Eco. Env. & Cons. 29 (January Suppl. Issue) : 2023; pp. (S308-S313)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i01s.046

Influence of Phosphorus and potassium on Growth and Yield of Chick Pea (*Cicer arietinum* L.) under Prayagraj Condition

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(Received 2 June, 2022; Accepted 8 August, 2022)

ABSTRACT

The field experiment entitled was "Influence of Phosphorus and Potassium levels on growth and yield of chickpea" conducted during *Rabi* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out on Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The treatments which are T_1: 20 kg/ha Phosphorus +10 kg/ha Potassium, T_2: 20kg/ha Phosphorus+20kg/ha Potassium, T_3:20kg/ha Phosphorus +30 kg/ha Potassium, T_4: 30 kg/ha Phosphorus +10 kg /ha Potassium, T_5: 30 kg/ha Phosphorus +20 kg /ha Potassium, T_6: 30 kg/ha Phosphorus +30 kg /ha Potassium, T_7: 40 kg/ha Phosphorus +10 kg /ha Potassium, T_8: 40 kg/ha Phosphorus +20 kg /ha Potassium, T_9: 40 kg/ha Phosphorus +30 kg /ha Potassium are used. The results shown that the steady increase in growth attributes of Chickpea at 100 DAS *viz.,* plant height (42.66 cm), Number of nodules per plant (6.33), Dry weight (29.17 g) were significantly higher in treatment 9 (40kg/haphosphorus+30 kg/ha potassium). Also, treatment 9 with 40kg/ha phosphorus +30 kg/ha potassium recorded maximum number of Pods per plant (43.60), seeds per pod (1.93), Test weight (210.50 g), maximum Seed yield (2.49 t/ha), Stover yield (4.60 t/ha) and Harvest Index (34.99 %) compared to other treatments.

***Key words**: Phosphorus, Potassium, Growth, Yield*

Introduction

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops. India has the largest area under pulses. The pulses are integral part of the cropping system of the farmers all over the country because these crops fit well in the crop rotation and crop mixture. Vegetarian people mostly depend on pulses, which are major constituents of Indian diets. Chickpea and Kabuli chickpea are the main source of dietary protein for the majority of Indians and are grown as grain legume. The legumes are not only important source of human diet but also occupy an important place to keep the soil productive because these crops enrich the soil through symbiotic nitrogen fixation. Chickpea is mainly used for preparation of chhola dish and other table purposes. It is also used as dal, besan, flour, crushed whole gram, boiled or roasted or cooked, salted or sweet preparation and green foliage as vegetables. Chickpea

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(Kabuli and Desi) has 17-20% protein and 60-64% carbohydrate.

On a global basis, Chickpea is the third most important pulse crop. During 2020-21, it will increased to 25.58 million MT. This shows an impressive growth of 91% or a compound annual growth rate (CAGR) of 4.42%. During 2020-21, chickpea had a loin's share of 49.3% in the total pulses production and average productivity of 1252 kg/ha. Out of which, 71 per cent of global area with 70 per cent of global production of Chickpea is contributed by India as it ranks 1st in area and production but lags behind several countries in terms of productivity because of poor adoption of improved varieties and production technologies by farmers. Apart from India, Australia (12.35%), Myanmar (3.25%) and Ethiopia (2.92%) are the major Chickpea producing countries of the world. The Chickpea production in India has gone up from 38.55 to 112.29 lakh tonnes during 2020-21, while the area has also gone up from 51.85 to 105.61 lakh ha, whereas, the yield has steadily increased from 744 kg/ha to 1063 kg/ha during the same period. Madhya Pradesh is leading state in terms of area and production as it contributes around 34 and 40 per cent share to the total area and production of gram in the country (Annual Report 2020-21, Directorate of Pulses Development). Due to stagnant productivity over the years, Chickpea import to India has been bagged in largely to counterbalance domestic short supply and hence it became the major importer of Chickpea (5.90 lakh tonnes) during 2020-21. The countries which exports Chickpea to India are Canada, Australia, Iran, Myanmar, Tanzania, Pakistan, Turkey and Frances Phosphorus About 80-90 per cent of total nitrogen requirement of chickpea is met through biological nitrogen fixation. Phosphorus fertilization is important for chickpea, having very specific key-role in biological nitrogen fixation. It improves root development and nodulation. Although information is available on the P level in desi chickpea, the information on the response of kabuli chickpea to phosphorus is rather limited.

It is grown in an about 30% of the national pulse acreage which contributes to about 38% of national pulse production in India. Phosphorus is an important fertilizer in chickpea production; it is an import fertilizer which enhanced the cost of production (Dotaniya *et al.,* 2013; Dotaniya and Datta, 2013). Phosphorus stimulates early root development leaf size, tillering, flowering, grain yield, and fastens maturity.

It is a constituent of certain nucleic acid that is phospholipids, chromosome and the co- enzymes nicotinamide adenine dinucleotide (NAD), adenosine triphosphate (ATP), and nicotinamide adenosine dineciteotide phosphate (NADP)

Potassium is one of the major elements taken up by the plant. Plants absorb it in larger amounts as compared to other minerals except nitrogen. It helps in formation of proteins and chlorophyll. It has most importance for imparting drought and disease resistance and has synergistic effect with nitrogen and phosphorus (Das, 2016). Though, it is not a constituent of organic structures but it regulates enzymatic activities (over 60 enzymes require K for activation), translocation of photo synthates and considerably improves seed yield of chickpea if applied as a fertilizer.

Potassium application significantly affected the growth (plant height and number of pods) as well as yield and yield contributing parameters grain weight, biomass, yield and straw yield.

The effect of Potassium application was prominent in chickpea plant showing maximum plant height and maximum number of pods.

Materials and Methods

The present examination was carried out during *Kharif* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28°N latitude, 81.54°E longitude and 98 m altitude above the mean sea level. The experiment laid out in Randomized Block Design which consisting of nine treatments with T_1: 20 kg/ha Phosphorus +10 kg/ha Potassium, T_2: 20 kg/ha Phosphorus +20 kg/ha Potassium, T_3: 20 kg/ha Phosphorus +30 kg/ha Potassium, T_4: 30 kg/ha Phosphorus +10 kg /ha Potassium, T_5: 30 kg/ha Phosphorus +20 kg /ha Potassium, T_6: 30 kg/ha Phosphorus +30 kg /ha Potassium, T_7: 40 kg/ha Phosphorus +10 kg /ha Potassium, T_8: 40 kg/ha Phosphorus +20 kg /ha Potassium, T_9: 40 kg/ha Phosphorus +30 kg /ha Potassium are used. The experimental site was uniform in topography and sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in Organic carbon (0.38%), medium available N (225 kg/ha) higher available P (19.50 kg /ha) and medium available K (213.7 kg/ ha. In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it af-

ter harvest several yield parameters were recorded those parameters are growth parameters, plant height, no. of nodules/plant and plant dry weight are recorded. The yield parameters like No. of pods/plant, No. of seeds/pod, Test weight (g), seed yield, stover yield and harvest index were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design.

Results and Discussion

Growth attributes Plant height

Plant height of chickpea at 100 DAS plant height (42.66 cm) was recorded with the of 40 kg/ha phosphorus +30 kg/ha. However, the treatments with the application of 30 kg/ha phosphorus +30 kg/ha potassium (42.21 cm), 40 kg/ha phosphorus+20 kg/ha potassium (42.37 cm) was found to be statistically at par with 40 kg/ha phosphorus +30 kg/ha as compared to all the treatments. The Increasing P and Fe levels, increased the plant height, branch per plant, pods per plant, seed per pod and test weight; in 40 kg P_2O_5 per ha with 5 kg Fe per ha plot, significantly improved yield attributes compared to rest of the treatments. The effect of application of iron 5 and 7.5 kg Fe per ha was found at par on growth and, yield and yield attributes was reported by Pingoliya *et al.* (2014).

The plant height (102.40 cm), branches per plant (31.10), and grain yield (1.06 t /ha) were recorded in higher rate of P over the control, whereas increasing the P level from 50 to 75 kg P_2O_5 per ha did not show any significant effect on branches per plant was reported by Memon *et al.* (2016).

Number of nodules/plant

Number of nodules per plant of chickpea at 100 DAS higher no of nodules (6.33 cm) was recorded with the application of 40 kg/ha phosphorus +30 kg/ha potassium, as compared to other treatments and statistically at par with the application of 40 kg/ha phosphorus +20 kg/ha potassium (6.27cm), 30 kg/ha phosphorus +30 kg/ha potassium (6.07 cm). The application of phosphorus at 60 kg/ ha, sulphur at 20 kg/ ha and seed inoculation with PSB + Rhizobium significantly increased the growth, dry weight, number of nodules per plant and yields (grain and straw yield) of chickpea over control /un-inoculated. Phosphorus at 60 kg/ha gave height of 43.74 cm at harvest, dry weight of 33g/plant, 16.42 branches/plant, 21.76 q/ha of grain yield and 25.06 q/ha of straw yield was concluded by Singh *et al.* (2018).

Plant dry weight (g/plant)

Plant dry weight of chickpea at 100 DAS higher plant dry weight (29.17 g) was recorded with the application of 40 kg/ha phosphorus +30 kg/ha potassium, as compared to other treatments and statistically at par with application of 40 kg/ha phosphorus +20 kg/ha potassium (29.09 g), 30 kg/ha phosphorus +30 kg/ha potassium (28.92 g) and 30 kg/ha phosphorus +20 kg/ha potassium(28.63 g). All nodulation parameters excluding the nodule color of chickpea were significantly affected by P rate, and the maximum values were recorded at 45 and 60 kg P_2O_5/ha. Nodule rating and dry weight per plant increased at 60 (47.50 and 6.44%) and 45 (52.30 and 6.60%) kg P_2O_5/ ha, respectively, relative to the control treatment was observed by Meleta *et al.* (2019).

Table 1. Effect of Phosphorus and potassium on Growth attributes of Chickpea

Treatments	Plant height (cm)	Nodules/plant	Dry weight(g/plant)
1. 20 kg/ha phosphorus +10kg/ha potassium	38.74	4.87	26.17
2. 20 kg/ha phosphorus +20 kg/ha potassium	39.50	5.00	26.53
3. 20 kg/ha phosphorus +30 kg/ha potassium	40.14	5.60	27.73
4. 30 kg/ha phosphorus +10kg/ha potassium	39.64	5.33	26.87
5. 30 kg/ha phosphorus +20 kg/ha potassium	41.19	5.80	28.63
6. 30 kg/ha phosphorus +30 kg/ha potassium	42.21	6.07	28.92
7. 40 kg/ha phosphorus +10kg/ha potassium	39.80	5.53	27.53
8. 40 kg/ha phosphorus +20 kg/ha potassium	42.37	6.27	29.09
9. 40 kg/ha phosphorus +30 kg/ha potassium	42.66	6.33	29.17
F- test	S	S	S
S. EM (±)	0.16	0.11	0.27
C. D. (P = 0.05)	0.47	0.34	0.80

Yield attrubutes and Yield

Number of Pods per plant

Number of Pods per plant of chickpea at 100 DAS higher number of Pods/plant (43.60) were recorded with the treatment 40 kg/ha phosphorus +30 kg/ha potassium which was superior over rest of all treatments and treatment with 40 kg/ha phosphorus +20 kg/ha potassium, 30 kg/ha phosphorus +30 kg/ha potassium, were statistically at par with treatment 40 kg/ha phosphorus +30 kg/ha potassium. The application of P 60 kg /ha resulted in significantly higher grain yield (2.74 t /ha) mainly due to the significantly higher primary branches per plant (8.10), pods per plant (33.60), and 100-grain weight (13.10 g). It improved the grain yield by 6.80% over P at 30 kg/ha and 53.90% over the control was observed by Das *et al.* (2015).

Number of Seeds per pods

Number of Seeds per pod of chickpea at 100 DAS higher Number of seeds per pod (1.93) were recorded with the treatment 40 kg/ha phosphorus +30 kg/ha potassium which was superior over rest of all treatments and treatment with 40 kg/ha phosphorus +20 kg/ha potassium, 30 kg/ha phosphorus +30 kg/ha potassium were statistically at par with treatment 40 kg/ha phosphorus +30 kg/ha potassium. The growth and yield components were significantly increased by different potash levels. However, the differences between control and 25 kg K2O/ ha were no significant for the number of pods per plant and 1000-seed weight. The application of 25 kg K2O /ha could not increase the seed and biological yield significantly thereafter, seed yield increased gradually with the increase in potash levels and the maximum seed yield (2341 kg/ ha) was obtained with 150 kg K2O/ ha was reported by Ali *et al.* (2007).

Test weight (g)

Test weight of chickpea at 100 DAS higher Test weight (210.50 g) was recorded with the treatment 40 kg/ha phosphorus +30 kg/ha potassium which was superior over rest of all treatments and treatment with 40 kg/ha phosphorus +20 kg/ha potassium, 30 kg/ha phosphorus +30 kg/ha potassium were statistically at par with treatment 40 kg/ha phosphorus +30 kg/ha potassium.The application of 90 kg P205/ ha to both kharif and rabi crops proved to be the best with respect to grain and haulm yield as compared to application of 30 and 60 kg P205 /ha in chickpea was observed by Thakur *et al.* (2004)

Seed yield (t/ha)

Seed yield of chickpea at 100 DAS highest Seed yield (2.49 t/ha) was recorded with treatment 40 kg/ha phosphorus +30 kg/ha potassium which was superior over rest of all treatments and treatment with 30 kg/ha phosphorus +30 kg/ha potassium, 40 kg/ha phosphorus +20 kg/ha potassium,30 kg/ha phosphorus +20 kg/ha potassium were statistically at par with treatment 40 kg/ha phosphorus +30 kg/ha potassium. By increasing levels of P up to 60 kg P2O5/ ha resulted in a significant increase in P content, uptake and seed yield of chickpea over control a field experiment conducted at IARI, New Delhi

Table 2. Effect of Phosphorus and potassium on yield attributes in Chickpea.

Treatments	Pods/ plant	Seeds/ pod	Test Weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest Index (%)
1. 20 kg/ha phosphorus +10kg/ha potassium	39.13	1.00	181.13	2.03	4.18	32.72
2. 20 kg/ha phosphorus +20 kg/ha potassium	39.27	1.27	186.20	2.08	4.27	32.71
3. 20 kg/ha phosphorus +30 kg/ha potassium	41.47	1.60	199.07	2.27	4.34	34.37
4. 30 kg/ha phosphorus +10kg/ha potassium	40.40	1.33	190.60	2.12	4.24	33.31
5. 30 kg/ha phosphorus +20 kg/ha potassium	42.07	1.67	203.10	2.31	4.45	34.21
6. 30 kg/ha phosphorus +30 kg/ha potassium	42.73	1.80	206.23	2.34	4.47	34.37
7. 40 kg/ha phosphorus +10kg/ha potassium	40.87	1.47	194.00	2.17	4.29	33.57
8. 40 kg/ha phosphorus +20 kg/ha potassium	43.07	1.87	208.27	2.41	4.51	34.81
9. 40 kg/ha phosphorus +30 kg/ha potassium	43.60	1.93	210.50	2.49	4.60	34.99
F test	**S**	**S**	**S**	**S**	**S**	**NS**
S. EM (±)	0.31	0.06	1.66	0.09	0.07	0.75
CD (P = 0.05)	0.93	0.18	4.98	0.20	0.15	—

during 1997-1998 and 1998-1999 and they reported by Meena *et al.* (2005).

Stover yield (t/ha)

Stover yield of chickpea at 100 DAS highest Stover yield (4.60 t/ha) was recorded with treatment 40 kg/ha phosphorus +30 kg/ha potassium which was superior over rest of all treatments and treatment with 30 kg/ha phosphorus +30 kg/ha potassium,40 kg/ha phosphorus +20 kg/ha potassium were statistically at par with treatment 40 kg/ha phosphorus +30 kg/ha potassium. The application of P up to 40 kg P_2O_5 /ha significantly increased the uptake of N and P in grain and straw of chickpea over control and 20 kg P_2O_5/ ha was found by Singh *et al*. (2003). The application of P_2O_5 at 60 kg /ha recorded higher grain yield as compared to no P205 and application of 30 or 90 kg P205/ha maximum (3180 kg/ha) straw yield, while minimum (2528 kg /ha) straw yield was observed in plots was explained by Abdul Basir *et al.* (2005).

Harvest Index (%)

Harvest index of chickpea at 100 DAS highest Harvest index (34.99 %) was recorded with treatment 40 kg/ha phosphorus +30 kg/ha potassium which was superior over rest of all treatments and there was significant difference among the treatments. The application of Phosphorus at 60 kg/ha gave 2067.3 kg/ha of seed yield, 4257.9 kg/ha of straw yield and 32.7% harvest index. Also, dry matter accumulation, plant height was highest in the treatment with Ferrous application was reported by Singh *et al.* (2017)

Conclusion

It is concluded that highest yield in chickpea during Rabi season, application of Phosphrous 40 kg/ha + Potassium 30 kg/ha was recorded highest productivity such as plant height, number of nodules, number of pods per plant, number of seeds per pod, seed yield and stover yield was recorded maximum in gross return, net return and benefit cost ratio.

Acknowledgement

I express thankfulness to my advisor Dr. Umesha. C and all the faculty members of Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj 211 007, Uttar Pradesh. For providing us essential facilities to undertake the studies.

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