Influence of Biofertilizer and Phosphorus on Yield and Economics of Chickpea (*Cicer arietinum* L.)

ABSTRACT

The field experiment entitled "Influence of Biofertilizer and Phosphorus on Yield and Economics of Chickpea (*Cicer arietinum* L.)" was conducted during *rabi* season, 2022 at Crop Research Farm in the Department of agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj Uttar Pradesh. The study included Biofertilizer *Rhizobium*, PSB and *Rhizobium* + PSB, and three levels of Phosphorus (20, 40 and 60 kg/ha) and control. The experiment was layout in Randomized Block Design (RBD) with 10 treatments and replicated thrice. The soil in the experimental area was sandy loam with pH (7.8), Organic Carbon (0.43%), Available N (181.58 kg/ha), Available P (15.45 kg/ha) and Available K (197.64 kg/ha). Application of (*Rhizobium* + PSB + Phosphorus 60 kg/ha) produces higher Seed yield (1537.20 kg/ha.), Stover yield (3195.12 kg/ha.), Gross Return (INR 97985/ha.), Net Return (INR 66560/ha.) and B:C Ratio (2.12).

Keywords: Chickpea, Biofertilizer, Phosphorus, Yield and Economics.

Introduction

"Chickpea (*Cicer arietinum* L.) is a multipurpose pulse crop consumed by the people in different forms *viz*. dal leaves, germinated seed etc. Chickpea belongs to the family Leguminosae. This pulse crop contains between 17% and 23% protein" **(Ali and Kumar, 2006; Kumar *et al*., 2014)**. "chickpea is grown in about 50 countries around the world covering an area of 149.66 lakh ha with an average global productivity of 1252 kg/ha. India is the leading producer of chickpea contributing to about 70% of the world's chickpea production. In India, Madhya Pradesh (39%), Maharashtra (14%), Rajasthan (14%), Uttar Pradesh (7%), Karnataka (6%) and Gujarat (5%) are the major chickpea growing states. In India pulses are grown nearly in 28.83 m ha with an annual production of 25.72 m t and productivity of 0.8 t ha Some of the states like Uttar Pradesh is about 8.24 m ha with an annual production of 9.97 m t and productivity of 1.08 t ha major producer of chickpea in India as advocated by Ministry of agriculture and Farmers Welfare” **(GOI, 2020-21)**.

The importance of bio-fertilizers, which provide the macro and micronutrients required for plant growth, is also well acknowledged. *Rhizobium* and pulse plants work together to increase soil fertility. *Rhizobium* usage has provided up new avenues for phosphorus nutrition. *Rhizobium* seed inoculation improved the production of chickpea seeds and stover as well as the number of nodules and pods/plant **(Swarnkar *et al*., 2010)**. The cheapest source to improve P availability, particularly in legumes, which increases agricultural yield, has been identified as phosphorus solubilizing bacteria (PSB). In addition to preserving the soil fertility, using effective nutrient management techniques in conjunction with PSB will help to increase chickpea yield and quality **(Singh *et al*., 2014)**. A crucial characteristic in sustainable farming for boosting plant yields is PSB's capacity to transform insoluble forms of P into an accessible form.

Phosphorus is an essential structural element of many molecules and serves a crucial functional role in the transmission of energy and the regulation of metabolism. Additionally, phosphorus is essential for pod filling, which eventually increases grain output. It has a positive impact on yield, growth, and nodulation. it is crucial in both the energy transfer reaction and the oxidation and reduction reactions. Fertilization with phosphorus is a significant input in the production of crops **(Blackshaw *et al*. 2004)**. As a component of nucleoproteins and nucleotides, it participates in metabolic processes and plays a crucial part in the synthesis of energy-rich bonds like ADP and ATP.

2. MATERIALS AND METHODS

This experiment was laid out during the *Rabi* season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The crop research farm is situated at 25^0 39” 42” N latitude, 81^0 67” 56” E longitude and at an altitude of 98 m above mean sea level. The experiment was laid out in Randomized Block Design Which consisting of ten treatments with T_1 – (*Rhizobium* + Phosphorus 20 kg/ha), T_2 – (PSB + Phosphorus 20 kg/ha), T_3 – (*Rhizobium* + PSB + Phosphorus 20 kg/ha), T_4 - (*Rhizobium* + Phosphorus 40 kg/ha), T_5 -(PSB + Phosphorus 40 kg/ha), T_6 - (*Rhizobium* + PSB + Phosphorus 60 kg/ha), T_7 - (*Rhizobium* + Phosphorus 60 kg/ha), T_8 - (PSB + Phosphorus 60 kg/ha), T_9 -(*Rhizobium* + PSB + Phosphorus 60 kg/ha), T_{10} - Control (RDF 20-50-20). Seeds are sown at a spacing of 30×10 cm to a seed rate of 80 kg/ha.

The recommended dose of nitrogen (20 kg/ha) via Urea, phosphorus (50 kg/ha) via SSP and potassium (20 kg/ha) via MOP. Nitrogen, phosphorus and potash was applied as basal at the time of sowing. One hand weeding was done manually with *Khurpi* at 25 DAS followed by second manual weeding was done at 45 DAS. This was done to control grass as well as broad leaf weeds. At 30 days after sowing nipping was done by removing the tips of the younger plant. Two irrigation was applied to field. All agronomic practices are followed in order in the crop period. "Experimental data collected was subjected to statistical analysis by adopting Fisher's method of analysis of variance (ANOVA) as outlined by Gomez and Gomez. Critical Difference (CD) values were calculated wherever the 'F' test was found significant at 5 percent level" (**Gomez and Gomez, 1984)**

RESULT AND DISCUSSION:

Seed Yield (kg/ha):

The data revealed that Treatment 9 [*Rhizobium* + PSB + Phosphorus 60 kg/ha] was recorded significantly maximum Seed yield (1537.20 kg/ha) which was superior over all other treatments in (Table 1). Significant increase in seed yield might be due to the Dual inoculation of *Rhizobium* can increase seed yield in pulse crop up to 10 to 15% while PSB increase availability of insoluble phosphorous into soil. Results were similar to **Singh *et al*. (2018)**. "Further seed yield was with application of phosphatic fertilizer therefore provided balance nutrition to the crop which resulted in higher seed yield of lentil. Phosphorus also increased the photosynthesis and translocation of assimilates to different plant parts for enhanced growth and yield attributing characters of the crop as observed in number of pods/plant and number of seeds/pod. In the later stage, the excess assimilates stored in the leaves was translocated towards sink development which ultimately contributed to higher seed yield". [12] These findings were supported by **Choubey *et al*., (2013)**.

Stover yield (kg/ha):

The data revealed that Treatment 9 [*Rhizobium* + PSB + Phosphorus 60 kg/ha] was recorded significantly maximum Stover yield (3195.12 kg/ha) which was superior over all other treatments in (Table 2). Significant increase in stover yield with Dual inoculation of *Rhizobium*, PSB increase in nitrogen availability in soil leads to increase in content of nitrogen in seed and increase in P availability through solubilization of insoluble native P and production of plant growth promoting substances. Results were similar to **(Singh *et al.*, 2014)**. “Significant and higher stover yield was with application of phosphorus might have contributed for better growth of plant as expressed in terms of plant height, number of nodules/plants, dry weight, which improved nutrient uptake, resulted increased in stover yield”. [13] Similar findings were reported by **Choubey *et al.*, (2013)**.

ECONOMICS

Cost of Cultivation (INR/ha)

Cost of production (INR 31445/ha) was found to be highest in treatment 8 [PSB + Phosphorus 60 kg/ha] as compared to other treatment.

Gross return (INR/ha)

Gross return (INR 97985/ha) was found to be highest in treatment 9 [*Rhizobium* + PSB + Phosphorus 60 kg/ha] as compared to other treatment.

Net return (INR/ha)

Net return (INR 66560/ha) was found to be highest in treatment 9 [*Rhizobium* + PSB + Phosphorus 60 kg/ha] as compared to other treatment.

B: C Ratio

Benefit Cost Ratio (2.12) was found to be highest in treatment 9 [*Rhizobium* + PSB + Phosphorus 60 kg/ha] as compared to other treatment. Similar findings are also recorded by **Singh, D. and Singh, H. (2012)**.

CONCLUSION:

Based on the above findings it can be concluded that application of *Rhizobium* + PSB along with the application of Phosphorus 60 kg/ha (Treatment 9) observed highest seed yield, stover yield, gross return, net return and benefit- cost ratio in chickpea.

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Table: 1 Effect of Biofertilizer and Phosphorus on Yield of Chickpea.

S.No.	Treatment combinations	At Harvest	
		Seed Yield (kg/ha)	**Stover Yield (kg/ha)**
1.	*Rhizobium* + Phosphorus 20 kg/ha	1163.78	2802.96
2.	PSB + Phosphorus 20 kg/ha	1195.68	2843.36
3.	*Rhizobium* + PSB + Phosphorus 20 kg/ha	1383.03	3086.92
4.	*Rhizobium* + Phosphorus 40 kg/ha	1245.45	2925.04
5.	PSB + Phosphorus 40 kg/ha	1355.80	2953.61
6.	*Rhizobium* + PSB + Phosphorus 40 kg/ha	1416.56	3142.4
7.	*Rhizobium* + Phosphorus 60 kg/ha	1202.97	2912.16
8.	PSB + Phosphorus 60 kg/ha	1294.87	3040.72
9.	*Rhizobium* + PSB + Phosphorus 60 kg/ha	1537.20	3195.12
10.	Control (NPK 20-50-20 kg/ha)	1145.42	2714.23
	F-test	S	S
	SEm (±)	54.72	89.90
	CD (p=0.05)	162.57	267.07

Table: 2 Effect of Biofertilizer and Phosphorus on Economics of Chickpea

S.No.	Treatment combination	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	Benefit Cost ratio
1.	*Rhizobium* + Phosphorus 20 kg/ha	29594	76103	46509	1.57
2.	PSB + Phosphorus 20 kg/ha	29634	78006	48372	1.63
3.	*Rhizobium* + PSB + Phosphorus 20 kg/ha	29614	89219	59605	2.01
4.	*Rhizobium* + Phosphorus 40 kg/ha	30500	81070	50570	1.66
5.	PSB + Phosphorus 40 kg/ha	30540	87100	56560	1.85
6.	*Rhizobium* + PSB + Phosphorus 40 kg/ha	30520	91286	60766	1.99
7.	*Rhizobium* + Phosphorus 60 kg/ha	31405	78739	47334	1.51
8.	PSB + Phosphorus 60 kg/ha	31445	84285	52840	1.68
9.	*Rhizobium* + PSB + Phosphorus 60 kg/ha	31425	97985	66560	2.12
10.	Control (NPK 20-50-20 kg/ha)	28530	74679	46149	1.62