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Effect of Different Varieties and Phosphorus Levels on Growth, Yield, Protein content of Kabuli Chickpea (*Cicer arietinum* L.) and Nutrient Status of Soil

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Abstract

A field experiment conducted at Crop Research Centre (CRC), School of Agriculture, ITM University Gwalior, Madhya Pradesh during rabi season of 2021-22on Sandy Loam soil with consisting of twelve combinations of three kabuli chickpea varieties and four phosphorus levels. The experiment was laid down in Factorial Randomized Block Design with three replications. The results revealed that kabuli chickpea variety RVKG 101 grown with 75 kg P_2O_5 along with recommended dose of N (30 kg ha^{-1}) and K (20 kg ha^{-1}) produced significantly higher growth and yield parameters. Maximum protein content (20.69 %) was observed in JGK 1 variety followed by RVKG 101 (20.34 %) Maximum net return and B:C ratio was also observed with RVKG 101 grown with 75 kg P_2O_5 ha^{-1}. Application of phosphorus at different levels gave significantly higher available N and P content in soil after harvest of the chickpea as compared to control treatment.

Key words: kabuli chickpea varieties, available nutrients, phosphorus and protein content

Introduction

The large area of chickpea cultivation in India is occupied by traditional varieties. The yield of this crop is not only low but most unstable. There is a great scope to increase its production by growing promising chickpea varieties. New cultivars (varieties) having superior characters are coming forward to identify their production potential and suitability for the different agro climate and micro-environmental conditions.

Phosphorus fertilizers seem to be an important constraint in bumper harvest of the crop in most of the chickpea growing areas which are deficient in phosphorus. The supply of phosphorus to legumes is more important than of nitrogen because, later being fixed by symbiosis with *Rhizobium* bacteria. Phosphorus stimulates nodulation, early root development, plant growth, yield and quality of grains etc. Phosphorus application to legumes not only benefits the current crop but also favorably affects the succeeding non-legume crop. It also improves the crop quality and resistance against plant diseases. Availability of soil P is critical for growth and development of chickpea, and a poor P availability limits its productivity. Phosphorus deficiency is a critical nutrient-deficiency problem in the Indian soils and may cause up to 29-45% yield losses in chickpea. The adequate supply of phosphorus to legume is more important than that of nitrogen. Because it has been beneficial effect on root development, nodulation, growth and yield. Low phosphorus status of soil was found limiting N_2 fixation in legumes. Phosphorus requirement for legumes deriving a large part of their N by N_2 fixation is often higher than those supplied with fertilizer N. Improved P nutrition has been reported to increase nodule numbers and BNF activity in French bean. Keeping in views the present study 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 organic carbon and available nitrogen and medium in phosphorus content. The experimental crop chickpea (kabuli) was sown on 4th December 2021 and harvested on 16-19th March 2022. The study involve twelve treatment combinations consisting of four levels of phosphorus viz. **P_0:** 00 kg ha^{-1} **P_1:** 25 kg ha^{-1}, **P_2:** 50 kg ha^{-1} and **P_3:** 75 kg ha^{-1} in and three varieties **V_1:** RVKG 101, **V_2:** NBeG 119 and **V_3:** JGK 1 in factorial randomized block design with three replications. The recommended dose of nitrogen and potassium adopted was 30: 20 kg ha^{-1}.The total amount of nitrogen, phosphorus and potash were supplied through urea, SSP and muriate of potash as basal. All the varieties of kabuli chickpea were sown @ 80 kg ha^{-1} with seed treatment. Growth and yield attributes parameters was recorded at harvest. The protein content (%) in chickpea grain was worked out by multiplying nitrogen content of grain with factor 6.25. 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

Effect of varieties and phosphorus level on growth and yield attributes parameters

Maximum value of growth and yield attributes parameters was recorded with RVKG 101 was comparable with JGK 1. Minimum valuewas recorded with NBeG 119 variety which was inferior in all varietal treatments. The differences in growth characters due to varieties may be attributed to their inherent characteristics.

The results revealed that (Table-1) the application of phosphorus increased the growth parameters (i.e. plant height and number of branches) as well as yield attributes parameters (viz. number of pod $plant^{-1}$, and test weight) in kabuli chickpea and maximum value was recorded with 75 kg ha^{-1} treatment which was significantly higher as compared to control and 25 kg ha^{-1} levels but was at par with 50 kg ha^{-1} level. The higher value of different growth and yield attributes parameters with 75 kg P_2O_5/ha might was due to increased rate of energy metabolism and also might was attributed to beneficial effect of phosphorus on root proliferation, nodulation and accelerating effect of P on the synthesis of protoplasm there by the plants grew tall, higher pace of dry matter production and higher number of branches/plant. The favourable effects of phosphorus application on plant height have also been reported by others[6].

The beneficial effect of phosphorus may be attributed to its important role in energy transformation and plant metabolism providing conductive conditions for the better utilization of photosynthesis which ultimately caused better flowering, fruiting as well as increase in the size of pods[7].

Application phosphorus showed significantly higher test weight as compared to control and maximum value (41.63 g) was noted with 75 kg ha^{-1} treatment which was significantly higher as compared to 25 and 50 kg ha^{-1} treatment.

Table 1 Yield attributes, yield, protein content and economics of kabuli chickpea as influenced by varieties and phosphorus levels

Treatments	Plant height (cm)	No. of branches Plant^{-1}	Number of pods plant^{-1}	Test weight (g)	Seed Yield (q ha^{-1})	Harvest index (%)	Protein content (%)	Gross Return (Rs. ha$^{-1)}$	Net Return (Rs. ha$^{-1)}$	B : C ratio
Varieties (V)										
V_1: RVKG 101	46.49	19.01	53.90	40.15	17.7	42.31	20.34	155234	110159	3.44
V_2: NBeG 119	43.92	17.59	47.93	37.46	15.69	37.97	19.17	138447	93372	3.07
V_3: JGK 1	44.14	17.91	50.60	40.72	16.64	38.47	20.69	146710	101635	3.25
S.E m.±	**0.73**	**0.28**	**1.08**	**0.32**	**0.27**	**0.52**	**0.23**	**-**	**-**	**-**
C.D. (5%)	**2.13**	**0.82**	**3.18**	**0.94**	**0.78**	**1.52**	**0.67**	**-**	**-**	**-**
Phosphorus Levels (P)										
P_0: 00 kg ha^{-1}	39.32	16.21	38.18	36.91	12.22	36.67	18.90	108100	77425	3.52
P_1: 25 kg ha^{-1}	44.74	17.66	49.37	38.87	16.38	38.63	19.95	144446	112677	4.55
P_2: 50 kg ha^{-1}	47.09	18.73	55.73	40.37	18.49	40.81	20.43	162531	129669	4.95
P_3: 75 kg ha^{-1}	48.26	20.06	59.95	41.63	19.62	42.23	20.97	172142	138186	5.07
S.E m.±	**0.84**	**0.32**	**1.25**	**0.37**	**0.31**	**0.60**	**0.29**	**-**	**-**	**-**
C.D. (5%)	**2.46**	**0.95**	**3.67**	**1.08**	**0.90**	**1.75**	**0.77**	**-**	**-**	**-**
Interaction (V x P)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**-**	**-**	**-**

Seed yield

Seed yield of chickpea was observed in the range of 15.69 to 17.70 q ha^{-1} under different varietal treatments. Maximum seed yield (17.70 q ha^{-1}) was observed with RVKG 101 variety which was significantly higher as compared to JGK 1 and NBeG 119 varieties. JGK 1 variety also recorded significantly higher seed yield as compared to NBeG 119. This may be ascribed that the differences in growth and yield attributing parameters of varieties are due to genetic characters of each variety.

Under different phosphorus levels, seed yield was ranged from 12.22 to 19.62 q ha^{-1}. It is evident from result that increasing the phosphorus levels up to 75 kg ha^{-1} increased the seed yield and maximum value (19.62 q ha^{-1}) was noted with 75 kg ha^{-1} treatment which was 60.56, 19.78 and 6.11 per cent significantly higher as compared to control, 25 and 50 kg ha^{-1} treatment. Minimum seed yield (12.22 q ha^{-1}) was noted with control treatment.Higher values of yield and yield attributes may be described to the effect of P on root development, energy transformation and metabolic processes of the plant, which in term resulted in greater translocation of photosynthates towards the sink development. Similar results have been reported earlier investigators[1,6].

Protein content

Protein content in kabuli chickpea seed was found in the range of 19.17 to 20.69 per cent under different varieties. Maximum protein content (20.69 %) was observed in JGK 1 followed by RVKG 101 variety with 20.34 per cent protein content and both the varieties were at par from each other and significantly superior to NBeG 119 variety which show least protein (19.17%) content[3].

It is clear from result that maximum protein content (20.97 %) noted with higher level of phosphorus i.e.75 kg ha^{-1} which was significantly higher to control and 25 kg ha^{-1} but was at par with 50 kg ha^{-1} treatment. This increase of protein content in seed with the P application might be due to significant increase of number of root nodules (N fixation) and hence resulted increased N content in seed ultimately the protein content[2].

Effect of varieties and phosphorus level on economical parameters of chickpea

Under different treatment of varieties and phosphorus, maximum gross and net return was obtained with $\mathbf{V_1}$***:*** RVKG 101 and $\mathbf{P_3}$**:**75 kg P_2O_5 ha^{-1} treatments. Under different variety treatments, maximum B: C ratio 3.44 was recorded with $\mathbf{V_1}$***:*** RVKG 101. Whereas, in different phosphorus levels, maximum B:C ratio 5.07 was recorded with $\mathbf{P_3}$**:** 75 kg P_2O_5 ha^{-1}, which might be due to the higher seed and straw yield in these treatments.

Effect on Soil Properties

It is apparent from results (table-2) that the different doses of P applied in different varieties did not show any significant effect on pH and electrical conductivity in different treatments and it was observed more or less the same in different treatments. It might be due to high buffering capacity of the soil. Under different varieties, organic carbon content and available N, P & K was statistically at par with all the varieties under tested.

Table 2 Effect of varieties and phosphorus levels on soil parameters and available nutrients after harvest of chickpea

Treatments	Soil parameters			Available nutrients (kg ha^{-1})		
	pH (1:2)	EC(dSm^{-1})	OC (%)	N	P	K
Initial status	**7.78**	**0.23**	**0.445**	**208.4**	**13.82**	**224.2**
Varieties (V)						
V_1: RVKG 101	7.87	0.30	0.444	216.6	14.97	224.4
V_2: NBeG 119	7.83	0.30	0.457	212.5	15.44	225.9
V_3: JGK 1	7.85	0.32	0.459	214.0	15.20	229.4
F-Test	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
SE m (±)	**0.02**	**0.02**	**0.005**	**1.6**	**0.17**	**3.1**
C. D. at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Phosphorus Levels (P)						
P_0: 00 kg ha^{-1}	7.82	0.30	0.433	208.8	12.88	224.6
P_1: 25 kg ha^{-1}	7.86	0.30	0.452	211.5	14.46	230.0
P_2: 50 kg ha^{-1}	7.87	0.32	0.458	216.6	16.20	230.6
P_3: 75 kg ha^{-1}	7.86	0.31	0.470	220.4	17.27	221.1
F-Test	**NS**	**NS**	**S***	**S***	**S***	**NS**
SE m (±)	**0.02**	**0.02**	**0.006**	**1.8**	**0.19**	**3.6**
C. D. at 5%	**0.06**	**0.05**	**0.017**	**5.4**	**0.56**	**10.5**
Interaction (V x P)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Szakiel, A., C. Paczkowski and M. Henry, 2010. Influence

Whereas, application of phosphorus at different levels gave significantly higher organic carbon content in soil than control of respective nutrient. Maximum organic carbon content (0.470 %) was observed with 75 kg a ha^{-1} treatment which was higher as compared to other lower levels of phosphorus i.e. 25 and 50 kg ha^{-1}.

Application of phosphorus at different levels gave significantly higher available N and P content in soil after harvest of the chickpea as compared to control treatment. Maximum available N (220.4 kg ha^{-1}) and P (17.27 kg ha^{-1}) content was observed with 75 kg a ha^{-1} treatment which was higher as compared to control and other lower levels of phosphorus i.e. 25 and 50 kg ha^{-1}[4].

Higher available N in fertilized plots might be due to the fact that P helped in better nodulation which might have resulted in more N-fixation in plant roots and the improvement in P status of soil may be ascribed to application of phosphorous[5].

Conclusion

On the basis of present investigation, it may be concluded that kabuli chickpea variety RVKG 101 grown with 75 kg P_2O_5 along with recommended dose of N (30 kg ha^{-1}) and K (20 kg ha^{-1}) produced significantly higher growth and yield parameters. Maximum net return and B : C ratio was also observed with RVKG 101 grown with 75 kg P_2O_5 ha^{-1}. So, to get better yield and higher economic benefit from kabuli chick pea productions farmers are suggested to use the RVKG 101 variety with 75 kg P_2O_5 in Gwalior district of grid region of Madhya Pradesh.

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