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The Role of Biofertilizers and Phosphorus on Growth and Yield of Chickpea (*Cicer arietinum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An agronomic investigation to study the response of Biofertilizers and Phosphorus in chickpea crop. Experiment was conducted during *Rabi* season of year 2023 at Crop Research Farm, Department of Agronomy. The treatments consisted of three levels of Biofertilizers (PSB- 20, Rhizobium-20, and Rhizobium+PSB-20g/kg seed) and 3 levels of Phosphorus (30,45,60 kg/ha) along with RDF control (20-40-20 kg N-P-K/ha). The experiment was laid out in Randomized Block Design with three replications. Application of Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed + PSB 20g/kg seed (Treatment 9) was recorded highest growth attribute (plant height, maximum plant dry weight, no. of

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nodules, CGR and RGR) and yield attribute (pods per plant, seeds per pod and test weight) along with produced higher seed yield (20.71 kg/ha), straw yield (4147.13 kg/ha) and harvest index (28.98%).

Keywords: Biofertilizers; chickpea; phosphorus; rhizobium; growth and yield attribute.

1. 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 (*Cicer arietinum* L.) belongs to the family Leguminosae. It is also known as Gram, Bengal gram and king of pulses but its vernacular name is "Channa" which is an important pulse crop grown in northern India during *Rabi* season. Chickpea is the most important seed legume and improving its yield and quality is a necessity. It is mainly grown as a rain-fed crop during the *Rabi* season on conserved soil moisture from the preceding monsoon" [1]. The desi type however, is more prominent – it accounts for close to 80-85% and the kabuli type around 15-20% of the world's total production. India produces mostly the desi type chickpeas.

"Chickpea is a major *Rabi* pulse crop and is largely grown in marginal and sub marginal lands of semi-arid tropics, which are characterized by poor fertility status and moisture stress. 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. 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" [2]. **"**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" [3].

"Chickpea is an excellent source of protein (18-22%), carbohydrates (52-70%), fat (4-10%), minerals (calcium, phosphorus, iron etc.) and vitamins. It is an excellent animal feed and its straw has good forage value" [4].

"The role of Bio-fertilizers is also well recognized which supplies macro and micro nutrients necessary for the plant growth. Bio-fertilizers also develops a sustainable agriculture system by maintaining soil fertility, soil physical properties, ecological balance and providing stability to the production without polluting soil, water and air. Biofertilizers- a cost-effective renewable energy source play a crucial role in reducing the inorganic fertilizer application and at the same time increasing the crop yield besides maintaining soil fertility. *Rhizobium* is unique in that they are the only nitrogen-fixing bacteria living in a symbiotic relationship with legumes. The productivity of leguminous crops in dry land could be improved by *Rhizobium* inoculation" [5] "*Rhizobium* multi strain inoculation significantly increased dry weight of shoots, roots and nodules and number of nodules of chickpea. *Rhizobium* sp. to control the chickpea diseases has also been reported" [6].

"Chickpea is a major pulse crop in India. There is a good possibility to increase its production by exploiting better colonization of the roots and rhizospheres through application of effective nitrogen fixing bacteria to the seed or to the soil. This can minimize uses of nitrogenous fertilizer, which is very costly in this country. Using high yielding varieties of chickpea along with use of effective rhizobial strains can enhance the yield" [7]. "Use of PSB culture increase nodulation, crop growth, nutrient uptake and crop yield. phosphate solubilizing bacterial (PSB) inoculants play an important role in making P available to crop plants as they increase the yield *Rhizobium* and phosphate solubilizing bacteria (PSB) had shown advantage in enhancing chickpea productivity. The enhanced root development and nodulation through application of phosphorus helps in improving the supply of nutrients and water to the growing parts resulting in more dry matter production in chickpea" [8].

"Phosphorus also plays a key role in pod filling and ultimately enhances the grain yield. The nitrogen-fixing capability of legumes can be enhanced by the supply of adequate amounts of nutrients, especially phosphorus (P) and sulphur (S)" [9] The addition of phosphorus in these crops also provides shoot hardiness, photosynthesis regulation, enhances nodulation,

improved grain quality and plant growth, ultimately superior yields [10].

2. MATERIALS AND METHODS

The experiment was conducted during the *Rabi* season 2023, at the Crop Research Farm (CRF), Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) which is located at 25° 39' 42"N latitude, 81° 67 56" E longitude, and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the river *Yamuna* by the side of Allahabad Rewa Road about 5 km away from Prayagraj (U.P) city. This farm has sufficient irrigation facilities accessible. The lowest 7.6 temperature during the growing season is between and 18.6^0C, while the highest temperature during that time is between 18.6 and 35^0C. During the cropping period, relative humidity ranged from 38.75 to 94.57 percent. The experiment was laid out in Randomized Block Design with three replications. 10 treatments *viz.* T_1- Phosphorus 30 kg/ha + PSB 20g/kg seed, T_2 – Phosphorus 30 kg/ha + Rhizobium 20g/kg seed, T_3 – Phosphorus 30 kg/ha + *Rhizobium* 20g/kg seed + PSB 20g/kg seed, T_4– Phosphorus 45 kg/ha + PSB 20g/kg seed, T_5– Phosphorus 45 kg/ha + *Rhizobium* 20g/kg seed, T_6 – Phosphorus 45 kg/ha Rhizobium 20g/kg seed + PSB 20g/kg seed, T_7– Phosphorus 60 kg/ha+ PSB 20g/kg seed, T_8– Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed, T_9 – Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed + PSB 20g/kg seed and T_{10}– Control. All plots of experiment were equally fertilized with recommended dose of fertilizers. Fertilizers were applied at 3-5cm deep furrows were made along the seed rows with a hand hoe. The nutrient source was Urea, MOP to fulfill the requirement of nitrogen, phosphorous and potassium. The recommended dose of N 20 kg/ha, P 40 kg/ha and K 20 kg/ha were applied according to the treatment details. Nitrogen, phosphorus and potash was applied as basal at the time of sowing. Seed treatment with *Rhizobium*, PSB will be done before 24 hours of sowing according to the treatment details. The soil at the test location was sandy loam, with medium amounts of organic carbon (0.62 %), available nitrogen (225 kg ha^{-1}), available phosphorus (38.2 kg ha^{-1}), and available potash (240.7 kg ha^{-1}) with a moderate response that was somewhat alkaline (8 pH). Seeds were sown in line manually on 7th November 2023 at a depth of 3 cm in furrows with seed rate of 80 kg/ha. Seeds are covered with soil immediately after sowing the seeds. The spacing of crop between row-row and plant to plant was 30x10 cm. The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by Gomez and Gomez [11].

3. RESULTS AND DISCUSSION

3.1 Growth Attributing Characters

“At 100 DAS, significantly and higher plant height (66.87 cm) and dry weight (18.49g/plant) was recorded with Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed + PSB 20g/kg seed (Table 1). However, the treatment Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed was found to be statistically at par with treatment 9. Plant height with *Rhizobium* and PSB might be due to increase in uptake of N and P by the plants, which might be due to more N-fixation and P-solubilization through micro-organisms. Similar findings also reported earlier” by [12], Singh et al. [13]. “Significantly maximum number of nodules per plant (21.66,31.99 and 29.55 at 40,60 and 90 DAS respectively) was recorded with application of Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed + PSB 20g/kg seed. However, treatment Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed was found statistically at par with Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed + PSB 20g/kg seed. Application of *Rhizobium*, increase the number of nodules by availability of nitrogenase enzyme PSB facilitates the nodule formation by proper development of nodules by increasing availability of phosphorus through the mobilizing the unavailable phosphorus present in soil” Singh et al. [13].

“Effect of Biofertilizer and Phosphorus on Crop Growth Rate (Table 2) at 20-40, 40-60 and 60-80 DAS were found no significant difference to used various treatments. However, at 80-100 DAS, was recorded significantly maximum crop growth rate (37.23 g/m^2 /day) with Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed. Significantly higher RGR recorded (0.4, 0.07 and 0.03 g/g/day at 20-40, 40-60 and 80-100 DAS respectively) with Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed. CGR and RGR were higher might be due to application of Phosphorus which increased the chlorophyll content and higher photosynthates. Similar finding also reported” by [14,15].

3.2 Yield and Yield Attributing Characters

“Increases in growth-related characters eventually showed up in yield-related characters

Table 1. Effect of Biofertilizer and Phosphorus on growth attributing characters in chickpea

Notation	Treatments	Plant height at 100 DAS	Dry weight at 10 DAS	Number of nodules		
				40 DAS	60 DAS	80 DAS
T_1	Phosphorus 30 kg/ha + PSB 20g/kg seed	60.31	17.05	16.23	25.78	21.01
T_2	Phosphorus 30 kg/ha + *Rhizobium* 20g/kg seed	63.90	17.11	17.20	24.81	22.45
T_3	Phosphorus 30 kg/ha + *Rhizobium* 20g/kg seed + PSB 20g/kg seed	64.18	17.80	17.27	27.92	23.60
T_4	Phosphorus 45 kg/ha + PSB 20g/kg seed	61.31	17.54	18.00	28.45	24.23
T_5	Phosphorus 45 kg/ha + *Rhizobium* 20g/kg seed	64.48	17.84	18.21	25.36	22.92
T_6	Phosphorus 45 kg/ha *Rhizobium* 20g/kg seed + PSB 20g/kg seed	65.62	17.93	18.63	26.14	23.86
T_7	Phosphorus 60 kg/ha+ PSB 20g/kg seed	62.58	16.89	19.67	29.33	26.26
T_8	Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed	66.27	18.07	20.53	29.00	26.63
T_9	Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed + PSB 20g/kg seed	66.87	18.49	21.66	31.99	29.55
T_{10}	Control	58.78	16.82	14.57	24.11	22.68
	SE m±	0.64	0.23	1.25	1.27	0.91
	C.D. at 5%	1.90	0.71	3.72	3.78	2.70

Table 2. Effect of Biofertilizer and Phosphorus on CGR and RGR in chickpea

Notation	Treatments	CGR				RGR			
		20-40 DAS	40-60 DAS	60-80 DAS	80-100 DAS	20-40 DAS	40-60 DAS	60-80 DAS	80-100 DAS
T_1	Phosphorus 30 kg/ha + PSB 20g/kg seed	2.88	8.71	9.60	3.96	0.04	0.05	9.60	0.01
T_2	Phosphorus 30 kg/ha + *Rhizobium* 20g/kg seed	2.89	9.33	9.55	3.48	0.04	0.05	9.55	0.01
T_3	Phosphorus 30 kg/ha + *Rhizobium* 20g/kg seed + PSB 20g/kg seed	2.91	9.39	9.04	5.22	0.04	0.05	9.04	0.02
T_4	Phosphorus 45 kg/ha + PSB 20g/kg seed	2.79	9.61	9.35	4.79	0.04	0.05	9.35	0.01
T_5	Phosphorus 45 kg/ha + *Rhizobium* 20g/kg seed	2.84	9.40	9.46	4.77	0.04	0.05	9.46	0.01
T_6	Phosphorus 45 kg/ha *Rhizobium* 20g/kg seed + PSB 20g/kg seed	2.86	9.26	9.64	5.10	0.03	0.05	9.64	0.01
T_7	Phosphorus 60 kg/ha+ PSB 20g/kg seed	2.88	9.36	9.55	2.99	0.04	0.05	9.55	0.01
T_8	Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed	2.98	9.36	9.33	5.37	0.03	0.06	9.33	0.01
T_9	Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed + PSB 20g/kg seed	2.86	9.33	9.85	5.28	0.04	0.07	9.85	0.03
T_{10}	Control	2.72	9.28	8.65	5.23	0.03	0.04	8.65	0.01
	SE m±	0.06	0.19	0.44	0.48	0.002	0.0008	0.0011	0.0009
	C.D. at 5%	NS	NS	NS	1.45	0.006	0.002	NS	0.002

Table 3. Effect of Biofertilizer and Phosphorus on yield and yield attributing characters in chickpea

Notation	Treatments	No. of pods /plant	Number of seeds/pod	Test weight (g)	SeedYield (kg/ha)	StrawYield (kg/ha)	Harvest index (%)
T_1	Phosphorus 30 kg/ha + PSB 20g/kg seed	49.30	1.75	39.3	1225.18	2956.10	23.49
T_2	Phosphorus 30 kg/ha + *Rhizobium* 20g/kg seed	50.6	1.88	40.6	1275.06	3695.23	25.89
T_3	Phosphorus 30 kg/ha + *Rhizobium* 20g/kg seed + PSB 20g/kg seed	53.73	1.90	40.9	1305.00	3757.03	21.26
T_4	Phosphorus 45 kg/ha + PSB 20g/kg seed	52.8	1.94	39.6	1339.57	3024.01	25.90
T_5	Phosphorus 45 kg/ha + *Rhizobium* 20g/kg seed	56.46	1.95	41.5	1508.01	3847.30	22.67
T_6	Phosphorus 45 kg/ha *Rhizobium* 20g/kg seed + PSB 20g/kg seed	58.06	1.90	41.6	1514.00	3992.18	22.78
T_7	Phosphorus 60 kg/ha+ PSB 20g/kg seed	58.73	1.92	39.7	1477.17	3161.07	32.22
T_8	Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed	64.33	1.97	41.8	1748.00	4074.11	27.57
T_9	Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed + PSB 20g/kg seed	67.60	2.20	42.2	2071.10	4147.13	28.98
T_{10}	Control	48.80	1.35	39.6	1149.09	2667.05	26.24
	SE m±	2.53	0.14	1.17	0.78	40.15	1.3
	C.D. at 5%	7.52	0.42	NS	2.32	119.29	3.15

viz. number of pod/plants, number of seeds/pod and test weight (Table 3); which were recorded higher (67.60, 2.20 and 42.2g respectively) with T_9 (Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed + PSB 20g/kg seed). Higher number of pod/plants, number of seeds/pod and test weight were recorded with the application of phosphorus which it might be the reason of moderate plant nutrients availability due to which the plant produces more number of pod/plants, number of seeds/pod and test weight as compare to other treatments and also phosphorus strongly increases the reproduction of the plants i.e., flowering and fruiting. These results were similar with that" of Abid et al. [16].

"The benefits of Biofertilizer and Phosphorus on different yield-contributing traits such as *viz*. pod/plants, number of seeds/pod and test weight & growth characters (plant height, number of nodous, CGR, RGR and dry matter accumulation) resulted in Higher grain yield, straw yield, and harvest index (2071 kg/ha, 4147.13kg/ha and 28.98% respectively). Effect of Biofertilizer and Phosphorus on yield and yield attributing characters have been also reported" by [17,18].

4. CONCLUSION

It can be concluded from the present investigation that Biofertilizer and Phosphorus with Phosphorus 60 kg/ha+ *Rhizobium* 20g/kg seed + PSB 20g/kg seed was recorded maximum growth & yield attributing characters along with yield of chickpea.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Singh G, Sekhon HS, Sharma P. Effect of irrigation and biofertilizer on water use, nodulation, growth and yield of chickpea (*Cicer arietinum* L.). Archives of Agronomy and Soil Science. 2011;57:715–726.
2. GOI. Economics and statistics of Indian agriculture. Annual report, Government of India, New Delhi; 2020-21.
3. Ashutosh Tripathi, Rajnish, Ram Niwas and AS Yadav Response of integrated nutrient management on growth and productivity of wheat (*Triticum aestivum* L.) 2022;11(7):991-994.
4. Prasad R. Textbook of field crops production. Vol. 1, pp 320-321. Indian Council of Agricultural Research, New Delhi; 2012.
5. Abdelgani ME, Osman AG, Mohamed SS. Restoring soil fertility of desertified lands through biological nitrogen fixation In: Desertification in the third millennium (eds.A.S. Sharhan, W.W. Wood, A.S. Goudie, A. Fowler and E.M. Abdellatif). A.A. Balkima Publishers. Lisse, the Netherlands. 2003;335-338.
6. Arfaoui A, Sifi B, Boudabous A, Hadrami IEl, Cherif M. Identification of rhizobium isolates possessing antagonistic activity against *Fusarium oxysporum* F. sp. ciceris, the causal agent of Fusarium wilt of chickpea. Journal of Plant Pathology. 2006;88:67-75.
7. Bhuyan MAH, Khanam D, Hossain MF, Ahmed MS. Effect of rhizobium inoculation on nodulation and yield of chickpea in calcareous soil. Bangladesh Journal of Agriculture Research. 2008;33(3):549-554.
8. Das AK, Khaliq QA, Haque MM, Islam MS. Effect of phosphorus fertilization on dry matter accumulation, nodulation and yield in chickpea. Bangladesh Research Publication Journal. 2008;1:47-60.
9. Islam M, Mohsan S, Ali S, Khalid R, Fayyaz Ul, Hassan MA, Subhani A. Growth, nitrogen fixation and nutrient uptake by chickpea (*Cicer arietinum* L.) in response to phosphorus and sulphur application under rainfed conditions in Pakistan. International Journal of Agriculture and Biology. 2011;13:725–730.
10. Kumar S, Tripathi DK, Bharose R, Kumar MKR, Kumar R. Effect of different fertility level and micronutrients on nodulation and nutrient uptake by chickpea. Asian Journal of Soil Science. 2016;11(1):63-65.
11. Gomez KA, Gomez AA. Statistical procedures for agricultural research. John wiley & sons; 1984.
12. Patel KK, Pandey AK, Baheliya AK, Rai R, Bhadauria S, Sachan R. Production and economic feasibility of chickpea (*Cicer arietinum* L.) by the diverse bioinputs and

soil nutrients amendments. International Journal of Plant & Soil Science. 2022;34(21):15-24.
13. Singh R, Pratap Singh. D, Singh G, Singh AK. Effect of phosphorus, Sulphur and biofertilizers on growth attributes and yield of chickpea (*Cicer arietinum* L.) Journal of Pharmacognosy and Phytochemistry. 2018;7(2):3871-3875.
14. Kumar J, Kumar S, Prakash V. Effect of biofertilizers and phosphorus levels on soil fertility, yield and nodulation in chickpea (*Cicer arietinum* L.). Journal of the Indian Society of Soil Science. 2019;67(2):199-203.
15. Chauhan MP, Singh IS. Variability estimate and identifying chickpea (*Cicer arietinum* L.) genotype for yield and yield attributes in salt affected soil. Legume Research. 2017;23(3):199- 200.
16. Abid Ali. Effect of phosphorous and zinc on yield of lentil. Pure Applied Biology. 2017;6(4):1397-1402.'
17. Singh Y, Singh B, Kumar D. Effect of phosphorus levels and biofertilizer on yield attributes, yield and nutrient uptake of chickpea (*Cicer arietinum* L.) under rainfed condition. Research on Crops. 2014;15(1):90-95.
18. Choubey SK, Dwivedi VP, Srivastava NK. Effect of different levels of phosphorus and sulphur on growth, yield and quality of lentil. Indian Journal Science and Research. 2013;4(2):149-150.

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