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Effect of Different Levels of Phosphorus and Potassium on Growth, Yield and Quality of Chickpea *(Cicer arietinum* L.)

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Abstract

The present experiment was carried out on sandy loam soil of the School of Agriculture, ITM University, Gwalior (M. P.) during the Rabi season of 2021-22 to find out the suitable level of phosphorus and potassium for higher productivity of chickpea for this region. The experiment was conducted in Randomized Block Design (R.B.D) with three replications having 10 treatments of different levels of phosphorus and potassium. Application of phosphorus and potassium with different levels produced significantly higher growth and yield attributes parameters over control. Maximum seed yield (18.51 q ha^{-1}) was noted in T_{10} (75 kg P_2O_5 + 60 kg K_2O), closely followed by T_9 (75 kg P_2O_5 + 40 kg K_2O) and T_7 (50 kg P_2O_5 + 60 kg K_2O) with 18.22 and 18.12 q/ha seed yield and these treatments were statistically at par from each other. Maximum protein content (19.88 %) was observed with 50 kg P_2O_5 + 60 kg K_2O treatments. All the phosphorus and potassium fertilizers applied treatments resulted more in benefit: cost ratio over control.

Keywords: chickpea, phosphorus, potassium and protein content

Introduction

Fertilizers are the most important inputs in crop production. An adequate supply of chemical fertilizers is closely associated with growth and development of plant. Among three essential nutrients, availability of phosphorus and potassium from soil are in question due to fixation and buffering capacity of soils. Phosphorus is vital to plant growth and is found in every living plant cell. It is involved in several key plant functions, including energy transfer, photosynthesis, transformation of sugars and starches, nutrient movement within the plant and transfer of genetic characteristic from one generation to the next. Potassium is a key nutrient in the plant's tolerance to stress such as high/low temperatures, drought, disease and pest occurrences. It is an activator of dozens of important enzymes, such as protein synthesis, sugar transformation, N and C metabolism and photosynthesis. Potassium influences the water economy and crop growth through its effects on water uptake, root growth, maintenance of turgor, transpiration and stomatal regulation (Nelson, 1980). It is very important for cell growth, which is an important process for the function and development of plants.

Therefore, both of these nutrients are very important and play an significant role in crop productivity, but at present time, hike in prices of phosphorus and potassium fertilizers due to pull of government subsidy further aggravated the problem of imbalance use of nutrient. For find out the best combination of phosphorus and potassium for higher productivity of chickpea for this region's the present experiment was carried out.

Materials and Methods

A field experiment was conducted at the Agriculture Research Farm, School of Agriculture, ITM University, Gwalior, (M.P.) during the Rabi season of 2021-22.

The soil of the experimental site was Sandy Loam in texture, low in available nitrogen and medium to phosphorus and potassium. The experimental crop chickpea (Cv. NBeG-119) was sown on 3rd December 2021 and harvested on 18 March 2022. Under present experiment ten different combination of phosphorus and potassium applied treatments along with control of both nutrients were tested and each treatment was replicated three times in randomizes block design. The recommended dose of nitrogen adopted was 30kg ha^{-1}.The total amount of nitrogen, phosphorus and potash were supplied through urea, SSP and muriate of potash as basal. Nodulation parameters were recorded at 45 DAS stage whereas growth and yield attributes parameter was at harvest. The protein content (%) in chickpea grain was worked out by multiplying nitrogen content of grain with factor 6.25 (A.O.A.C. 1984).Economical parameters of chickpea crop were calculated as per present market prices. All data collected were subjected to the analysis of variance and significant means separated where appropriate by the least significant difference at 0.05 probability level.

Results and Discussion

Nodulation parameters

The result reported in table 1 revealed that application of phosphorus and potassium with different combinations, recorded significantly higher nodulation parameters (nodule number, root length and its fresh weight) as compared to control(0 kg P_2O_5 + 0 kg K_2O). This might be due to the application of phosphorus responsible for the root elongation, the most prominent effect of P has been observed on the root system of plants as it promotes the formation of lateral and fibrous roots[4]. Nodules weight is directly associated with number of nodules. Increasing levels of potassium from 20 to 40 kg/ha with different phosphorus level, increased the nodule fresh weight significantly then after also increased but not reaches the level of significance[1].

Growth and yield attributes parameters

The result revealed (Table-1) that, the growth and yield attributes parameters was significantly affected due to application of phosphorus and potassium It is revealed from the results that increasing levels of phosphorus from 25 to 50 kg/ha with different potassium level significantly increased the growth parameters. On the other side application of potassium up to 40 kg/ha with different levels of phosphorus increased the growth parameters.

The increase of growth parameters with the application of P and K might be due to the beneficial effect of phosphorus and potassium as increased cell division root growth and involved in many vital plant growth. The significant increase in growth parameters with P and K application was also reported by many others[5, 8].

Significant increase in plant height with potassium application can be attributed to the fact that potash enhances plant vigour and strengthens the stalk. Application of K increased the availability of nitrogen and phosphorus which resulted in better plant growth and more number of branches per plant.

In present study, The maximum number of pod (63.73 $plant^{-1}$) were recorded under 75 kg P_2O_5 + 60 kg $K_2O(T_{10})$ which was significantly higher over rest all the treatments

except T_9(75 kg P_2O_5 + 40 kg K_2O) and T_7 (50 kg P_2O_5 + 60 kg K_2O) treatments. The results are almost same as were reported by Smiullah and Khan (2003) who noticed that addition of potassium @ 40 kg ha^{-1} doubled the number of pods per plant. Higher values of yield attributes as well as test weight of chickpea may be described that the effect of P and K on root development, energy transformation and metabolic processes of the plant, which in turn resulted in greater translocation of photo synthates towards the sink development. Similar results have been reported earlier[3,4].

Yield parameters

Under present study, seed yield varied from 10.45 to 18.51 q ha^{-1} under different treatments and the magnitude of increase in yield due to various treatments of phosphorus and potassium was 22.1 to 77.1 per cent over control. The increase in seed yield due to phosphorus and potassium application might be due to balanced improvement in nutrient availability that enhanced horizontal expansion of chickpea by encouraging cell division in the meristematic region. Nitrogen, phosphorus and potassium might have increased the photosynthetic efficiency and thus increased the production of photosynthates which is the iatrical part of yield attributes parameters and ultimately the yield[8,10].

Maximum seed yield (18.51 q ha^{-1}) was noted in T_{10} (75 kg P_2O_5 + 60 kg K_2O), closely followed by T_9 (75 kg P_2O_5 + 40 kg K_2O) and T_7 (50 kg P_2O_5 + 60 kg K_2O) with 18.22 and 18.12 q/ha seed yield and these treatments were statistically at par from each other and significantly superior to T_2 (25 kg P_2O_5 + 20 kg K_2O) and T_5 (50 kg P_2O_5 + 20 kg K_2O) treatments. The improvement in seed yield in these treatments was might be due this treatment combination of P and K performed better in the respect of growth, nodulation and yield attributes parameters of chickpea. Similar finding have been reported by many others[2,5].

The increase in seed yield and harvest index due increasing levels of potassium with same level of phosphorus might be due to role of potassium in translocation of photosynthates and its ability to develop bold seeds and higher seed yield and harvest index[1].

Quality parameters

Data on quality parameters (i.e. protein content and protein yield) revealed that the protein content of chickpea seed was observed in the range of 15.98 to 19.88 per cent under different treatments. Maximum protein content (19.88 %) was observed under 50 kg P_2O_5 + 60 kg K_2O which was at par with 75 kg P_2O_5 + 60 kg K_2O), 75 kg P_2O_5 + 40 kg K_2O, 50 kg P_2O_5 + 40 kg K_2O) and 25 kg P_2O_5 + 60 kg K_2O) treatments with 19.68, 19.49, 19.22 and 19.13 % of protein content. Whereas minimum protein (15.98 %) was recorded under control plots. The improvement in protein content was might be due to the more concentration of nitrogen in the seed, which included by the soil through fertilizers and as well as atmospheric nitrogen fixation. it is well-established fact that nitrogen is the main constituent of amino acids and it ultimately increased the crude protein content of plants. This is in harmony with the published work of others[4].

Table 1 Effect of different combinations of phosphorus and potassium on nodulation, growth and yield attributes parameter of chickpea

Tr. No.	Treatments	Nodulation parameters at 45 DAS				Growth and yield attributes parameters at maturity			
		Nodule number	Nodule Fresh weight (mg plant^{-1})	Root length (cm)	Root fresh weight (g plant^{-1})	Plant height (cm)	No. of branches plant^{-1}	Number of pods plant^{-1}	Test weight (g)
T_1	Control (0 kg P_2O_5 + 0 kg K_2O)	8.03	521.6	7.55	1.01	29.71	14.47	28.20	17.94
T_2	25 kg P_2O_5 + 20 kg K_2O	10.17	624.6	8.81	1.23	41.32	16.67	38.40	18.27
T_3	25 kg P_2O_5 + 40 kg K_2O	11.11	702.4	10.21	1.21	46.07	17.60	43.93	19.84
T_4	25 kg P_2O_5 + 60 kg K_2O	11.97	730.5	10.48	1.34	50.14	18.70	49.27	20.32
T_5	50 kg P_2O_5 + 20 kg K_2O	13.11	703.8	10.07	1.28	49.74	17.85	48.80	18.55
T_6	50 kg P_2O_5 + 40 kg K_2O	14.17	755.6	11.03	1.36	53.33	19.18	56.33	21.02
T_7	50 kg P_2O_5 + 60 kg K_2O	15.08	772.5	11.38	1.42	54.70	19.03	56.40	21.59
T_8	75 kg P_2O_5 + 20 kg K_2O	14.67	712.3	11.61	1.35	54.18	18.30	52.27	20.46
T_9	75 kg P_2O_5 + 40 kg K_2O	15.68	768.6	11.89	1.36	54.87	18.78	60.33	22.41
T_{10}	75 kg P_2O_5 + 60 kg K_2O	16.22	767.0	11.95	1.39	55.52	19.13	63.73	22.34
S.E. (m)±		**0.71**	**16.2**	**0.39**	**0.06**	**0.98**	**0.56**	**2.34**	**0.51**
C.D. (5%)		**2.10**	**48.2**	**1.15**	**0.18**	**2.91**	**1.65**	**6.97**	**1.51**

The improvement in protein content due to potassium may be ascribed that potassium has synergistic effect on nitrogen uptake, facilitates protein synthesis and activate different enzymes. As the protein yield was the multiplication of protein yield and seed yield. so that its trend similar to seed yield was obtained with different treatments and increasing levels of potassium from 20 to 60 kg/ha with different levels of phosphorus significantly increased the protein yield up to 60 kg K_2O with 25 kg P_2O_5 level and up to 40 kg K_2O with 50 and 75 kg P_2O_5 levels then after increased only numerical value and not touch the level of significance[8].

Economical parameters

Under present study the maximum gross and net return was obtained from T_{10}(75 kg P_2O_5 + 60 kg K_2O) followed by T_9 (75 kg P_2O_5 + 40 kg K_2O) and T_7 (50 kg P_2O_5 + 60 kg K_2O) treatments. Whereas minimum value of gross and net return was in control treatments.

This might be due to higher seed and straw yields obtained under this treatment, which directly contributed to net returns. The cost involved under this treatment was comparatively lower than additional income, which led to more net returns. The results conform with the findings of earlier workers[6].

All the phosphorus and potassium fertilizers applied treatments resulted more benefit: cost ratio over control. The maximum B:C ratio (3.28) was obtained from T_6 (50 kg P_2O_5 + 40 kg K_2O) followed by T_6 (50 kg P_2O_5 + 60 kg K_2O) andT_9 (75 kg P_2O_5 + 40 kg K_2O) with 3.25 and 3.21 B:C ratio. Whereas minimum B:C ratio (2.16) noted under control treatment. The higher B C ratio was attributed to the more gross return with lower cost of cultivation involved with it[1,7].

Conclusion

Thus, from present study we can conclude that the chickpea crop sown with 100% N + 50 - 75 kg P_2O_5 + 40 kg K_2O produced economically seed and protein yield and also gave higher benefit cost ratio in soil of which show medium status of available P and K of Gwalior district of Madhya Pradesh.

Table 2 Effect of different combinations of phosphorus and potassium on yield, quality and economical parameters of chickpea

Tr. No.	Treatments	Yield parameters		Quality parameters		Economical parameters		
		Seed Yield (q ha^{-1})	Harvest index (%)	Protein content (%)	Protein yield (kg ha^{-1})	Gross Income(Rs./ha)	Net Income(Rs./ha)	B:C Ratio
T_1	Control (0 kg P_2O_5 + 0 kg K_2O)	10.45	38.18	15.98	166.68	60859	32655	2.16
T_2	25 kg P_2O_5 + 20 kg K_2O	12.76	40.00	16.47	210.46	74008	44110	2.48
T_3	25 kg P_2O_5 + 40 kg K_2O	14.43	41.32	17.79	257.05	83463	52965	2.74
T_4	25 kg P_2O_5 + 60 kg K_2O	14.72	42.06	19.13	281.54	85016	53918	2.73
T_5	50 kg P_2O_5 + 20 kg K_2O	15.49	40.82	17.89	276.90	89687	58696	2.89
T_6	50 kg P_2O_5 + 40 kg K_2O	17.96	42.36	19.22	335.35	103668	72077	3.28
T_7	50 kg P_2O_5 + 60 kg K_2O	18.12	42.47	19.88	362.12	104570	72379	3.25
T_8	75 kg P_2O_5 + 20 kg K_2O	17.57	41.62	18.45	324.51	101565	69480	3.17
T_9	75 kg P_2O_5 + 40 kg K_2O	18.22	43.12	19.49	356.21	105016	72331	3.21
T_{10}	75 kg P_2O_5 + 60 kg K_2O	18.51	43.42	19.68	366.03	106629	73344	3.20
S.E. (m)±		**0.54**	**0.47**	**0.27**	**10.78**	-	-	-
C.D. (5%)		**1.60**	**1.40**	**0.82**	**32.03**	-	-	-

References

1. Goud, V.V., Konde, N.M., Mohod, P.V. and Kharche, V.K. (2014). Response of chickpea to potassium fertilization on yield, quality, soil fertility and economic in Vertisols. *Legume Research*, 37(3):311-315.
2. Kumar Boini Jyothi and Mehera, Biswarup (2022). Effect of potassium and sulphur on growth and yield of chickpea (*Cicer arietinum* L.) *The Pharma Innovation Journal*, 11(4):2139-2143.
3. Kumar, Hemant, Yadav, Birendra Singh, Singh, Ripudaman, Yadav, D.D., Chahal, V.P., Yadav, Ruchi and Yadav, Omkar Singh (2018). Effect of potassium levels on performance of chickpea (*Cicer arietinum* L.) under different genotypes. *International Journal of Chemical Studies*, 6(6): 1675-1677.
4. Meera, S., Saravana, Pandian P., Indirani, R. and Ragavan, T. (2019). Influence of phosphorus and molybdenum on growth attributes and yield of black gram in typic haplustalf. *International Journal of Chemical Studies*, 7(3): 2533-2536.
5. Memon, M., Rajput, A.N., Rajput, A., Memon, N., Jamro, G.M., and Kumbhar M.I. (2016). Response of chickpea cultivars to phosphorus application. *Soil and Environment*, 35(1):22-29.
6. Palla, Hari and Dawson, Joy (2022). Effect of phosphorus, potassium and bio-fertilizer on growth and yield of chick pea (*Cicer arietinum* L.) The *Pharma Innovation Journal*, 11(5):1429-1432.
7. Siddiqui, S.N., Umar S., Husen, A. and Iqbal, M. (2015). Effect of phosphorus on plant growth and nutrient accumulation in high and low zinc accumulating chickpea genotypes. *Annals of Phytomed*, 4(2):102-105.
8. Singh, R., Kumar, S., Kumar, H., Kumar, M., Kumar, A., and Kumar, D. (2017). Effect of irrigation and integrated nutrient management on growth and yield of chickpea (*Cicer arietinum* L.*). Plant Archives*, 17(2):1319-1323.
9. Sudhir, Kumar, Jaibir, Tomar, Kishore, Giri Raj, Kumar Arvind, and Singh, Subodh (2012). Effect of phosphorus and sulphur on growth and yield of pigeon pea (*Cajanus cajan*). *Advance Research Journal of crop Improvement*, 3(1): 50-52.
10. Tripathi, L.K., Thomas, T., and Kumar, S. (2013). Impact of nitrogen and phosphorus on growth and yield of chickpea (*Cicer arietinum* L.). *An Asian Journal of Soil Science*, 8(2):260-263.