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# Effect of biofertilizers and micronutrients (Zn & B) on growth, yield and economics of chickpea (*Cicer arietinum* L.)

**M Manohar Reddy, Biswarup Mehera and Manas BE Thodkar**

**Abstract**
A field experiment was conducted during *Rabi* season of 2021 at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (U.P) to investigate the effect of biofertilizers and micronutrients (Zn & B) on growth and yield of Chickpea. The treatments consist of biofertilizers (*viz.*, Rhizobium, Phosphate Solubilizing bacteria and Rhizobium + Phosphate Solubilizing bacteria) and micronutrients (Zinc 0.5%, Boron 0.5%, and Zinc 0.5% + Boron 0.5%), whose effect is observed on chickpea (var. RVG 202). The experiment was laid out in randomized block design with ten treatments replicated thrice. The treatment with application of Rhizobium(10g/kg) + Phosphate Solubilizing bacteria(10g/kg) + Zinc(0.5%) + Boron(0.5%) recorded significantly higher plant height (50.21cm), number of branches per plant (20.20), plant dry weight (26.89 g), number of pods per plant (34.26), number of seeds per pod (2.26), seed yield (3.01 t/ha), Stover yield (5.70 t/ha) and test weight (234.96g), compared to other treatment combinations. Maximum Gross return (150544.28 INR/ha), Net return (99400.12 INR/ha) and B: C ratio (2.94) were recorded in treatment with the application of Rhizobium (10g/kg) + Phosphate solubilizing bacteria (PSB) (10g/kg) + zinc (0.5%) + Boron (0.5%) as well.

**Keywords:** Chickpea, biofertilizers, micronutrients, growth, yield, economics

## Introduction
Chickpea is one of the world's most important pulse crops. Scientifically it is named *Cicer arietinum* L. belonged to Leguminosae family. It is a highly nutritious pulse crop and food legumes that are cultivated throughout the world. Chickpea is believed to be originated in south-eastern Turkey and adjoining Syria. There are two important varieties of chickpea which are commercially grown across the world i.e., Desi and Kabuli. Chickpeas are grown in over 50 countries, out of which major producing countries are India, Turkey (7%), Pakistan (5%), Iran (3%), Mexico (3%), Australia (2%), Ethiopia (2%), Canada (2%), Myanmar and Iraq. Among which Ethiopia has the highest chickpea productivity (2038 kg/ha), followed by Mexico (1918 kg/ha) and Australia (1875 kg/ha). Ethiopia just makes up 2.92% and 1.55% in production and area of the world, yet productivity is extremely high when compared to India. India ranks first both in area and production of chickpea in the world as it contributes 70.57% (8.12 million ha) to the total world area and 69.21% (11 million metric tons) to the total world production followed by Australia. India lags behind several countries in terms of productivity of chickpea. The world's largest importer of pulses and chickpeas is India due to high demand and limited supply. Over the past years the cost of cultivation of chickpea is following an increasing trend. The biggest issue with chickpeas in India is, the lowest productivity compared to other countries. Hence more focus should be given on the improvement of the chickpea productivity. The modern agriculture is getting more and more dependent upon the steady supply of synthetic inputs (Inorganic fertilizers). These inorganic fertilisers result into faster vegetative growth and improves crop grain yield but finally results in agricultural intensification and soil degradation. The dependence on inorganic fertilizers can be reduced by use of bio fertilizers in crop cultivation which not only supplies essential nutrients but also help in safeguarding the soil health and also the quality of crop produce. Biofertilizers improve soil fertility level by fixing atmospheric nitrogen, solubilizing insoluble soil phosphates, and releasing plant growth substances in the soil. Biofertilizers are cost effective, eco-friendly, and renewable sources of plant nutrition. Chickpea can meet a significant portion (4–85%) of its N requirement through symbiotic $N_2$ fixation process when grown in association with effective and compatible biofertilizer strain.

Meanwhile, micronutrient zinc is a structural constituent and regulatory co-factor of enzymes involved in various plant biochemical pathways, including photosynthesis, respiration, chlorophyll biosynthesis, and protein, lipid, carbohydrate and nucleic acid synthesis and degradation as well as pollen functionality and fertilisation (Patel M.M. *et al*.2009). whereas Boron influences plant hormone levels, photosynthetic activity, and generative growth in plants, which has an influence on chickpea seed yield. It plays a vital role for chickpea growth especially flowering, fruit and seed set and yields (Ahlawat *et al*., 2007) [2]. Boron influences the absorption of N, P, K and its deficiency affects the optimum levels of macronutrients.

Considering the above facts, the present investigation entitled "effect of biofertilizers and micronutrient on growth, yield and economics of chickpea was conducted to study and construct a best possible combination of biofertilizers and micronutrient (Zn & B) to be adopted in chickpea in eastern Uttar Pradesh conditions.

## Material and Methods

A field experiment was conducted during *Rabi season* of *2021* at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (UP). The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), medium in organic carbon (0.48%), medium in available Nitrogen (278.93 kg/ha), low in available Phosphorous (19.03 kg/ha) and medium in available Potash (238.1 kg/ha). The treatments consist of biofertilizers (*viz.*, Rhizobium, Phosphate Solubilizing bacteria and Rhizobium + Phosphate Solubilizing bacteria) and micronutrients (Zinc 0.5%, Boron 0.5%, and Zinc 0.5% + Boron 0.5%), whose effect is observed on chickpea (var. RVG 202). The experiment was laid out in Randomized Block Design with ten treatments replicated thrice. The experiment comprising ten treatment possible combination of above factor, *viz*., $T_1$: Rhizobium (20g/kg) + zinc (0.5%) $T_2$: Rhizobium (20g/kg) + boron (0.5%), $T_3$: Rhizobium (20g/kg) + zinc (0.5%) + boron (0.5%), $T_4$: Phosphate solubilizing bacteria (PSB) (20g/kg) + zinc (0.5%), $T_5$: Phosphate solubilizing bacteria (PSB) (20g/kg) + boron (0.5%), $T_6$: Phosphate solubilizing bacteria (PSB) (20g/kg) + zinc (0.5%) + boron (0.5%), $T_7$: Rhizobium (10g/kg) + Phosphate solubilizing bacteria (PSB) (10g/kg) + zinc (0.5%), $T_8$: Rhizobium (10g/kg) + Phosphate solubilizing bacteria (PSB) (10g/kg) + boron (0.5%), $T_9$: Rhizobium (10g/kg) + Phosphate solubilizing bacteria (PSB) (10g/kg) + zinc (0.5%) + Boron (0.5%), $T_{10}$: Control, observations regarding growth, yield and economics was recorded during the field experiment.

## Result and Discussion

### Growth

The data related to plant growth was analysed at different plant growth stages. It was observed that plant growth increased at a rapid rate during the early crop period starting from the initial stage to crop development stage and then it was stable during the period thereafter irrespective of the treatments. However, treatment with application of Rhizobium (10g/kg) + Phosphate solubilizing bacteria (PSB) (10g/kg) + zinc (0.5%) + Boron (0.5%) recorded significantly higher plant height (50.21 cm), number of branches per plant (20.20) and plant dry weight (26.89 g) compared to other treatment combinations.

Plant growth of chickpea increased significantly during all crop growth stages, this might be due to the fact that integrated use of bio fertilizers and micronutrient leads to better adaption of plants and also supplied the plant with required nutrients throughout the cropping season, this allowed the plant to grow with lesser competition. The foliar spray of micronutrient supplies zinc and boron which creates a stimuli in the plant system and enhancing the cell division increasing growth in plant, ultimately promoting the required growth and development. Similar findings were reported by Khoja *et al.* (2002) [7] and Verma *et al. (*2004) [10].

### Yield attributes

The effects of seed inoculation with biofertilizers and foliar micronutrient administration on maturity time, pods per plant, seeds per pod and test weight were all significant. The combinational inoculation treatments had the highest values of these characteristics, i.e., treatment with application of Rhizobium (10g/kg) + Phosphate solubilizing bacteria (PSB) (10g/kg) + zinc (0.5%) + Boron (0.5%) recorded maximum number of pods per plant (34.26), seed per pod (2.26) and higher test weight (234.96 g) compared to other treatment combinations.

The better performance of yield attributes might be due to the combinational effect of biofertilizers and micronutrients as it increased biological nitrogen fixation and other physiological process in addition the micronutrients resulted in rapid vegetative and post reproductive growth which significantly enhanced the yield attributes in chickpea. Similar findings were reported by Bidya rani *et al*. (2016) [4] and Balachandra *et al*. (2003).

### Yield

After analysing the data collected during the field experiment, it was discovered that treatments with the application of Rhizobium (10g/kg) + Phosphate solubilizing bacteria (PSB) (10g/kg) + zinc (0.5%) + Boron (0.5%) recorded significantly higher grain yield (3.01 t/ha), stover yield (5.70 t/ha) and harvest index (34.51%) compared to other treatment combinations.

The grain yield is the final expression of physiological and metabolic activities of the plant. The increase in seed yield in treatment with application of Rhizobium (10g/kg) + Phosphate solubilizing bacteria (PSB) (10g/kg) + zinc (0.5%) + Boron (0.5%) might be due to cumulative effect of biofertilizers and micronutrient as they contribute in better plant growth and effectively increased the yield per unit area. Similar findings were reported by Bozorgi H.R. *et al*. (2014) [5] and Ramprasad D.P. *et al*. (2011).

### Economics

The economic was evaluated for different treatment combination, it was observed that treatments with the application of Rhizobium (10g/kg) + Phosphate solubilizing bacteria (PSB) (10g/kg) + zinc (0.5%) + Boron (0.5%) recorded significantly higher gross return (INR 150544.28/ha), net return (INR 99400.12/ha) and B:C ratio (2.94) as against other treatment combinations.

**Table 1:** Growth attributes of Chickpea as influenced by Biofertilizers and Micronutrients (Zn & B).

| Treatment | Growth attributes (100 DAS) | | |
|---|---|---|---|
| | **Plant height (cm)** | **No. of Branches/plant** | **Plant dry Weigh(g)** |
| Rhizobium (20g/kg) + zinc (0.5%) | 45.06 | 18.53 | 26.41 |
| Rhizobium (20g/kg) + boron (0.5%) | 43.24 | 18.40 | 26.35 |
| Rhizobium (20g/kg) + zinc (0.5%) + boron (0.5%) | 48.40 | 19.40 | 26.77 |
| PSB (20g/kg) + zinc (0.5%) | 43.73 | 17.93 | 26.26 |
| PSB (20g/kg) + boron (0.5%) | 43.10 | 17.67 | 26.21 |
| PSB (20g/kg) + zinc (0.5%) + boron (0.5%) | 47.31 | 19.07 | 26.65 |
| Rhizobium (10g/kg) + PSB (10g/kg) + zinc (0.5%) | 45.79 | 18.53 | 26.49 |
| Rhizobium (10g/kg) + PSB (10g/kg) + boron (0.5%) | 43.57 | 18.20 | 26.41 |
| Rhizobium (10g/kg) + PSB (10g/kg) + zinc (0.5%) + boron (0.5%) | 50.21 | 20.20 | 26.89 |
| Control | 41.26 | 16.80 | 26.14 |
| S.Em(±) | 0.31 | 0.15 | 0.02 |
| CD (p=0.05) | 0.94 | 0.45 | 0.07 |

**Table 2:** Yield attributes of Chickpea as influenced by Biofertilizers and Micronutrients (Zn & B).

| Treatment | Yield attributes | | |
|---|---|---|---|
| | **No. of pods/plant** | **No. of seeds/plant** | **Test weight (g)** |
| Rhizobium (20g/kg) + zinc (0.5%) | 29.26 | 2.00 | 228.62 |
| Rhizobium (20g/kg) + boron (0.5%) | 28.46 | 2.00 | 225.69 |
| Rhizobium (20g/kg) + zinc (0.5%) + boron (0.5%) | 31.53 | 2.00 | 231.76 |
| PSB (20g/kg) + zinc (0.5%) | 29.46 | 2.00 | 227.90 |
| PSB (20g/kg) + boron (0.5%) | 27.13 | 2.00 | 225.58 |
| PSB (20g/kg) + zinc (0.5%) + boron (0.5%) | 30.26 | 2.00 | 230.30 |
| Rhizobium (10g/kg) + PSB (10g/kg) + zinc (0.5%) | 29.13 | 2.00 | 227.36 |
| Rhizobium (10g/kg) + PSB (10g/kg) + boron (0.5%) | 28.40 | 2.00 | 226.38 |
| Rhizobium (10g/kg) + PSB (10g/kg) + zinc (0.5%) + boron (0.5%) | 34.26 | 2.26 | 234.96 |
| Control | 22.60 | 1.80 | 219.67 |
| S.Em(±) | 0.33 | 0.02 | 0.36 |
| CD (p=0.05) | 1.00 | 0.06 | 1.07 |

**Table 3:** Yield of Chickpea as influenced by Biofertilizers and Micronutrients (Zn & B)

| | **Seed yield (t/ha)** | **Stover yield (t/ha)** | **Harvest index (%)** |
|---|---|---|---|
| Rhizobium (20g/kg) + zinc (0.5%) | 2.20 | 4.61 | 32.40 |
| Rhizobium (20g/kg) + boron (0.5%) | 2.12 | 4.45 | 32.27 |
| Rhizobium (20g/kg) + zinc (0.5%) + boron (0.5%) | 2.41 | 5.43 | 30.77 |
| PSB (20g/kg) + zinc (0.5%) | 2.21 | 4.33 | 33.83 |
| PSB (20g/kg) + boron (0.5%) | 2.01 | 4.02 | 33.43 |
| PSB (20g/kg) + zinc (0.5%) + boron (0.5%) | 2.30 | 4.97 | 31.67 |
| Rhizobium (10g/kg) + PSB (10g/kg) + zinc (0.5%) | 2.18 | 4.28 | 33.81 |
| Rhizobium (10g/kg) + PSB (10g/kg) + boron (0.5%) | 2.12 | 4.19 | 33.68 |
| Rhizobium (10g/kg) + PSB (10g/kg) + zinc (0.5%) + boron (0.5%) | 3.01 | 5.70 | 34.51 |
| Control | 1.63 | 3.79 | 30.29 |
| S.Em(±) | 0.05 | 0.15 | 0.82 |
| CD (p=0.05) | 0.17 | 0.46 | 2.43 |

**Table 4:** Economics of different treatment combinations as influenced by Biofertilizers and Micronutrients (Zn & B)

| | **Cost of Cultivation (INR/ha)** | **Gross Returns (INR/ha)** | **Net Returns (INR/ha)** | **B:C Ratio** |
|---|---|---|---|---|
| Rhizobium (20g/kg) + zinc (0.5%) | 51394.16 | 110399.92 | 59005.76 | 2.15 |
| Rhizobium (20g/kg) + boron (0.5%) | 51294.16 | 106008.28 | 54714.12 | 2.07 |
| Rhizobium (20g/kg) + zinc (0.5%) + boron (0.5%) | 51544.16 | 120588.36 | 69044.20 | 2.34 |
| PSB (20g/kg) + zinc (0.5%) | 50594.16 | 110805.35 | 60211.19 | 2.19 |
| PSB (20g/kg) + boron (0.5%) | 50494.16 | 100990.69 | 50496.53 | 2.00 |
| PSB (20g/kg) + zinc (0.5%) + boron (0.5%) | 50744.16 | 115016.04 | 64271.88 | 2.27 |
| Rhizobium (10g/kg) + PSB (10g/kg) + zinc (0.5%) | 50994.16 | 109293.51 | 58299.35 | 2.14 |
| Rhizobium (10g/kg) + PSB (10g/kg) + boron (0.5%) | 50894.16 | 106080.81 | 55186.65 | 2.08 |
| Rhizobium (10g/kg) + PSB (10g/kg) + zinc (0.5%) + boron (0.5%) | 51144.16 | 150544.28 | 99400.12 | 2.94 |
| Control | 50144.16 | 81912.01 | 31767.85 | 1.63 |

*Data was not subjected to statistical analysis.

## Conclusion

Based on the above experimental findings, it is concluded that application of biofertilizers and foliar application of micronutrients in combination of Rhizobium (10g/kg) +

Phosphate solubilizing bacteria (PSB) (10g/kg) + zinc (0.5%) + Boron (0.5%) accomplished better growth parameters, yield attributes, higher seed yield, higher gross returns and net returns in chickpea under eastern Uttar Pradesh conditions.

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