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Productivity and Profitability of chickpea as Influenced by varying levels of phosphorus and Bio-fertilizers under sub-tropical conditions of Madhya Pradesh

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ABSTRACT

Afield experiment was conducted at the Crop Research Centre of School of Agriculture, ITM University, Gwalior, (M.P.) during *Rabi* 2021–22 and 2022–23 to study the influence of phosphorus and bio-fertilizers on productivity and profitability of summer black gram under sub-tropical condition of Madhya Pradesh. The experiment was laid out in factorial randomized block design by taking four levels of phosphorus*viz*. 0 kg $P_2O_5ha^{-1}$, 30 kg $P_2O_5ha^{-1}$, 40 kg $P_2O_5ha^{-1}$, 50 kg $P_2O_5ha^{-1}$ and bio-fertilizers (No inoculation, PSB, *Rhizobium*, PSB + *Rhizobium* which were replicated thrice. The chickpea variety "JG-16" was uniformly fertilized by 20 kg N/ha through Urea. However, phosphorus and bio-fertilizers were applied as per the requirement of the treatments. The crop was managed as per the recommended package and practices. The experimental study revealed that among the phosphorus levels, the application of 50 kg P/ha recorded significantly high seed and stover yield. However, among the bio-fertilizers, application of Phosphate solubilizing bacteria + *Rhizobium* resulted in highest seed and stover yield of chickpea. Among the economic analysis, application of 50 kg ha^{-1} phosphorus and combined treatment of Phosphate solubilizing bacteria+ *Rhizobium* incurred the highest cost of cultivation, highest gross return, net return and Benefit cost ratio. Therefore, for chickpea cultivation, application of 50kg ha^{-1} phosphorus and treatment of Phosphate solubilizing bacteria+ *Rhizobium* was proved to be profitable.

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

Introduction

India is the largest producer and consumer of pulse crops throughout the World. It is one of the most important legume crops in South and South East Asia. It contributes around 25 % of the world's total production of pulses. Even though India accounts for one-third of the world's total area cultivated with pulses, these crops are essential to the Indian food system. Pulses are a significant group of crops in India, and because they make up a substantial percentage of the country's exports.Pulses serve as a main crop, green manure crop, catch crop, cover crop, and intercrop. They are equally essential in Indian agriculture because of their high productivity and low-input requirement. Of the major pulses, chick Pea (*Cicer arietinum* L.) also known as the gram pea, garbanzo bean, or ceci bean is the third most significant pulse crop grown worldwide, behind dry beans and peas. Chickpea has the ability to fix 140 kg of atmospheric nitrogen per hectare with its ability of symbiotic Nitrogen fixation. However, excessive cultivation and growing of nutrient-exhausting crops have caused the soil deficient in macro- as well as in micronutrients due to nutrient mining. Nowadays, the use of only nitrogenous fertilizers has contributed to soil nutrient imbalance, notably in terms of the availability of micronutrients. The nutrient application must be adjusted for agricultural production because unbalanced use lowers crop yields. Nonetheless, a little amount of nitrogenous fertilizer is needed during the early stages of crop establishment because grams is a leguminous crop and can meet a large portion of its nitrogen needs by fixing atmospheric nitrogen.

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 to 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 in order 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 aids crop plants in absorbing nutrients through their interaction in the rhizosphere and have the capacity to 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 of significance. 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). In order to increase yield and economic return from chickpea, it is essential to apply sufficient fertilizers and the right strain of biofertilizers.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 andBio-fertilizers under sub-tropical conditions of Madhya Pradesh.

Materials and Methods

Weather and climate details: The experimental site, in general is bestowed with sub-tropical climate which experiences the mean annual rainfall of 900 mm and is having 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 per cent of rainfall is received from June to early October, whereas the remaining 25-30 per cent of rain is received throughout the year with a major portion of rains during the winters.

Experimental site: An investigation was conducted in the *Rabi* 2021–22 and 2022–23 at the 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 (AMSL) which is having a value of $26^0 14'$ N latitude and $78^0 14'$ E longitude it falls in the sub-tropical areas on the outskirts of Gwalior, Madhya Pradesh.

Soil type: The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction (pH 7.57), low in organic carbon (4.0 g/kg), available nitrogen (183.50 kg/ha) and potassium (243.0

kg/ha) but medium in available phosphorus (14.40 kg/ha) with electrical conductivity in the safer range.

Experimental design and treatment details: The field experiment comprised of sixteentreatment combinations, which were laid out in factorial randomized block design with three replications. The treatments comprised of two factors, i.e. phosphorus levels *viz*., 0 kg P_2O_5ha^{-1}, 30 kg P_2O_5ha^{-1}, 40 kg P_2O_5ha^{-1}, 0 kg P_2O_5ha^{-1} and bio-fertilizers, i.e no inoculation, PSB, *Rhizobium*, PSB + *Rhizobium*

Methodology and crop management: The green gram crop variety, JG-16 was sown in lines at a spacing of 30 cm between the rows × 10 cm between the plants. Chickpea crop was fertilized with recommendeddose 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.

Yield and Yield attributes: Data on yield was obtained at harvest. From the individual plot, net plot was harvested and subsequently, the grain, stover and biological yield thus obtained were weighed and expressed in kg ha^{-1}.

Computation of economic parameters: Among economic parameters, net return per ha was calculated by deducting cultivation cost from gross returns. Benefit cost (B:C) ratio was calculated by dividing net returns with total cost of cultivation to evaluate the economic viability of treatments.

Statistical analysis: Statistical analysis of yield and yield attributes was performed to examine the effect of different treatments. The analysis of variance was conducted using OP-Stat 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 % probability level. Standard errors along with critical difference at 5 % of significance were computed for discriminating the treatment effects for chance effects.

Results and Discussion

Yield (kg ha^{-1})

The data on seed and stover yield of chickpea was

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)			Biological yield (kg/ha)			Harvest Index (%)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
P_0 = 0 kg P_2O_5ha^{-1}	1651.26	1775.66	1713.46	3794.85	3804.75	3799.80	5446.11	5580.41	5513.26	30.45	31.90	31.18
P_1 = 30 kg P_2O_5ha^{-1}	1825.57	1998.98	1912.28	4101.23	4154.49	4127.86	5926.80	6153.47	6040.14	30.72	32.49	31.61
P_2 = 40 kg P_2O_5ha^{-1}	2016.91	2195.57	2106.24	4498.23	4548.34	4523.28	6515.14	6743.91	6629.53	30.89	32.52	31.70
P_3 = 50 kg P_2O_5ha^{-1}	2076.58	2248.63	2162.60	4522.98	4600.40	4561.69	6599.56	6849.03	6724.29	31.43	32.82	32.13
SEm±	51.42	47.05	46.10	102.78	100.94	101.46	127.67	122.99	123.79	0.67	0.59	0.59
CD (P=0.05)	148.51	135.89	133.14	296.84	291.55	293.04	368.75	355.21	357.54	NS	NS	NS
Biofertilizers												
B_0 = No inoculation (Control)	1665.66	1827.41	1746.53	3855.68	3941.43	3898.55	5521.33	5768.84	5645.08	30.25	31.79	31.02
B_1 = PSB	1961.17	2107.26	2034.22	4291.80	4317.45	4304.62	6252.97	6424.71	6338.84	31.30	32.78	32.04
B_2 = *Rhizobium*	1831.21	2017.46	1924.34	4154.70	4239.77	4197.23	5985.91	6257.23	6121.57	30.62	32.30	31.46
B_3= PSB + *Rhizobium*	2112.29	2266.70	2189.49	4615.11	4609.35	4612.23	6727.40	6876.04	6801.72	31.33	32.86	32.09
SEm±	51.42	47.05	46.10	102.78	100.94	101.46	127.67	122.99	123.79	0.67	0.59	0.59
CD (p=0.05)	148.51	135.89	133.14	296.84	291.55	293.04	368.75	355.21	357.54	NS	NS	NS
Phosphorus level × Biofertilizers												
CD (P=0.05)	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

influenced by varying levels of phosphorus and bio-fertilizers (Table 1) among the varying levels of phosphorus, the application of 50 kg P ha^{-1} recorded highest grain yield, stover yield and ultimately the biological yield. On the other hand, the minimum grain yield, stover yield and ultimately the biological yield was observed with the application of phosphorus was 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 nodule bacteria for fixation of nitrogen to be utilized by plants during 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 was significantly increased seed yield of chickpea. This could be attributed to better supply of phosphorus resulting in higher branch and pod and there by higher yield. It is an established fact that phosphorus plays an important role in the formation of new shoots and number of branches/ plant. In addition, it regulates the photosynthetic and carbohydrate metabolism which can be considered to be one the major factors limiting growth particularly during the reproductive phase.

Among the bio-fertilizers, the maximum grain yield, stover yield and biological yield was recorded with the application of PSB+ *Rhizobium* followed by application of PSB while the lowest grain yield, stover yield and biological yield was observed with no inoculation. This is due to Bulk inoculation of beneficial microbes plays important role in improving

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 kgha^{-1} under without seed inoculation	39348.3	96483.7	57135.39	1.45
P0B1	Application of P_2O_5@ 0 kgha^{-1} under seed inoculation with PSB	39573.31	104351.3	64777.95	1.64
P0B2	Application of P_2O_5@ 0 kgha^{-1} under seed inoculation with *Rhizobium*	39573.31	102606.5	63033.19	1.59
P0B3	Application of P_2O_5@ 0 kgha^{-1} under seed inoculation with PSB &*Rhizobium*	39898.31	108150.8	68252.51	1.71
P1B0	Application of P_2O_5@ 30 kgha^{-1} under without seed inoculation	42204.56	106947.3	64742.75	1.53
P1B1	Application of P_2O_5@ 30 kgha^{-1} under seed inoculation with PSB	42429.56	115607	73177.46	1.72
P1B2	Application of P_2O_5@ 30 kgha^{-1} under seed inoculation with *Rhizobium*	42429.56	113446.6	71017.07	1.67
P1B3	Application of P_2O_5@ 30 kgha^{-1} under seed inoculation with PSB &*Rhizobium*	42754.56	121995.9	79241.35	1.85
P2B0	Application of P_2O_5@ 40 kgha^{-1} under without seed inoculation	43223.31	107584.9	64361.63	1.49
P2B1	Application of P_2O_5@ 40 kgha^{-1} under seed inoculation with PSB	43448.31	128991.8	85543.5	1.97
P2B2	Application of P_2O_5@ 40 kgha^{-1} under seed inoculation with *Rhizobium*	43448.31	121555.5	78107.17	1.80
P2B3	Application of P_2O_5@ 40 kgha^{-1} under seed inoculation with PSB &*Rhizobium*	43773.31	146040.6	102267.3	2.34
P3B0	Application of P_2O_5@ 50 kgha^{-1} under without seed inoculation	44235.51	108826.3	64590.79	1.46
P3B1	Application of P_2O_5@ 50 kgha^{-1} under seed inoculation with PSB	44460.51	137213.9	92753.41	2.09
P3B2	Application of P_2O_5@ 50 kgha^{-1} under seed inoculation with *Rhizobium*	44460.51	123796.7	79336.17	1.78
P3B3	Application of P_2O_5@50 kgha^{-1} under seed inoculation with PSB & *Rhizobium*	44785.51	146835.4	102049.8	2.28

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 and Saket and Rahi, 2019).

Economics

The data on economics as influenced by different levels of phosphorus and bio fertilizers are presented in Table 2 revealed that among the phosphorus levels, the higher cost of cultivation was incurred with the application of 50 kg P_2O_5 ha^{-1} followed by the application of 40 kg P_2O_5 ha^{-1}. Further, the highest gross returns, net returns and benefit: cost ratio were fetched with the application of 50 kg P_2O_5 ha^{-1} followed by the application of 40 kg P_2O_5 ha^{-1}.

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 was recorded with the application of PSB+ Rhizobium followed by the application of PSB. This was possibly due to proportionately highest net return as compared to the cost involved which contributed to B: C ratio. These results are in close agreement with the findings reported by Rabari *et al.* (2022).

Conclusion

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

References

Ali, H., Khan, M.A. and Randhawa, S.A. 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.

Anonymous, 2020-21. Directorate of Economics and Statistics, Govt. of Madhya Pradesh.

Kachave, R.R., Indulkar, B.S., Vaidya, P.H., Ingole, A.J. and Patil, N.M. 2018. Effect of phosphorus and PSB on growth yield and quality of black gram (*vigna mungo* L.) in inceptisol. *International Journal of Current Microbiology and Applied Science*. 7: 3359-3365.

Khan, M.A., 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: 106-08.

Kumar, D., Arvadiya, L.K., Desai, K.L., Usadadiya, V.P. and Patel, A.M. 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.

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

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

Ogola, A.H., Odhiambo, G.D., Okalebo, J.R. and Muyekho, F.N. 2012. Influence of phosphorus on selected desmodium growth and nodulation parameters. *ARPN Journal of Agricutlure and Biological Science*. 7: 294-301.

Rabari, K.V., Chaudhary, M.P., Patel, K.M., Sundesha, D.L. and Joshi, D.P. 2022. Effect of Phosphorus and Biofertilizers on Yield and Economics of Blackgram. *International Journal of Agriculture Sciences.* 14(4):11234- 11236.

Rudresh, D.L., Shivaprakasha, M.K., Prasad, R.D. 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.* 28:139-46.

Saket, A.K. 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.