Journal of Food Legumes
37(1): 80-83, 2024
DOI: 10.59797/jfl.v37.i1.179

Research Paper

Productivity and profitability of chickpea as influenced by varying levels of phosphorus and bio-fertilizers under sub-tropical conditions of Madhya Pradesh

Aman Parashar*, Jaidev Sharma, Shama Parveen, Awadhesh Kishore and Priyanka Chand

Department of Agronomy, School of Agriculture, ITM University, Gwalior, India

***Corresponding author email:** aman96parashar@gmail.com*

Received: *23 January 2024*
Accepted: *31 March 2024*

Handling Editor:
Dr. Mohd. Hashim, ICAR-Indian Institute of Pulses Research, Kanpur, India

ABSTRACT

In the present study, the influence of phosphorus and bio-fertilizers was investigated on the productivity and profitability of summer black gram. The experimental study revealed that among the phosphorus levels, the application of 50 kg P ha^{-1} recorded significantly the high seed (1108 Kg ha^{-1}) and stover (2616 Kg ha^{-1}) yield. However, among the bio-fertilizers, the application of phosphate solubilizing bacteria + *Rhizobium* resulted in the highest seed (1116 Kg ha^{-1}) and stover yield of chickpea (2655 Kg ha^{-1}). Application of 50 kg ha^{-1} phosphorus and combined treatment of phosphate solubilizing bacteria + *Rhizobium* incurred the highest cost of cultivation (₹ 30,421 ha^{-1}), highest gross return (₹ 1,00,015 ha^{-1}), net return (₹ 69,594 ha^{-1}) and benefit-cost ratio (₹ 2.29). It can be concluded that the applicationof 50 kg ha^{-1} phosphorus and treatment of phosphate solubilizing bacteria+ *Rhizobium* in chickpea cultivation may be profitable.

***Key words*:** Biofertilizers, Chickpea, Economics. Phosphorus, Yield.

INTRODUCTION

India is the largest producer and consumer of pulse crops throughout the World. In South and Southeast Asia, it is among the most significant legume crops. It makes up about 25% of all pulses produced worldwide. Although pulses are grown in only one-third of the world's total area, India depends heavily on these crops for its food system. Given that they account for a sizeable portion of India's exports, pulses are an important class of crop there. Pulses are used as a catch crop, cover crop, main crop, intercrop, and green manure crop. Their minimal input requirements and excellent output make them equally vital to Indian agriculture. After dry beans and peas, chickpea (*Cicer arietinum* L.), commonly referred to as the gram pea, garbanzo bean, or ceci bean, is the third most important pulse crop farmed globally. Thanks to their symbiotic nitrogen fixation potential, chickpeas can fix 140 kg of atmospheric nitrogen per hectare. However, nutrient mining brought about by over-cultivation and the growth of crops that deplete minerals has left the soil lacking in both macro- and micronutrients. These days, the exclusive use of nitrogenous fertilizers has led to an imbalance in soil nutrients, particularly in micronutrient availability. Unbalanced use of nutrients reduces crop yields; therefore, the application of nutrients must be regulated for agricultural production.

A key macronutrient that is needed by plants for growth and development is phosphorus. Orthophosphate anion is the form of phosphorus that plants take up from soil solution. It is a major component of ATP, RNA, and DNA and hence plays a crucial role in the transmission of genetic information and intracellular energy within living cells. It conducts a wide range of activities associated with growth and development and is required by the majority of young, rapidly growing tissues (Ogola *et al.* 2012). Phosphorus boosts the symbiotic organic process because it makes bacterium cells mobile, which is necessary for their migration to plant organs for nodulation. Phosphorus aids in healthy root growth, which increases root nodules and then speeds up the organic process. Accordingly, 80% of India's soils require the use of P at recommended amounts (Motsara 2002), and the application of some P fertilizer would be necessary to stop P mining from the soils to maintain high agricultural yields.

Bio-fertilizers, also known as microbial inoculants, are substances used to treat soil and seeds that contain living or dormant cells of beneficial microorganism strains (Mishra *et al.* 2010). These organisms aid crop plants in absorbing nutrients through their interaction in the rhizosphere and can biologically change nutritionally important elements from an unavailable to an available form. The biofertilizers that reside in the root zone encourage plant development and nutrient uptake by releasing auxins and gibberellins. They also raise the levels of the powerful plant growth hormones gibberellic acid and indole acetic acid in plants. For plants to use atmospheric nitrogen, it must be altered or fixed. In addition to promoting plant growth and development, biofertilizers lower production costs because they tend to utilize fewer chemical fertilizer doses. They can be utilized for leguminous crops, vegetables, food, and fodder (Ali *et al*. 2006). Three regularly used microorganisms as biofertilizers (PGPR) are rhizobia, plant growth-promoting rhizobacteria, and phosphate-solubilizing bacteria (PSB). Pulses have similar nutritional needs as cereal, however because of their special biological nitrogen fixation ability, just 20 kg ha^{-1} of nitrogen is advised. *Rhizobium* and phosphate solubilizing bacteria (PSB) play a crucial part in N_2 fixation and P solubilizations, which gives them a significant amount. *Rhizobium* and PSB use have been beneficial in raising chickpea productivity (Rudresh *et al*. 2005). Hence, applying phosphatic fertilizers coupled with PSB enhances the uptake of phosphorus by plants as well as significantly raising crop production (Kachave *et al*. 2018). To increase yield and economic return from chickpea, it is essential to apply sufficient fertilizers and the right strain of biofertilizers. The present study is important in supporting earlier research, particularly concerning Madhya Pradesh's Gird region. Thus, keeping the above fact in view, an experiment was conducted to assess the productivity and profitability of chickpea as influenced by varying levels of phosphorus and bio-fertilizers under sub-tropical conditions of Madhya Pradesh.

MATERIALS AND METHODS

The experiment was conducted under a sub-tropical climate which experiences the mean annual rainfall of 900 mm and has the hot and dry early summers followed by hot and humid monsoon season and cold winters. Of the total rainfall received in the Gwalior outskirts, only 70-75 % of rainfall is received from June to early October, whereas the remaining 25-30 % of rain is received throughout the year with a major portion of rains during the winters. The present investigation was conducted in *Rabi* 2021–22 and 2022–23 at the Crop Research Centre of School of Agriculture, ITM University, Gwalior (M.P.). Geographically, the experimental site is located at an elevation of 206 meters above mean sea level which has a value of 26°14' N latitude and 78°14' E longitude It falls in the sub-tropical areas on the outskirts of Gwalior, Madhya Pradesh.

The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction (pH 7.57); low in organic carbon (4.0%); available nitrogen (183.5 kg ha^{-1}) and potassium (243.0 kg ha^{-1}), however they were medium in terms of available phosphorus (14.4 kg ha^{-1}).

Experimental design and treatment details

The field experiment comprised sixteen treatment combinations, which were laid out in a factorial randomized block design with three replications. The treatments comprised of two factors i.e. phosphorus levels *viz*., 0, 30, 40, 50 kg P_2O_5 ha^{-1} and bio-fertilizers i,e., no inoculation, PSB, *Rhizobium*, PSB + *Rhizobium*.

Crop management

The chickpea crop variety, JG-16 was sown in lines at a spacing of 30 cm between the rows × 10 cm between the plants. The crop was fertilized with a recommended dose of nitrogen through urea @ 20 kg ha^{-1} which was broadcasted in the field a day before the sowing. However, phosphorus application was made as per the requirement of the treatment and application of biofertilizers *i.e. Rhizobium* and Phosphate solubilizing bacteria (PSB), were applied through seed treatment method just before sowing as per the treatment. Further, the crop was managed as per regional recommendations of the crop.

The grain and stover yields of chickpea were recorded at harvest from the plots and scaled to per hectare. The cost of cultivation, net return, and benefit-cost ratio computation were based on the primary yield data and minimum support price. Statistical analysis of yield and yield attributes was performed to examine the effect of different treatments. The analysis of variance was conducted using OPSTAT developed by CCSHAU, Hisar for all observations recorded during the years. Fisher's test of significance was used to compare the difference between means at 5% significance level. Standard errors along with critical differences at 5% of significance were computed for discriminating the treatment effects for chance effects.

RESULTS AND DISCUSSION

Yield

Among the varying levels of phosphorus, the application of 50 kg P ha^{-1} recorded highest grain yield (1108 kg ha^{-1}), stover yield (2616 kg ha^{-1}), and ultimately the biological yield (3716 kg ha^{-1}) (Table 1). On the other hand, the minimum grain yield (910 kg ha^{-1}), stover yield (2361 kg ha^{-1}), and ultimately the biological yield (3271 kg ha^{-1}) was observed with the application of phosphorus applied @ 0 kg/ha. The maximum seed yield per plant as well as per hectare with optimum phosphorus rates was attributable to better nodulation and efficient functioning of nodulebacteria for fixation of nitrogen to be utilized by plants during the seed development stage in the synthesis of protein which in turn led to increase in seed yield. Khan *et al.* (2004) found that the increase in phosphorus levels significantly increased the seed yield of chickpea. This could be attributed to a better supply of phosphorus resulting in higher branches and pods and there by higher yield. It is a fact that phosphorus plays an important role in the formation of new shoots and the number of branches/plant. In addition, it regulates the photosynthetic and carbohydrate metabolism which can be considered to be one of the major factors limiting growth, particularly during the reproductive phase.

Among the bio-fertilizers, the maximum grain yield (1116 kg ha^{-1}), stover yield (2655 kg ha^{-1}) and biological yield (3767 kg ha^{-1}) was recorded with the application of PSB+ *Rhizobium* followed by application of PSB while the lowest grain yield (889 kg ha^{-1}) and stover yield (2318 kg ha^{-1}) was observed with no inoculation. This is due to the bulk inoculation of beneficial microbes plays an important role in improving three major aspects of determination i.e. strong sink development of reproductive structure, formation of vegetative higher photosynthesis, and production of assimilates to fill economically to sink (Kumar *et al.* 2015, Saket and Rahi 2019).

Economics

Table 2 presents data on the economic impact of varying levels of phosphorus and biofertilizers. The results show that, for all phosphorus levels, applying 50 kg P_2O_5 ha^{-1} resulted in the highest cultivation costs, followed by applying 40 kg P_2O_5 ha^{-1}. Furthermore, applying 50 kg of P_2O_5 ha^{-1} produced the highest gross returns, net returns, and benefit-cost ratios, with 40 kg of P_2O_5 ha^{-1} coming in second. Among the biofertilizers, the highest cost of cultivation was obtained with the application of PSB+ *Rhizobium* followed by the application of PSB. Further, the highest gross returns, net returns, and benefit-cost ratio were recorded with the application of PSB+ *Rhizobium* followed by the application of PSB. This was possibly due to the proportionately highest net return as compared to the cost involved which contributed to the B: C ratio. These results are in close agreement with the findings reported by Rabari *et al.* (2022).

Table 1. Effect of varying levels of phosphorous and biofertilizers on yield and harvest index of chickpea

Treatments	Grain yield (kg/ha)			Stover yield (kg/ha)			Harvest Index (%)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
P_0 = 0 kg P_2O_5 ha^{-1}	877	944	910	2267	2455	2361	28.03	27.86	27.94
P_1 = 30 kg P_2O_5 ha^{-1}	906	987	947	2323	2514	2419	27.99	28.22	28.12
P_2 = 40 kg P_2O_5 ha^{-1}	995	1075	1035	2440	2631	2536	28.91	28.96	28.94
P_3 = 50 kg P_2O_5 ha^{-1}	1067	1145	1108	2513	2718	2616	29.66	29.58	29.57
SEm±	28	28	31	57	60	58	0.62	0.57	0.59
CD (p=0.05)	80	80	90	165	174	169	NS	NS	NS
B_0 = No inoculation (Control)	852	925	889	2218	2418	2318	27.81	27.78	27.81
B_1 = PSB	994	1074	1034	2409	2581	2495	29.16	29.36	29.26
B_2 = *Rhizobium*	923	1002	962	2358	2567	2462	28.14	28.12	28.13
B_3= PSB + *Rhizobium*	1077	1155	1116	2557	2754	2655	29.47	29.36	29.36
SEm±	28	28	31	57	60	58	0.62	0.57	0.59
CD (p=0.05)	80	80	90	165	174	169	NS	NS	NS
Phosphorus level × Biofertilizers									
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Effect of varying levels of phosphorous and biofertilizers on relative economics of chickpea (Pooled)

Symbols	Treatments	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C ratio
P0B0	Application of P_2O_5 @ 0 kg ha^{-1} under without seed inoculation	27108	67167	40057	1.48
P0B1	Application of P_2O_5 @ 0 kg ha^{-1} under seed inoculation with PSB	27258	72196	44938	1.65
P0B2	Application of P_2O_5 @ 0 kg ha^{-1} under seed inoculation with *Rhizobium*	27258	69156	41898	1.54
P0B3	Application of P_2O_5 @ 0 kg ha^{-1} under seed inoculation with PSB & *Rhizobium*	27258	74738	47480	1.74
P1B0	Application of P_2O_5 @ 30 kg ha^{-1} under without seed inoculation	29006	70396	41390	1.43
P1B1	Application of P_2O_5 @ 30 kg ha^{-1} under seed inoculation with PSB	29156	74458	45302	1.55
P1B2	Application of P_2O_5 @ 30 kg ha^{-1} under seed inoculation with *Rhizobium*	29156	73744	44588	1.53
P1B3	Application of P_2O_5 @ 30 kg ha^{-1} under seed inoculation with PSB & *Rhizobium*	29156	75680	46524	1.60
P2B0	Application of P_2O_5 @ 40 kg ha^{-1} under without seed inoculation	29639	69361	39723	1.34
P2B1	Application of P_2O_5 @ 40 kg ha^{-1} under seed inoculation with PSB	29789	83211	53422	1.79
P2B2	Application of P_2O_5 @ 40 kg ha^{-1} under seed inoculation with *Rhizobium*	29789	77272	47483	1.59
P2B3	Application of P_2O_5 @ 40 kg ha^{-1} under seed inoculation with PSB & *Rhizobium*	2978	90486	60698	2.04
P3B0	Application of P_2O_5 @ 50 kg ha^{-1} under without seed inoculation	30271	69978	39707	1.31
P3B1	Application of P_2O_5 @ 50 kg ha^{-1} under seed inoculation with PSB	30421	89526	59105	1.94
P3B2	Application of P_2O_5 @ 50 kg ha^{-1} under seed inoculation with *Rhizobium*	30421	78636	48215	1.58
P3B3	Application of P_2O_5 @50 kg ha^{-1} under seed inoculation with PSB & *Rhizobium*	30421	100015	69594	2.29

CONCLUSION

It can be concluded that among the phosphorus levels, the application of 50 kg ha^{-1} phosphorus recorded significantly the highest seed yield and stover yield. Among the treatment combinations, the application of 50 kg ha^{-1} phosphorus and bio-fertilizers (PSB + *Rhizobium*) recorded the highest gross return, net return and benefit-cost ratio. Thus, for chickpea cultivation, the application of 50 kg ha^{-1} phosphorus and the application of Phosphate solubilizing bacteria + *Rhizobium* was found to be the most promising treatment for enhancing the yield in chickpea.

REFERENCES

Khan MA, Ali A and Tanveer A. 2004. Effect of seed inoculation and different levels of phosphorus on the yield and yield components of chickpea. Pakistan Journal of Life and social Sciences **1**: 106-108.

Rudresh DL, Shivaprakasha MK, Prasad RD. 2005. Effect of combined application of *Rhizobium*, phosphate solubilizing bacterium and Trichoderma spp. on growth, nutrient uptake and yield of chickpea (*Cicer aritenium* L.). Applied Soil Ecology Journal **28**: 139-146.

Kachave RR, Indulkar BS, Vaidya PH, Ingole AJ and Patil NM. 2018. Effect of phosphorus and PSB on growth yield and quality of black gram (*vigna mungo* L.) in inceptisol. International Journal of Current Microbiologyand Applied Science **7**: 3359-3365.

Kumar D, Arvadiya LK, Desai KL, Usadadiya VP and Patel AM. 2015. Growth and yield of chickpea (*Cicer arietinum* L.) as influenced by graded levels of fertilizers and bio-fertilizers. The Bioscan **10**(1): 335-338.

Ogola AH, Odhiambo GD, Okalebo JR and Muyekho FN. 2012. Influence of phosphorus on selected desmodium growth and nodulation parameters. ARPN Journal of Agriculture and Biological Science **7**: 294–301.

Motsara MR. 2002. Promoting Balanced Fertilization in India–Policies and Economic Issues. Fertilizer News **47**: 15-21.

Mishra A, Prasad K and Geeta R. 2010. Effect of bio-fertilizer inoculation on growth and yield of dwarf field pea (*Pisum sativum* L.) in conjugation with different doses of chemical fertilizers. Indian Journal of Agronomy **9**(4): 163-168.

Ali H, Khan MA and Randhawa SA. 2004. Interactive effect of seed inoculation and phosphorus application on growth and yield of chickpea (*Cicer arietinum* L.). International Journal of Agriculture and Biology **6**(1): 110-112.

Saket AK and Rahi S. 2019. Response of black gram (*Phaseolous mungo* L.) to applied sulphur and biofertilizers. International Journal of Advance Science and Research **4:** 1-4.

Rabari KV, Chaudhary MP, Patel KM, Sundesha DL and Joshi DP. 2022. Effect of Phosphorus and Biofertilizers on Yield and Economics of Blackgram. International Journal of Agriculture Sciences **14**(4): 11234-11236.