Indian Journal of Agronomy **64** (1): 138–141 (March 2019)

Research Communication

Effect of fertility levels and biofertilizers on the productivity and profitability of chickpea (*Cicer arietinum*)

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Received : January 2018; Revised accepted : February 2019

ABSTRACT

A field experiment was conducted during winter (*rabi*) season of 2016–17 at Chandra Sekhar Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh to evaluate the effect of fertility levels and biofertilizers on productivity and profitability of chickpea (*Cicer arietinum* L.). The treatments comprised of 4 fertility levels of [F_1 (control), F_2 (RDF 100%), F_3 (75% RDF), F_4 (50% RDF)] in the main-plots and 3 bio-fertilizer levels of [B_1 (*Rhizobium* + PSB), B_2 (*Rhizobium* + PGPR) and B_3 (*Rhizobium* + PSB + PGPR)] in sub-plots 3 times replicated split-plot design. The results showed that application of 100% RDF significantly enhanced the yield attributes, yield and net returns over the other treatments. Among the biofertilizer treatments application of *Rhizobium* + PSB + PGPR recorded significantly higher yield attributes, yield, net returns and benefit: cost ratio compared to other treatments. The combined application of 100% RDF with *Rhizobium* + PSB + PGPR resulted in significantly higher seed yield, gross return, net return and B: C ratio of chickpea over other combinations.

***Key words*:** Biofertilizers, Chickpea, Economics, Fertility levels, Yield

The green revolution in agriculture has been one of the most successful human achievements in India. This revolution resulted in global food security and played an important role in transforming developing countries, such as India, from being food-decient to having a food surplus (Hiremath *et al*., 2017). Chickpea is the world's third most important winter food legume. In India, it occupies about 9.18 million ha area, with a production of 8.22 million tonnes and productivity of 900 kg/ha (Anonymous, 2017). Uttar Pradesh is one of the important chickpea growing state and ranks third in respect to area as well as in production after Madhya Pradesh and Rajasthan. In Uttar Pradesh, chickpea crop occupied 12.6 lakh hectares area, 9.80 lakh tonnes production and 778 kg/ha productivity (Anonymous, 2017). Among the leguminous crops, chickpea occupies an important position due to its nutritious value (17–23% protein), which is deficient in the diet of Indian peoples. It is not only supply the protein, but also enrich the soil fertility through symbiotic nitrogen fixation. There is urgent need to enhance the productivity of chickpea to meet the rising demand, of pulses in India. Majority of farmers in India usually grow pulses on marginal land with indiscriminate use of chemical fertilizers without biofertilizers and other faulty management practices like intensive tillage unscientific application of irrigation etc. that has threatened the sustainability of the crop. There is decline in soil fertility due to reduction of soil organic matter and multi nutrient deficiency. This has become a major limitations for pulse crop production particularly in low-input agricultural systems around the world (Lynch, 2007). Biofertilizers, a type of organic fertilizers, are emerging as an ecologically safe means of fertilization. Commonly used microorganisms as biofertilizer are *Rhizobia,* phosphate solubilizing bacteria (PSB) and plant growth promoting *Rhizobacteria* (PGPR). Biofertilizers augment the biochemical processes in soil such as nitrogen fixation, phosphorus solubilization and mobilization, zinc solubilization, production of plant growth promoting substances and pathogen control. Biofertilizers provide an economically judicious, attractive and ecologically sound means of fertilization (Patel *et al.,* 2013) and are important for making agriculture more sustainable. Therefore, there is a need to find out eco-friendly, feasible and cheaper options to meet the nutrient needs of the chickpea grown in cropping systems for maintaining

Based on the M.Sc. thesis of the first author, submitted to Chandra Sekhar Azad university of Agriculture and Technology, Kanpur (unpublished)

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soil fertility and crop productivity, which is the need of present hour.

A field experiment was conducted during winter (*rabi*) season of 2016-17 at CSAUAT, Kanpur, Uttar Pradesh, which is situated at (25°18' N, 83°03' E and at an altitude of about 80.7 m above mean sea-level). The soil of the experimental field was sandy clay loam in texture with, bulk density 1.52 Mg/m^3, *p*H 7.6, EC 0.11 dS/m, organic carbon 0.30% and available N 188.0 kg/ha, available P 13.4 kg/ha and available K 173.3 kg/ha. Treatment combinations of 4 fertility levels, viz. F_1 (control), F_2 (RDF 100%), F_3 (75% RDF) and F_4 (50% RDF) in the main-plots and 3 treatments [B_1 (*Rhizobium* + PSB), B_2 (*Rhizobium* + PGPR) and B_3 (*Rhizobium* + PSB + PGPR)] in sub-plots, replicated thrice in split-plot design. The fertilizer nutrients were supplied through urea, diammonium phosphate and muriate of potash. Starter dose of nitrogen and full dose of phosphorus and potassium as per treatment were applied at sowing time. Seeds were treated with biofertilizers (20 g/kg of seed) as per standard procedure and were sown after drying for six hours under shade. Chickpea cultivar 'Udai' ('KPG 59') was sown at 40 × cm 10 cm spacing during first week of December with a seed rate of 75 kg/ha. Standard crop husbandry practices were followed during experimentation. The observations of yield attributes, yield and economics were recorded. The information were analysed statistically with standard procedure of ANOVA technique and treatments comparisons were made at 5% level of significance.

All the attributes of yield, viz. number of branches/ plant, number of pods/plant and number of seeds/pod were significantly affected by different fertility levels except 100-seed weight. However, at harvest stage maximum number of branches/plant were found with the application of 100% RDF which was statistically at par with 75% RDF, but significantly higher than 50% RDF and control treatment. Number of pods/plant and number of seeds/pod were found maximum with the application of 100% RDF, which was significantly higher than other treatments. Application of 100% RDF increased number of branches/ plant and pods/plant by enhancing cell differentiation and chlorophyll synthesis. Phosphorus help in vigorous plant root development which resulted in enhanced nutrient uptake, and photosynthates translocation in plant system (Fatima *et al.* 2008). This increase in number of seeds/ pod might be due to application of higher dose of fertilizers, which might have resulted from optimum fertilization of flowers and increased pollen grain viability and there by increased number of seeds/pod (Patil *et al.,* 2001). Biofertilizer treatments have significantly influenced the yield attributes, viz. number of branches/ plant, number of pods/plant and numbers of seeds/pod except 100-seed weight (Table 1). Maximum number of branches/ plant at harvest stage was found with *Rhizobium* + PSB + PGPR treatment, which was significantly higher than other treatments, respectively. Number of pods/plant was found with *Rhizobium* + PSB + PGPR treatment, which was statistically at par with *Rhizobium* + PSB treatment but significantly higher than *Rhizobium* + PGPR treatment. But, maximum number of seeds/plant was found with the application of *Rhizobium* + PSB + PGPR treatment, which was significantly higher than other treatments respectively.

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

Treatment	Branches/ plant	Pods/ plant	Seeds/ pod	100-seed weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest index (%)	Gross returns (×10^3 ₹/ha)	Cost of cultivation (× 10^3 ₹/ha)	Net returns (×10^3 ₹/ha)	Benefit: cost ratio
Fertility level (F)												
F_1	4.50	38.49	1.78	19.04	1.21	2.33	3.53	34.25	55.51	27.67	25.73	0.92
F_2	6.20	46.41	2.52	22.06	1.80	3.20	5.00	36.11	78.83	35.47	43.59	1.23
F_3	6.05	39.40	2.09	20.40	1.62	2.98	4.60	35.31	71.64	33.17	38.26	1.15
F_4	5.53	39.33	1.81	20.30	1.56	2.95	4.51	34.59	68.68	32.30	36.10	1.12
SEm±	0.17	0.92	0.06	0.89	0.03	0.09	0.14	0.70	1.99	–	0.96	0.03
CD (P=0.05)	0.59	3.17	0.22	NS	0.10	0.30	0.48	NS	6.89	–	3.33	0.10
Bio fertilizer (B)												
B_1	5.50	41.16	2.01	20.64	1.57	2.91	44.88	35.12	70.74	31.95	37.22	1.15
B_2	4.99	38.59	1.72	18.23	1.31	2.47	37.74	34.72	57.79	32.10	25.75	0.79
B_3	6.22	42.98	2.43	22.48	1.76	3.21	49.74	35.35	77.46	32.40	44.80	1.37
SEm±	0.13	0.68	0.05	1.12	0.02	0.07	1.04	0.56	1.07	–	0.79	0.03
CD (P=0.05)	0.39	2.03	0.14	NS	0.08	0.20	3.13	NS	3.22	–	2.37	0.08
F × B	NS	NS	NS	NS	S	NS	NS	NS	S	NS	S	S

F_1, Control; F_2, RDF 100%; F_3, 75% RDF; F_4, 50% RDF; B_1, *Rhizobium* + PSB; B_2, *Rhizobium* + PGPR and B_3, *Rhizobium* + PSB + PGPR

This may be due to higher uptake of nutrients by plants because of enhanced nitrogen fixing ability of nitrogen fixers by the addition of biofertilizers and also mineralize and solubilise the nutrients rapidly and provide them to the plants in optimum manner thereby stimulating plant growth that results more number of branches/plant, number of pods/plant and numbers of seeds/pod (Fatima *et al.,* 2008).

Seed, stover and biological yield was influenced significantly due to fertility levels except harvest index (Table 1). Higher seed yield was recorded with the application of 100% RDF, which was significantly higher than other treatments. The interaction effect of fertility levels and biofertilizers on seed yield was found significant. However, *Rhizobium* + PSB + PGPR along with application of 100% RDF gave the highest seed yield (2.0 t/ha), which was statistically at par with *Rhizobium* + PSB along with application of 100% RDF, but significantly higher than *Rhizobium* + PGPR along with application of 100% RDF. Application of 100% RDF along with *Rhizobium* + PSB + PGPR resulted higher seed yield (2.0 t/ha), which was statistically at par with 75% RDF along with application of *Rhizobium* + PSB + PGPR but significantly higher than other fertility levels along with application of *Rhizobium* + PSB + PGPR. Higher stover yield was found with the application of 100% RDF which was statistically at par with 75% RDF and significantly higher than other treatments. But, maximum biological yield was recorded with the application of 100% RDF, which was significantly higher than other treatments. The increase in seed and stover yields under adequate nutrients supply might be ascribed to mainly to the combined effect of higher plant height, more branches/plant, number of pods/plant, more number of seeds/pod and higher 100-seed weight, which was the result of better translocation of photosynthates from source to sink ultimately yield is increased. The increase in seed yield under adequate nutrients supply mainly due to more yield attributes ultimately resulted more seed yield. The increase in biological yield/ha could be attributed to increased seed and stover yields under these treatments and also the pattern of dry matter accumulation at different stages. Similar, observations were reported by Pathak *et al.* (2003). Biofertilizer treatments influenced significantly seed, stover and biological yields. However, higher seed, stover and biological yield was found with the application of *Rhizobium* + PSB + PGPR treatment, which was significantly higher than other treatments. The increase in seed, stover and biological yields may be due to proper establishment of *Rhizobium* strain, which resulted in supply of nitrogen in larger quantity to plants. The application of biofertilizer increased seed, stover and biological yields owing to marked improvement in dry matter accumulation, yield attributes and greater nutrient content and their uptake by chickpea crop (Pyare and Dwivedi, 2005).

Higher gross returns was obtained with the application of 100% RDF, which was significantly higher than other treatments. This might be owing to more seed yield. Gross returns influenced significantly by different biofertilizer treatments. However, maximum gross returns was recorded with the application of *Rhizobium* + PSB + PGPR treatment which was significantly higher than other treatments. The cost of cultivation was maximum with the application of 100% RDF and the lowest with the application of control treatment, respectively. Net returns was influenced significantly by different fertility levels. Maximum net returns was obtained with the application of 100% RDF which was significantly higher than other treatments. Net returns influenced significantly by different biofertilizer treatments. Maximum net returns were recorded with the application of *Rhizobium* + PSB + PGPR treatment which was significantly higher than other treatments. This may be attributed to treatment resulted more seed yield under application of *Rhizobium* + PSB + PGPR. Different fertility levels influenced effect on B: C ratio significant. The 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 biofertilizer treatments influenced effect on B: C ratio significantly. Maximum B: C ratio was recorded with the application of *Rhizobium* + PSB + PGPR treatment which was significantly higher than other treatments.

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