Effect of phosphorous and potassium on growth parameters, yield and yield attributes of chickpea *(Cicer arietinum L.)* under the rainfed condition in Chitrakoot

Abstract

Field experiments were conducted to Studies effect of phosphorus and potassium on growth parameters, yield components and yield of chickpea during rabi season of 2021-22 at Rajoula Agriculture farm, of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot, Satna (M.P.) The experiment consist of nine treatments combinations in factorial randomized block design with three replications consisted of three levels of phosphorous (50, 60 and 70 kg ha^{-1}) and three potassium levels (30, 40 and 50 kg ha^{-1}). Chickpea variety *IPC-2011-112* was grown with the recommended agronomic practices. On the basis of results emanated from investigation it can be concluded that among the growth parameters maximum plant height at 90 DAS is 37.40 cm, maximum number of branches at 90 DAS is 32.53 and maximum number of nodules $plant^{-1}$ at 45 DAS is 46.00 during the study were associated with the treatment T_9 [70 kg P_2O_5 ha^{-1}+ 50 kg K_2O ha^{-1}]. Similarly, among the yield components and productivity parameters maximum values in relation to number of pod $plant^{-1}$ (69.33), number of seed pod^{-1} (1.73), 100 grain wt. (22.66 gm) and grain yield (16.85 q ha^{-1}) was also found in the treatment T_9 [70 kg P_2O_5 ha^{-1}+ 50 kg K_2O ha^{-1}].

Key Words: Chickpea, Growth, Phosphorous, Potassium, and Yield.

Introduction

Pulses play a pivotal role and occupy a unique position in Indian agriculture by virtue of their inherent capacity to grow on marginal lands. It is an easily available source of protein in the rural heart of India. Pulses provide significant nutritional and health benefits and are known to reduce several non- communicable diseases such as colon cancer and cardio-vascular diseases **(Jukanti *et al.*, 2012).**

India is the largest producer (25% of global production), consumer (27% of world consumption) and importer (14%) of pulses in the world. India ranks first in the world in terms of pulse production (25% of total worlds production) **(FAOSTAT 2017).** In India chickpea occupies 10.17 million ha area, with a production of 11.35 million tonnes registering the productivity of 1116 kg/ha. In Uttar Pradesh, chickpea crop occupied 0.62 million hectares area, 0.85 million tonnes production and 1371 kg/ha productivity **(Anonymous, 2021).**

More than 90 per cent of total pulse production has been the contributed from 10 states namely Rajasthan, Maharashtra, Madhya Pradesh, Uttar Pradesh, Karnataka, Gujarat, Andhra Pradesh, Jharkhand, Telangana and Tamil Nadu. Rajasthan has the highest area (24.21%) under chickpea, followed by Maharashtra (22.82%), Madhya Pradesh (18.94%), Karnataka (10.27%), Uttar Pradesh (6.10%) and Andhra Pradesh (4.56%). **(Anonymous, 2021).**

Phosphorus (P) is an essential nutrient of numerous vital plant structural compounds. Phosphorus is one of the essential nutrients for legume growth and BNF **(Mhango *et al.*, 2008).**

Phosphorus deficiency can limit nodule number, leaf area, and biomass and grain development in legumes. Symbiotic nitrogen fixation has a high P demand because the process consumes large amounts of energy **(Schulze *et al.*, 2006)** and energy generating metabolism strongly depends upon the availability of P **(Plaxton, 2004). Singh and Sale (2000)** reported that P fertilization stimulates root growth, photosynthesis and increases hydraulic conductibility of roots. Phosphorus is used in numerous molecular and biochemical plant processes, particularly in energy acquisition, storage and utilization **(Epstein and Bloom, 2005).**

Legumes are heavy feeder of phosphorus and less responsive to nitrogen because of their capacity to meet their own nitrogen requirement through symbiotic fixation **(Kumar *et al.* 2016).** Phosphorus is connected with some particular plant growth factors that are root development, vigorous stem, enhanced flower formation and seed production, earlier and more uniform crop maturity, increase nitrogen fixing capacity of legumes, improvement in crop quality and resistance to plant diseases **(Rehan *et al.* 2018).** It is required for higher and sustainable production of grain legumes. Generally, legumes have higher P requisites due to more consumption of energy in the process of symbiotic nitrogen fixation **(Islam *et al.* 2012).**

Potassium application has been neglected in many countries, including India, which has resulted in soil K depletion in agricultural ecosystems and a decline in crop yields **(Regmi *et al*., 2002).** Higher yields and crop quality can be obtained at optimal N: K nutritional ratios. K is an essential macronutrient required for proper development of plants. In addition to activation of numerous enzymes, K plays an important role in the maintenance of electrical potential gradients across cell membranes and the generation of turgor. It is also essential for photosynthesis, protein synthesis and regulation of stomatal movement and is the major cation in the maintenance of cation-anion balances **(Marschner, 2002).** High availability of K enhances root development, producing more branching and lateral roots **(Egilla *et al*., 2001).**

Potassium is involved in many physiological process such as photosynthesis **(Vyas *et al*., 2001),** photosynthetic translocation, protein and starch synthesis, water energy relations **(Rao and Rao, 2004),** translocation of assimilates and activation of number of enzymes **(Sharma and Agrawal, 2002).**

Method and Materials

Experimental Sites

The experiment was carried out at Rajaula Agriculture farm, Mahatma Gandhi Chitrakoot Gramoday Vishwavidyalaya Chitrakoot, Satna (M.P.) which lies in the semi- arid and sub-tropical region of Madhya Pradesh between 25.148° North latitude and 80.855° East longitude. The altitude of town is about 190-210 meter above mean sea level.

Edaphic Condition

The soil of the experimental field was alluvial in origin, sandy loam in texture and slightly alkaline in reaction having pH 7.28 (1:2.5 soil: water suspension method given by **Jackson, 1973**), organic carbon percentage in soil is 0.34 per cent (Walkley and Black's rapid titration method given by **Walkley and Black, 1934**), with available nitrogen 98.0 kg ha^{-1} (Alkaline permanganate method given by **Subbiah and Asija, 1956**), available phosphorus as sodium bicarbonate-extractable P_2O_5 was 17.32 kg ha^{-1} (Olsen's calorimetrically method**, Olsen *et al*., 1954**) available potassium was 305.99 kg ha^{-1} (Flame photometer method given by **Hanwey and Heidel, 1952**)

Detail of treatments and design

The nine treatments combination of nutrient management practices having three each phosphorus levels (50, 60 and 70 kg ha^{-1}) and potassium levels (30, 40 and 50 kg ha^{-1}). Experiment was laid out in factorial randomized block design with three replications.

Table 1 : List of treatments used for the study

Treatment	**Treatment Details**	**Symbol**
T_1	50 kg P_2O_5 ha^{-1} + 30 kg K_2O ha^{-1}	$\mathbf{P_{50}K_{30}}$
T_2	50 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	$\mathbf{P_{50}K_{40}}$
T_3	50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1}	$\mathbf{P_{50}K_{50}}$

T_4	60 kg P_2O_5 ha^{-1} + 30 kg K_2O ha^{-1}	**$P_{60}K_{30}$**
T_5	60 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	**$P_{60}K_{40}$**
T_6	60 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1}	**$P_{60}K_{50}$**
T_7	70 kg P_2O_5 ha^{-1} + 30 kg K_2O ha^{-1}	**$P_{70}K_{30}$**
T_8	70 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	**$P_{70}K_{40}$**
T_9	70 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1}	**$P_{70}K_{50}$**

Crop Husbandry

A pre-sowing irrigation (Paleva) was done in the experimental field with an object to get optimum moisture conditions for attaining good germination. At proper tilth, one ploughing with tractor drawn mould bold plough was done followed by two ploughings by cultivator. Nitrogen @ 30 kg ha^{-1} applied uniformly through urea. Phosphorus and potassium was apply as per treatment at the time of sowing through single super phosphate and murate of potash respectively. The sowing of chickpea crop was done using a seed rate of 80 kg ha^{-1} in furrows opened by plough in the furrows spaced at 45 cm apart. Planking was done to cover the seeds with fine soil after sowing.

Harvesting and threshing: the crop was harvested at maturity and was allowed to dry in sun. Separate bundles were made for each plot and weighted. The after drying harvest was threshed manually.

Grain yield

After threshing the grain yield from each plot was separately weighed and recorded after converting into quintals per hectare.

Result and Discussion

Growth Parameters

Plant height (cm)

Plant height (cm) was significantly influenced by the use of different phosphorous and potassium levels. Plant height (cm) at 90 DAS was significantly higher P_2O_5@70 kg ha^{-1} as compared to P_2O_5@60 kg $ha^{-1}$and P_2O_5@50 kg ha^{-1}. The mean plant height (cm) at P_{50}, P_{60} and P_{70} were 33.79, 34.75 and 36.80 cm at 90 DAS. Plant height (cm) at 90 DAS was significantly higher in K_2O @50 kg ha^{-1} as compared to K_2O @40 kg ha^{-1} and K_2O @30 kg ha^{-1}. The mean plant height (cm) at K_{30}, K_{40} and K_{50} were 34.52, 35.03 and 35.80 cm at 90 DAS. The height of shoot was stimulated due to phosphorous which may be attributed to its essentiality in cell division. The consequences of the current investigation are additionally in concurrence with the investigation of **Murari *et al.* (2013), Singh and Singh (2012) and Yadav *et al.* (2022)**

Number of branches plant^{-1}

The no. of branches per plant is an important indication of growth. No. of branches per plant was significantly influenced by the use of different phosphorous levels at all growth stages. No. of branches per plant at 90 DAS was significantly higher P_2O_5@70 kg ha^{-1} as compared to P_2O_5@60 kg ha^{-1}and P_2O_5@50 kg ha^{-1}. The mean no. of branches per plant at P_{50}, P_{60} and P_{70} were 30.20, 31.22 and 32.24 at 90 DAS. No. of branches per plant of chickpea significantly increased with the use of different potassium levels. No. of branches per plant at 90 DAS was significantly higher in K_2O@50 kg ha^{-1} as compared to K_2O @40 kg ha^{-1} and K_2O @30 kg ha^{-1}. The mean no. of branches per plant at K_{30}, K_{40} and K_{50} were 30.68, 31.37 and 31.60 at 90 DAS. The results of the present investigation are also in agreement with the findings of **Jaybhay *et al*. (2015) and Yadav *et al.* (2022)**

Number of nodule plant^{-1}

The no. of nodule per plant is an important indication of growth. No. of nodule per plant was significantly influenced by the use of different phosphorous levels at all growth stages. No. of nodule per plant at 45was significantly higher P_2O_5@70 kg ha^{-1} as compared to P_2O_5@60 kg ha^{-1}and P_2O_5@50 kg ha^{-1}. The mean no. of nodule per plant at P_{50}, P_{60} and P_{70} were 29.00, 37.66 and 42.66 respectively at 45 days after sowing. No. of nodule per plant of chickpea significantly increased with the use of different potassium levels. No. of nodule per plant at 45 DAS was significantly higher in K_2O@50 kg ha^{-1} as compared to K_2O @40 kg ha^{-1} and K_2O @30 kg ha^{-1}. The mean no. of nodule per plant at K_{30}, K_{40} and K_{50} were 33.33, 36.33 and 39.66 respectively at 30 DAS. The consequences of the current investigation are additionally in concurrence with the investigation of **Thesiya *et al.* (2013) and Badini *et al.* (2015)**

Table-2: Growth parameters of chickpea as influenced by phosphorous and potassium levels

Treatments	Plant height (cm)	No. of branches plant^{-1}	No. of nodule plant^{-1}
P (kg ha^{-1})	**90 DAS**	**90 DAS**	**45 DAS**
50	33.79	30.20	29.00
60	34.75	31.22	37.66
70	36.80	32.24	42.66
SE(m)±	0.41	0.46	0.50

CD(P=0.05)	1.24	1.40	1.51
K (kg ha^{-1})			
30	34.52	30.68	33.33
40	35.03	31.37	36.33
50	35.80	31.60	39.66
SE(m)±	0.41	0.46	0.50
CD(P=0.05)	1.24	1.40	1.51
Interaction	S	S	S

Yield components and yield

No. of pod plant^{-1}

No. of pod plant^{-1} is an important indication of yield attributing characters. No. of pod plant^{-1} was significantly influenced by the use of different phosphorous levels at harvest stages. No. of pod plant^{-1} at harvest stage was significantly higher P_2O_5@70 kg ha^{-1} as compared to P_2O_5@60 kg ha^{-1}and P_2O_5@50 kg ha^{-1}. The mean no. of pod plant^{-1} at P_{50}, P_{60} and P_{70} were 54.86, 60.91 and 67.71 respectively at harvest stage. No. of pod plant^{-1} of chickpea significantly increased with the use of different potassium levels. No. of pod plant^{-1} at harvest stage was significantly higher in K_2O@50 kg ha^{-1} as compared to K_2O @40 kg ha^{-1} and K_2O @30 kg ha^{-1}. The mean no. of pod plant^{-1} at K_{30}, K_{40} and K_{50} were 59.44, 60.86 and 63.17 respectively at harvest stage. The results of the present investigation are also in agreement with the findings of **Neenu *et al.* (2014)**, **Ullah *et al.* (2018) and Kumar *et al.* (2019)**

No. of seed pod^{-1}

No. of seed pod^{-1} is an important indication of yield attributing characters. No. of seed pod^{-1} was significantly influenced by the use of different phosphorous levels at harvest stage. No. of seed pod^{-1} at harvest stage was significantly higher P_2O_5@70 kg ha^{-1} as compared to P_2O_5@60 kg ha^{-1}and P_2O_5@50 kg ha^{-1}. The mean no. of seed pod^{-1} at P_{50}, P_{60} and P_{70}were 1.52, 1.60 and 1.69 respectively at harvest stage. No. of seed pod^{-1} of chickpea significantly increased with the use of different potassium levels. No. of seed pod^{-1} at harvest stage was significantly higher in K_2O@50 kg ha^{-1} as compared to K_2O @40 kg ha^{-1} and K_2O @30 kg ha^{-1}. The mean no. of seed pod^{-1} at K_{30}, K_{40} and K_{50} were 1.57, 1.60 and 1.63 respectively at harvest stage. The consequences of the current investigation are additionally in concurrence with the investigation of **Shelake *et al.* (2011), Billore *et al.* (2009) and Patel *et al.* (2022).**

Seed Index

Seed index is an important indication of yield attributing characters. Seed index was significantly influenced by the use of different phosphorous levels at harvest stage. Seed index at harvest stage was significantly higher P_2O_5@70 kg ha^{-1} as compared to P_2O_5@60 kg $ha^{-1}$and P_2O_5@50 kg ha^{-1}. The mean seed index at P_{50}, P_{60} and P_{70}were 20.33, 21.44 and 22.33 gm respectively at harvest stage. Seed index of chickpea significantly increased with the use of different potassium levels. Seed index at harvest stage was significantly higher in K_2O @50 kg ha^{-1} as compared to K_2O @40 kg ha^{-1} and K_2O @30 kg ha^{-1}. The mean seed index at K_{30}, K_{40} and K_{50} were 20.88, 21.44 and 21.77 gm respectively at harvest stage. These results also confirms the findings of **Kumar *et al.* (2016), Sahare *et al.* (2019) and Sachan *et al.* (2022)**

Seed Yield (q ha^{-1})

Seed yield (q ha^{-1}) is an important indication of productivity characters. Seed yield (q ha^{-1}) was significantly influenced by the use of different phosphorous levels at harvest stage. Seed yield (q ha^{-1}) at harvest stage was significantly higher P_2O_5@70 kg ha^{-1} as compared to P_2O_5@60 kg ha^{-1}andP_2O_5@50 kg ha^{-1}. The mean seed yield (q ha^{-1}) atP_{50}, P_{60} and P_{70} were 13.02, 14.49 and 16.20 q ha^{-1} respectively at harvest stage. Seed yield (q ha^{-1}) **of** chickpea significantly increased with the use of different potassium levels. Seed yield (q ha^{-1}) at harvest stage was significantly higher in K_2O@50 kg ha^{-1} as compared to K_2O @40 kg ha^{-1} and K_2O @30 kg ha^{-1}. The mean seed yield (q ha^{-1}) at K_{30}, K_{40} and K_{50} were 14.02, 14.56 and 15.13 q ha^{-1}respectively at harvest stage. The results of the present investigation are also in agreement with the findings of **Tripathy *et al.* (2019), Pal *et al.* (2021), Singh *et al.* (2022) and Sachan *et al.* (2022)**

Table-3: Yield components and yield of chickpea as influenced by phosphorous and potassium levels

Treatments	No. of pod $plant^{-1}$	No. of seed pod^{-1}	Seed index (g)	Seed yield (q ha^{-1})
P (kg ha^{-1})	**At harvest**	**At harvest**	**At harvest**	**At harvest**
50	54.86	1.52	20.33	13.02
60	60.91	1.60	21.44	14.49
70	67.71	1.69	22.33	16.20
SE(m)±	0.94	0.65	0.37	0.017
CD(P=0.05)	2.84	1.95	1.13	0.052
K (kg ha^{-1})				

30	59.44	1.57	20.88	14.02
40	60.86	1.60	21.44	14.56
50	63.17	1.63	21.77	15.13
SE(m)±	0.94	0.65	0.37	0.017
CD(P=0.05)	2.84	1.95	1.13	0.052
Interaction	S	S	S	S

Conclusion

The present findings concluded that application of 70 kg P_2O_5 along with 50 kg K_2O ha^{-1} proved the most optimum and the beneficial fertility management for the "**IPC-2011-112**" Variety of Chickpea for the Bundelkhand /Chitrakoot region of Madhya Pradesh. This fertility management ($P_{70}K_{50}$) resulted to attain maximum growth parameters as well as yield and yield attributing characters.

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