; PSB; PGPR.

## 1. INTRODUCTION

The pulse crops in India are grown under a wide range of agro-climatic condition. They are an excellent source of dietary protein for human, nutritious feed for livestock. Pulses play an equally important role in rainfed and irrigated agriculture by improving physical, chemical and biological properties of soil and are considered excellent crop for natural resource management, environmental security, crop diversification and consequently for viable agriculture [1].

In India, Madhya Pradesh is the largest pulse producing state, which accounts for 23% of total pulse production. It covers 32.97% area of chickpea in country. Chickpea is the King of pulses consist of more than 1/3 of area and 40% total pulse production. In Asian region chickpea is the premier pulse crop of Indian sub-continent. India is the largest producer as well as consumer of chickpea in the world. It is grown in area of 6.3 million hec. With production of 5.1 mt. The average yield of chickpea is 806 kg/hec. [2].

It is an important source of energy, protein, soluble and insoluble fibre. Mature chickpea grains contain 60-65% Carbohydrates, 6% Fat and 12-25% Protein higher than any other pulse crop. Through symbiotic Nitrogen fixation, the crop meet up to 80% of soil nitrogen needs, so farmers have to apply less N fertilizers [3]. It governs the root growth. P is essential constituent of nucleic acid, phytin, phospholipid, ATP stimulates early root growth, enhances the activity of rhizobia and root nodules. Bio-fertilizers promote plant growth and development also reduce the cost of production as they tend to decrease the doses of chemical fertilizers used. Commonly used microorganisms as bio-fertilizer are Rhizobia, Phosphate Solubilizing Bacteria (PSB) and Plant Growth Promoting Rhizobacteria (PGPR). Seed inoculation with *Rhizobium* increases the nodulation through better root development and improves nutrient availability which is beneficial in improving the grain yield [4,5]. Inoculation of chickpea with *Rhizobium* significantly increased the nodulation and its dry weight, plant height, pods plant<sup>-1</sup>,

1000-grain weight, root length, root dry weight and grain yield (Shahzad et al., 2014; [6]. *Rhizobium* and phosphate solubilizing bacteria (PSB) assume a great importance on account of their vital role in N<sub>2</sub> fixation and P solubilizations. Use of *Rhizobium* and PSB had shown advantage in enhancing chickpea productivity (Rudresh et al. 2005; [7].

## 2. MATERIALS AND METHODS

The experiment was laid out in at the SIF Farm of CSAU&T, Kanpur, Uttar Pradesh. Experimental site area, Kanpur is situated in the central part of U.P. and have sub-tropical climate, characterized by hot summer and cool winters. Total rainfall received during the crop growing period was 15.90 mm. The experiment was consists of 12 treatment combinations and laid out in split plot design assigning four treatments in main plot viz. F<sub>1</sub>- Control, F<sub>2</sub>- RDF (Recommended dose of fertilizer) 100%, F<sub>3</sub>- RDF 75%, F<sub>4</sub>- RDF 50% and three treatments in sub plot viz. B<sub>1</sub>- *Rhizobium* + PSB, B<sub>2</sub>- *Rhizobium*+ PGPR, B<sub>3</sub>- *Rhizobium* + PSB + PGPR with three replications. Each treatment was randomly allocated with in them. The crop was fertilized with a recommended dose of @ 20-60-20-20 kg nitrogen, phosphorus, potassium and sulphur ha<sup>-1</sup>, respectively. Urea DAP, MOP and gandhak powder were used as the source of nitrogen, phosphorus, potassium and Sulphur respectively. Culture of bio-fertilizers i.e. *Rhizobium*, PGPR and PSB, each packet has 200g weight and used for seed treatment at the rate of 20g/kg seed. Seeds were treated with *bio-fertilizers* (20 g per kg of seed) as per standard procedure and were sown after drying for six hours under shade. Chickpea seeds were sown at 75 kg ha<sup>-1</sup> in the furrows opened by the kudal by manual labours at 40 cm row to row spacing and 10 cm plant to plant spacing. The observations were recorded yield attributes such as branches plant<sup>-1</sup>, pods plants<sup>-1</sup>, seeds pod<sup>-1</sup>, 100 seed weight and yield, harvest index (%). Harvest index can be calculated as follows:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

The information was analyzed statistically with standard procedure of ANOVA technique. The standard errors of mean were calculated in each item of investigation and critical differences (CD) at 5% level were worked out for comparing the treatment mean wherever 'F' test was found significant. Das et al. [4].

### 3. RESULTS AND DISCUSSION

At harvest stage maximum number of branches plant<sup>-1</sup> were found with 100% RDF which was statistically at par with 75% RDF but significantly higher than 50% RDF and control in table no 1. Number of pods plant<sup>-1</sup> and number of seeds pod<sup>-1</sup> was found maximum with 100% RDF which was significantly higher than other treatments under table no 1. Similar findings were also reported by [8, 9]. Bio-fertilizer treatments have significantly influenced the yield attributes, viz. number of branches plant<sup>-1</sup>, number of pods plant<sup>-1</sup> and numbers of seeds pod<sup>-1</sup> except 100-seed weight under table no 1. Maximum number of branches plant<sup>-1</sup> at harvest stage was found with B<sub>3</sub> which was significantly higher than other treatments, respectively [10].

The interaction effect of different fertility levels and bio-fertilizers on seed yield was found significant. Application of 100% RDF along with *Rhizobium* + PSB + PGPR resulted in higher seed yield (20 q ha<sup>-1</sup>) which was statistically at par with 75% RDF along with application *Rhizobium* + PSB + PGPR but significantly higher than other fertility levels along with application of *Rhizobium* + PSB + PGPR under table no 1. Higher stover yield was found with

100% RDF which was statistically at par with 75% RDF and significantly higher than other treatments. Higher seed, stover and biological yield were found with the application of B<sub>3</sub> which was significantly higher than other treatments. Increase in seed, stover and biological yield may be due to proper establishment of *Rhizobium* strain which resulted in supply of nitrogen in larger quantity to plants.

In table no. 4, cost of cultivation varies from treatments to treatments. The cost of cultivation was maximum with the application of 100 % RDF treatment and lowest with the application of control treatment respectively [6]. Higher net return was obtained with the application of 100% RDF which was significantly higher than other treatments. However, Maximum net returns were recorded with the application of B<sub>3</sub> treatment which was significantly higher than other treatments. Higher gross return was obtained with the application of 100% RDF which was significantly higher than other treatments. However, Gross returns influenced significantly by different bio-fertilizers treatments. However, maximum gross return was recorded with the application of B<sub>3</sub> treatment which was significantly higher than other treatments. Highest B:C ratio was obtained with the application of 100% RDF which was statistically similar with 75% RDF but significantly higher than other treatments. Different bio-fertilizers treatment were influenced significant effect on B:C ratio. However, maximum B:C ratio were recorded with the application of B<sub>3</sub> treatment which was significantly higher than other treatments respectively [11].

**Table 1. Effect of different fertility levels and bio-fertilizers on yield attributes of late sown chickpea**

Treatments	No. of Branches/plant	No. of pods/ plant	No. of seeds /pod	100 seed wt.(g)
<b>Fertility level (F)</b>				
F <sub>1</sub>	4.00	37.36	1.19	19.04
F <sub>2</sub>	5.13	45.05	1.43	22.06
F <sub>3</sub>	4.64	42.73	1.36	20.40
F <sub>4</sub>	4.43	40.80	1.29	20.20
SEm	0.12	0.99	0.02	0.90
CD (P=0.05)	0.43	3.42	0.08	NS
<b>Bio-fertilizer levels (B)</b>				
B <sub>1</sub>	4.50	41.43	<b>1.37</b>	20.66
B <sub>2</sub>	4.25	39.53	1.21	18.24
B <sub>3</sub>	4.90	43.50	1.41	22.50
SEm	0.08	0.48	0.01	1.13
CD(P=0.05)	0.24	1.44	0.05	NS
FxB	NS	NS	NS	NS

**Table 2. Effect of different fertility levels and bio-fertilizers on yield of late sown chickpea**

Treatments	Seed yield (q ha <sup>-1</sup> )	Stover yield (q ha <sup>-1</sup> )	Biological yield (q ha <sup>-1</sup> )	Harvest Index (%)
<b>Fertility levels</b>				
F <sub>1</sub>	12.15	20.92	40.69	34.27
F <sub>2</sub>	18.05	25.62	50.37	36.15
F <sub>3</sub>	16.30	25.40	48.91	35.32
F <sub>4</sub>	15.62	24.42	46.65	34.57
SEm ±	0.35	0.40	0.57	0.70
CD(P=0.05)	1.19	1.39	1.96	NS
<b>Bio-fertilizer levels</b>				
B <sub>1</sub>	15.75	24.60	47.26	36.12
B <sub>2</sub>	13.14	22.78	44.03	34.73
B <sub>3</sub>	17.68	24.90	48.67	35.37
SEm ±	0.28	0.39	0.48	0.57
CD	0.86	1.17	1.45	NS
(P=0.05)				
FXB	S	NS	NS	NS

**Table 3. Interaction effect of different fertility levels and bio-fertilizers on seed yield of late sown chickpea**

Treatments	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	Mean
B <sub>1</sub>	12	19	16	16	16
B <sub>2</sub>	11	15	13	13	13
B <sub>3</sub>	13	20	19	18	18
<b>Mean</b>	12	18	16	16	16
	SEm±			CD (P == 0.050)	
F at same level/ different B		0.57			1.85
B at same level/different F		0.59			1.82

**Table 4. Effect of fertility levels and bio-fertilizers on economics of chickpea**

Treatments	Gross returns (Rs ha <sup>-1</sup> )	Cost of cultivation (Rs ha <sup>-1</sup> )	Net returns (Rs ha <sup>-1</sup> )	B: C ratio
<b>Fertility levels</b>				
F <sub>1</sub>	99413.33	46241.0	52372.0	2.11
F <sub>2</sub>	124188.3	47041.0	77150.0	2.64
F <sub>3</sub>	118525.0	46969.6	71554.0	2.52
F <sub>4</sub>	112218.3	46418.3	65200.0	2.38
<b>Bio-fertilizer levels</b>				
B <sub>1</sub>	114303.7	47022.2	67265.2	2.43
B <sub>2</sub>	107016.2	46990.0	60026.2	2.27
B <sub>3</sub>	119438.7	47039.5	72416.0	2.54

## 6. CONCLUSION

Based on the finding of the study, it can be inferred that application of 100% RDF (F<sub>2</sub>) with Rhizobium + PSB + PGPR (B<sub>3</sub>) resulted maximum yield and yield attributes. However higher values of economics viz. net return, gross return and cost benefit ratio in chickpea were observed with the application of 100% RDF (F<sub>2</sub>) + (Rhizobium + PSB + PGPR) treatments except cost of cultivation.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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