Effect of fertility levels and biofertilizers on yield, yield attributes, and economics of chickpea (*Cicer arietinum* L.)

Abstract:

The present field 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 biofertilizers 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_1 (control), F_2 (RDF 100%), F_3 (75% RDF), F_4 (50% RDF)] in main plot and 3 treatments [B_1 (*Rhizobium* + PSB), B_2 (*Rhizobium* + PGPR) and B_3 (*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 the control. Among the different biofertilizers treatments application of *Rhizobium* + PSB + PGPR had significantly improved yield attributes and seed yield as compared 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 (F_2) + (Rhizobium + PSB + PGPR) treatments except cost of cultivation.

Key Words: Biofertilizers, Chickpea, Rhizobium, PSB

Introduction

The Pulses crops in India are grown under a wide range of agro-climatic condition. They are an excellent source of dietary protein for millions of people, nutritious feed for livestock and a mini nitrogen plant having profound ameliorative effect on soil. 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 **(Ali and Kumar 2006).** Globally, India is recognized as, a major player in pulses contributing 25% global production, (4-6mt.) and consumer (26-27mt). Import duty on chickpea has been fixed at 60%. The year 2017-2018 had, witnessed record production in pulses (25.23mt). 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 806kg/hec. **(FAOSTAT 2017-18).** 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. **(Sindhu *et al*., 1974).** Phosphorous is the second i.e. next to nitrogen. Due to deficiency of single element Phosphorous, plant cannot complete their life cycle. Hence, P is called 'Key to life'. 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. Biofertilizers promote plant growth and development also reduce the cost of production as they tend to decrease the doses of chemical fertilizers used. These can be used for fodder, food, vegetables and leguminous crops. Commonly used microorganisms as biofertilizer 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 **(Das *et al*., 2013)**. Inoculation of chickpea with *Rhizobium* significantly increased the nodulation and its dry weight, plant height, pods plant^{-1}, 1000-grain weight, root length, root dry weight and grain yield **(Shahzad *et al*., 2014).** Rhizobium and phosphate solubilizing bacteria (PSB) assume a great importance on account of their vital role in N2 fixation and P solubilizations. Use of Rhizobium and PSB had shown advantage in enhancing chickpea productivity **(Rudresh *et al.* 2005).**

Materials and Methods

The experiment was laid out in at the SIF Farm of CSAU&T, Kanpur, Uttar Pradesh. It is located on **25^{o}18′ N** latitude, **83^{0}03′ E** longitude and at an altitude of **80.71 meters** above mean sea level. 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 experimental field is sandy clay loam in texture, neutral in reaction (pH 7.6), EC (0.11 dS/m), low in organic carbon (0.30%), available N (188 kg/ha), medium in available P (13.4 kg ha^{-1}) and available K (173.3 kg/ha). The experiment was consists of 12 treatment combinations and laid out in split plot design assigning four treatments in main plot *viz.* F_1- Control, F_2- RDF 100%, F_3- RDF 75%, F_4- RDF 50% and three treatments in sub plot *viz*. B_1- Rhizobium+PSB, B_2- Rhizobium+ PGPR, B_3- 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^{-1}, respectively. Urea DAP, MOP and gandhak powder were used as the source of nitrogen, phosphorus, potassium and Sulphur respectively. Culture of biofertilizers 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 *biofertilizers* (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^{-1} 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 $plant^{-1}$, pods $plants^{-1}$, seeds pod^{-1}, 100 seed weight and yield, harvest index (%). Harvest index can be calculated as follows:

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

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. **Chandel (1998)**

Result and Discussion

At harvest stage maximum number of branches $plant^{-1}$ were found with 100% RDF which was statistically at par with 75% RDF but significantly higher than 50% RDF and control. Number of pods $plant^{-1}$ and number of seeds pod^{-1} was found maximum with 100% RDF which was significantly higher than other treatments. Similar findings were also reported by **(Raddy and Swamy, 2000; Patil *et al.*, 2001)**. Biofertilizer treatments have significantly influenced the yield attributes, viz. number of branches $plant^{-1}$, number of pods $plant^{-1}$ and numbers of seeds pod^{-1} except 100-seed weight. Maximum number of branches $plant^{-1}$ at harvest stage was found with B_3 which was significantly higher than other treatments, respectively. **(Meena *et al.*, 2005)**.

Table 1. Effect of different fertility levels and biofertilizers on yield attributes of late sown chickpea

Treatments	**No. of Branches/plant**	**No. of pods/ plant**	**No. of seeds /pod**	**100 seed wt.(g)**
Fertility level (F)				
F_1	4.00	37.36	1.19	19.04
F_2	5.13	45.05	1.43	22.06
F_3	4.64	42.73	1.36	20.40
F_4	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
Biofertilizer Level (B)				
B_1	4.50	41.43	**1.37**	20.66
B_2	4.25	39.53	1.21	18.24
B_3	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
F×B	NS	NS	NS	NS

The interaction effect of different fertility levels and biofertilizers on seed yield was found significant. Application of 100% RDF along with *Rhizobium*+ PSB+PGPR resulted in higher seed yield (20 q ha^{-1}) 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. Higher stover yield was found with 100% RDF which was statistically at par with 75% RDF and significantly higher than other treatments **(Singh *et al.* 2016).** Higher seed, stover and biological yield were found with the application of B_3 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 **(Chen *et al.* 2006).**

Table 2. Effect of different fertility levels and biofertilizers on yield of late sown chickpea

Treatments	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest Index (%)
Fertility levels				
F_1	12.15	20.92	40.69	34.27
F_2	18.05	25.62	50.37	36.15
F_3	16.30	25.40	48.91	35.32
F_4	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
Biofertilizers				
B_1	15.75	24.60	47.26	36.12
B_2	13.14	22.78	44.03	34.73
B_3	17.68	24.90	48.67	35.37
SEm ±	0.28	0.39	0.48	0.57
CD (P=0.05)	0.86	1.17	1.45	NS
FXB	S	NS	NS	NS

Table 3. Interaction effect of different fertility levels and biofertilizers on seed yield of late sown chickpea

Treatments	F_1	F_2	F_3	F_4	Mean
B_1	12	19	16	16	16
B_2	11	15	13	13	13
B_3	13	20	19	18	18
Mean	12	18	16	16	16
	SEm±			CD (P == 0.050)	
F at same level/ different B	0.57			1.85	

Bat same level/different F	0.59	1.82

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. 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_3 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 biofertilizers treatments. However, maximum gross return was recorded with the application of B_3 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 biofertilizers treatment were influenced significant effect on B:C ratio. However, maximum B:C ratio were recorded with the application of B_3 treatment which was significantly higher than other treatments.

Table 4. Effect of fertility levels and biofertilizers on economics of chickpea

Treatments	Gross returns (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net returns (Rs ha^{-1})	B: C ratio
Fertility levels				
F_1	99413.33	46241.0	52372.0	2.11
F_2	124188.3	47041.0	77150.0	2.64
F_3	118525.0	46969.6	71554.0	2.52
F_4	112218.3	46418.3	65200.0	2.38
Biofertilizers				
B_1	114303.7	47022.2	67265.2	2.43
B_2	107016.2	46990.0	60026.2	2.27
B_3	119438.7	47039.5	72416.0	2.54

Conclusion

Based on the finding of the present study, it can be inferred that application of 100% RDF (F_2) with Rhizobium + PSB + PGPR (B_3) 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_2) + (Rhizobium + PSB + PGPR) treatments except cost of cultivation.

References

Ali, A., M.S. Zia, Rahmatullah, A. Shah and M. Yasin (1998). Nodulation in Sesbania bispinosa as affected by nitrogen application. Pakistan Journal of Soil Science 15: 183-185.

Chandel SRS (1998). Advance agriculture statics, 2nd Edition, Kalyani Publication, New Delhi.

Chen Y P, Rekha P D, Arunshen A B, Lai W A and Young C C. (2006) Phosphate solubilizing bacteria from subtropical soil and their tri-calcium phosphate solubilizing abilities. *Appl Soil Ecol* **34:** 33-41

Das, S.K.; Chopra, P.; Chatterjee, S.R.; Abrol, Y.P. and -Deb, D.L. (1975) Influence of Sulphur fertilization on yield of maize and protein quality of cereals. *Fert. News.* 20(3): 30 – 32

Fatima, Z., Bano, A., Sial, R., Aslam, M., (2008). Response of chickpea to plant growth regulators on nitrogen fixation and yield. *Pakistan Journal of Botany* 40(5): 2005-2013.

Gupta, S.C. and Gangwar, S. (2012). Effect of molybdenum, iron and microbial inoculants on symbiotic traits, nutrient uptake and yield of chickpea. Journal of Food legumes. 25(1):45-49.

Jat, R. S. and Ahlawat, I. P. S. (2004). Effect of vermicompost, biofertilizer and phosphorus on growth, yield and nutrient uptake by gram (*Cicer arietinum* L.) and their residual effect on fodder maize (*Zea mays* L.). *Indian Journal of Agricultural Sciences* **74** (7): 359-361.

Jat, M.R. and Mali, A.L. (1992) Effect of P and seeding rate on physiological parameters and yield of chickpea.*Indian J.Agron*, **37**(1): 189-190.

Meena KN, Pareek RG, Jat RS (2005). Effect of phosphorus and biofertilizers on yield and quality of chickpea. An. Agric. Res. New Series Vol. 2005; 22(3):388-390.

Patil,B.P. and Jadhav,M.S.(1994) Effect of fertilizer and *Rhizobium* on yield of greengram on medium black soils of Konkan,*J. Indian Soc. Coastal Agric.*phy Siological Res.**12** (1&2):103-104.

Rudresh D L, Shivaprakasha M K, Prasad R D (2005) Effect of combined application of *Rhizobium*, phosphate solubilizing bacterium and Trichoderma spp. on growth, nutrient uptake and yield of chickpea (*Cicer aritenium* L.). *App Soil Ecol* 28: 139-46.

Singh, R.K., Shukla, D.N. and Nirmal, D.E. (2006). Effect of bio-fertilizers, fertility level and weed management on weed growth and yield of late sown chickpea (Cicer arietinum L.). Indian J. of Agric. Sci. 76 (9):561-563.