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Effect of different biofertlizers on Yield and Economics in chickpea (*Cicerarietinum* L.)

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Abstract
A field study was carried out at Instructional Farm Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during *Rabi* season 2017-2018 to evaluate effect of different bio-fertilizers on yield and economics of chickpea (*Cicerarietinum* L.). The experiment was comprised with eight treatments (T_1) Control + RDF 100%, (T_2) *Azotobacter*, (T_3) *Rhizobium*, (T_4) Phosphorus solubilizing bacteria (PSB), (T_5) *Rhizobium* + PSB, (T_6) *Rhizobium* + *Azotobacter*, (T_7) *Azotobacter* + PSB, (T_8) *Rhizobium* + PSB + *Azotobacter*. The result revealed that among all the treatments, *Rhizobium* + PSB + *Azotobacter* (T_8) treatment recorded maximum Seed yield **(**22.06 q/ha) straw yield (38.60 q/ha) and gave maximum values of gross return, net returns and benefit cost ratio which is closely followed by T_5 (*Rhizobium* + PSB).

Keywords: Yield, Economics, Azotobacter, PSB, Seed Yield

Introduction
Pulses play a pivotal role and occupy a unique position in Indian agriculture. It provides protein rich diet to vegetarian mass of the country. Chickpea (*Cicerarietinum* L.) seed contain about 20-22% of protein. *Arbuscularmycorrizae*, more commonly known as AM fungi, has a more appropriate meaning. The term refers to the presence of intracellular structurearbuscles that formed in the roots during various phases of development. The AM are found in root system of most flower plants. The AM fungi increased P uptake by plants in three ways (i) absorption of P from soil by hyphae, (ii) translocation of P along with hyphae, and (iii) the transfer of P to cortical root cells, which is readily used by plant. Phosphorus solubilizing bacteria (PSB) has been proved as the cheapest source to increase P availability particularly in legumes which enhance productivity of crops. The PSB possess the ability to bring sparingly soluble inorganic or organic phosphates into soluble form by secreting organic acids. Organic acid may chelate Ca, Al, Fe and Mg resulting in effective availability of these elements along with soil P and hence it's higher utilization by plants. Phosphobacterin is found in soils rich in organic matter and low in available P. The ability of PSB to convert insoluble forms of P to an accessible form is an important trait in sustainable farming for increasing plant yields. In particular, PSB is capable of increasing availability of P to plants either bymineralization of organic P or by solubilization of inorganic P by production of acids. *Azotobacter* is a heterotrophic aerobic bacterium. The free living bacteria fixes nitrogen in the rhizosphere and provides it to the plant. The inoculation useful for cereal and non leguminous crop plants. *Azotobacter* is sensitive to the acidic reaction. *Azotobacter* is believed to be as good as *Rhizobium* under irrigated conditions. *Azotaobacter* a free living N_2fixs has been tried by researcher mainly in cereals, vegetables and the crops other than legumes and is reported to be beneficial in increasing the grain yield of these crops by increasing the nitrogen availability through N_2 fixation in soil.

Materials and methods
A field experiment was conducted at Instructional Farm of the ANDUAT, Kumarganj, Ayodhya (U.P.), during rabi of 2017-18 to evaluate the influence of bio fertilizers on yield and

economics of chickpea. The chickpea cultivated variety Radhey that is 150 days duration variety was sown at 30cm x 10cm spacing with 4m x 3m plot size under subtropical region of Indo Gangetic plains with an average annual rainfall of 1250 mm. The soil of experimental field was clay in texture, alkaline in reaction (pH 8.2 to 8.5). Low in available N (152 kg ha^{-1}), medium in P_2O_5 (16.5 kg ha^{-1}) and high in K_2O (320 kg ha^{-1}) and low in organic carbon (0.21%) respectively. All treatments were randomly allocated and replicated three times in a randomized block design was adopted for the experimentation. The experiment was comprised with eight treatments (T_1) Control + RDF 100%, (T_2) *Azotobacter*, (T_3) *Rhizobium*, (T_4) Phosphorus solubilizing bacteria (PSB), (T_5) *Rhizobium* + PSB, (T_6) *Rhizobium* + *Azotobacter*, (T_7) *Azotobacter* + PSB, (T_8) *Rhizobium* + PSB + *Azotobacter*. For Grain yield (q ha^{-1}) the total biomass of each plot was threshed and cleaned, the seeds obtained were weighed and converted into q ha^{-1}**.** Straw yield was also recorded from each plot by subtraction the grain yield from the total biological yield and expressed in qha^{-1}.The economics of various treatments was calculated by converting the total yield into money value. The cost of cultivation was computed on the prevailing market of expenditure.Net income was calculated by with the following formulae: Net income (Rs ha^{-1}) = Gross income (Rs ha^{-1}) -cost of cultivation. Benefit cost ratio was calculated by dividing net return to the cost of cultivation of the individual treatment combination.

$$BCR = \frac{\text{Net return (Rs.)}}{\text{Cost of cultivation (Rs.)}}$$

The data recorded on various parameters were subjected to statistical analysis following analysis of variance technique and were tested at 5% level of significance to interpret the significant differences.

Result and Discussion

Seed yield and straw yield

Data showed in the table 1 revealed that seed yield increased with the application of RDF100% along with bio-fertilizers (*Rhizobium*, PSB and *Azotobacter*). The maximum seed yield was recorded with treatment T_8 (*Rhizobium* + PSB + *Azotobacter*) followed by T_5 (*Rhizobium* + PSB) which was statistically at par with the treatments T_3 (*Rhizobium*), T_6 (*Rhizobium* + *Azotobacter*) T_4 (Phosphorus solubilizing bacteria) and T_7 *(Azotobacter* + PSB). Data pertaining to seed and straw yield as influenced by various treatments indicated that seed yield of chickpea increased significantly with the inoculation of Rhizobium and PSB. The T_8 (RDF 100% Rhizobium, PSB and azotobacter) had the significant effect on seed yield, straw yield and harvesting index. The inoculation of Rhizobium and PSB enhance the phosphorus availability and this available phosphorus enhances the number of seed yield and straw yield. This might be because of more solubility of P and other nutrients which increased the nutrient availability resulted in sufficient formation of photosynthates which promotes the metabolic activities, accelerates cell division and formation of meristem. Similar findings were reported by Chandra and Pareek (2002), Tiwari *et al.* (2005) [5] and Jarande *et al.* (2006) [2]. The crop having the more harvest index which has more seed yield. Similar results are also reported by Gupta *et al*. 2006 [1].

Economic

Data showed in the table 2 revealed that the maximum cost of cultivation was computed under the application of T_8 (Rhizobium, PSB and azotobacter) followed by T_5 (Rhizobium+ PSB). The minimum cost of cultivation in control T_1 RDF 100%). Highest net return was recorded under treatment T_8 (RDF 100%, Rhizobium, PSB and azotobacter). Maximum gross return (Rs. 125077.2) was computed in T_8 (Rhizobium, PSB and azotobacter) followed by T_5 (Rhizobium + PSB). The minimum gross return (Rs100452) was noted in control T_1 (RDF100%). net returns (Rs 91212.0) was estimated under T_8 (Rhizobium, PSB and azotobacter) followed by T_5 (Rhizobium + PSB). The minimum net return (Rs 67181.8) was estimated in control T_1 (RDF100%) and cost benefit ratio (2.69) was computed in treatment in T_8 (Rhizobium, PSB and azotobacter) followed by T_5 (Rhizobium + PSB). The minimum cost benefit ratio was computed under control T_1 (RDF100%). The treatment T_8 (Rhizobium, PSB and azotobacter) was found significant in higher values of net returns and benefit cost ratio, which might be due to the higher grain and Stover yield. Similar results were found by Swaminathan *et al*. (2007) [4] and Prabhu *et al*. (2010) [3].

Conclusion

On the basis of above discussion it may concluded that the application *Rhizobium* + PSB + *Azotobacter* (T_8) treatment recorded maximum Seed yield (22.06 q/ha) straw yield (38.60 q/ha) and gave maximum values of gross return, net returns and benefit cost ratio which is closely followed by T_5 (*Rhizobium* + PSB), hence this treatment can be recommended for higher yield and may be opted for getting higher benefit: cost ratio.

Table 1: Effect of different Biofertilizer on Seed and Straw Yield

Treatment	Yield (q ha^{-1})	
	Seed	Straw
T_1 Control (RDF100%)	18.10	28.05
T_2 *Azotobacter*	19.06	29.73
T_3 *Rhizobium*	20.70	32.70
T_4 Phosphorus solubilizing bacteria	19.90	31.24
T_5 *Rhizobium* + PSB	21.63	35.04
T_6 *Rhizobium* + *Azotobacter*	20.86	33.58
T_7 *Azotobacter* + PSB	20.56	32.89
T_8 *Rhizobium* + PSB + *Azotobacter*	22.06	38.60
SEm$\pm$	0.75	1.21
CD at5%	2.26	3.67

Table 2: Effect of Different Biofertlizers on Economics

Treatments	Cost of cultivation (Rsha^{-1})	Gross Income (Rsha^{-1})	Net return (Rsha^{-1})	Benefit Cost ratio
T_1 Control (RDF100%)	33265.2	100452	67181.8	2.01
T_2 *Azotobacter*	33415.2	105895.2	72480.0	2.16
T_3 *Rhizobium*	33415.2	115254	81838.8	2.44
T_4 Phosphorus solublizing bacteria	33415.2	110682	76965.0	2.30
T_5 *Rhizobium* + PSB	33715.2	120954.6	87239.4	2.58
T_6 *Rhizobium* + *Azotobacter*	33715.2	116521.2	82806.0	2.45
T_7 *Azotobacter* + PSB	33715.2	114721.2	81006.0	2.40
T_8 *Rhizobium* + PSB + *Azotobacter*	33865.2	125077.2	91212.0	2.69

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