Effect of phosphorous and vermicompost on growth characterstics and yield of chickpea (*Cicer aretinum* L.)

Abstract

A field experiment was conducted at Rajaula Agriculture farm, of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot, Satna (M.P.) during Rabi season of 2021-22. To study the effect of phosphorous and vermicompost on growth parameters, yield components and yield of chickpea the experiment comprised of 12 treatment combinations in randomized block design with three replications. Chickpea variety GNG-1958 (Marudhar) was grown with the recommended agronomic practices. On the basis of the results emanated from present investigation, it could be concluded that application of P_2O_5 @ 75 kg ha^{-1} + V @ 5.0 t ha^{-1} significantly recorded maximum growth parameters such as viz. plant height at 90 days (42.7 cm), number of leaves at 60 days (27.2) and number of nodule $plant^{-1}$ (13.4), maximum yield attributing characters such as number of pod $plant^{-1}$ (60.8), number of seed $plant^{-1}$ (64.4) and seed index (27.56 gm). Similarly the maximum seed yield (17.2 q ha-1) was associated with the treatment fertilized with P_2O_5 @ 75 kg ha^{-1} + V @ 5.0 t ha^{-1}.

Key Words: Chickpea, growth, potassium, vermicompost and yield.

Introduction

"India is the largest producer and consumer of pulses in the world. Among the pulses, chickpea is the most important grown in every part of India. It is largest produced food legume in South Asia. Chickpea (*Cicer arietinum* L.) is a major legume crop cultivated for its edible seeds legume of the genus *Cicer*, Tribe *Cicereae*, family *Fabaceae* (*leguminaceae*), and subfamily *Papilionaceae*. It provide protein rich diet to the vegetarian of the Indian and complement the stable cereals in the diets with proteins, essential amino acids, vitamins and minerals" **(Pingoliya *et al*. 2013).**

"In India food grains occupy 65% of total gross cropped area comprising cereals in 50% and pulses in about 14%. Within pulses, gram occupies 5% area followed by Mung 3%, Urd & Arhar (2% each) (Annual Report 2021-22). 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).**

"They contain 22- 24 % protein, which is almost twice the protein in wheat & thrice that of rice" **(Shukla *et al.* 2013)** and "carbohydrate (61.51%), fat (4.5%) and relatively free from anti nutritional factors" **(Saxena, 1990). "**Chickpea is rich in protein content (20.47g/100g), carbohydrate (62.95g/100g), fibre (12.2g/100g), phosphorous (252mg/l00g), high amount of minerals such as calcium (57mg/100g), magnesium (79mg/100g), iron (4.31mg/l00g) and zinc (15mg/100g), low in fat content and most of it is polyunsaturated" **(Wallace *et al.* 2016).** "It is originated in south eastern turkey" **(Redden *et al.* 2007). "**Chickpea as a legume crop plays a significant role in improving soil fertility by fixing the atmospheric nitrogen" **(Balai *et al.* 2017).**

"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).**

"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).**

"Regular application of organics in amounts sufficient to meet the requirements of crops not only results in increasing crop yield but also improve the soil fertility and organic matter content" **(Ramesh *et al*., 2008).** "Continuous use of inorganic fertilizers has brought loss of vital soil fauna and flora. Organic production systems maintained and improved the soil health through stimulating the activity of soil organisms and organic manures are also helpful in alleviating the increasing incidence or deficiency of secondary and micronutrients and is capable of sustaining crop productivity. Organic manures modify the soil physical behavior and increases the efficiency of applied nutrients" **(Pandey *et al*., 2007).** "Organic manures not only supply a higher amount of different nutrient elements but also contains beneficial microbes like nitrogen fixing bacteria, mycorrhizae and growth promoting substances for betterment of crops" **(Barik *et al*., 2006).**

"Vermicompost is usually a finely divided peat-like material with excellent structure, porosity, aeration, drainage and moisture-holding capacity" **(Ismail 2005; Edwards *et al.*, 2011).** It plays a vital role in dictating the biochemical cycles as it supports the growth and activities of soil micro flora. It enhances the colonization of *Mycorrhizae, Rhizobium, Azotobacter* and *Azospirillum* which in turn improve the nitrogen (N) as well as phosphorus (P_2O_5) supply and other micronutrients (Zn, Fe, Cu, Mn) besides imparting the resistance to plant against various soil borne diseases and insect pest attack. It enhances the root growth due to better soil physico-chemical properties of soil.

Materials and Method

Experimental Site

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 was moist, well drained with uniform plane topography. The soil of the experimental field was 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 0.24 per cent (Walkley and Black's rapid titration method given by **Walkley and Black, 1934**), with available nitrogen 98 kg ha^{-1} (Alkaline permanganate method given by **Subbiah and Asija, 1956**), available phosphorus as sodium bicarbonate-extractable P 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 12 treatments combination of nutrient management practices having four each phosphorus levels (0, 45, 60 and 75 kg ha^{-1}) and vermicompost 5 levels (0, 2.5, 5.0 t ha^{-1}). Experiment was laid out in Factorial Randomized Block Design with three replications.

Table -1: detail of the treatment combinations:

Symbol	Treatment Combinations	Details of Treatment
T_1	$\mathbf{P_0V_0}$	Control
T_2	$\mathbf{P_0V_1}$	P_2O_5 @ 0 kg ha^{-1} + V @ 2.5 t ha^{-1} (300 g)

T_3	**P_0V_2**	P_2O_5 @ 0 kg ha^{-1} + V @ 5 t ha^{-1} (600 g)
T_4	**P_1V_0**	P_2O_5 @ 45 kg ha^{-1} + V @ 0 t ha^{-1} (0 g)
T_5	**P_1V_1**	P_2O_5 @ 45 kg ha^{-1} + V @ 2.5 t ha^{-1} (300 g)
T_6	**P_1V_2**	P_2O_5 @ 45 kg ha^{-1} + V @ 5 t ha^{-1} (600 g)
T_7	**P_2V_0**	P_2O_5 @ 60 kg ha^{-1} + V @ 0 t ha^{-1} (0 g)
T_8	**P_2V_1**	P_2O_5 @ 60 kg ha^{-1} + V @ 2.5 t ha^{-1} (300 g)
T_9	**P_2V_2**	P_2O_5 @ 60 kg ha^{-1} + V @ 5 t ha^{-1} (600 g)
T10	**P_3V_0**	P_2O_5 @ 75 kg ha^{-1} + V @ 0 t ha^{-1} (0 g)
T11	**P_3V_1**	P_2O_5 @ 75 kg ha^{-1} + V @ 2.5 t ha^{-1} (300 g)
T12	**P_3V_2**	P_2O_5 @ 75 kg ha^{-1} + V @ 5 t ha^{-1} (600 g)

Preparation of experimental field

The field was prepared by ploughing with a tractor drawn disc plough by cross harrowing and planking. The field was levelled and weeds, grasses were removed with the help rake. There after field was laid out as per plan of layout manually.

Application of manures and fertilizers

"FYM was applied @ 10q ha^{-1} as basal dose. After the layout of experimental plot, the fertilizers were applied in the plots and thoroughly mixed with soil. As per the experimental recommended doses of Nitrogen, Phosphorus and Potassium were applied to all the plots. Recommended dose of Nitrogen, Phosphorus and Potassium were applied through Urea, DAP and MOP (30:60:30 kg ha^{-1})" [Kumar, et al.2022].

Harvesting and Threshing

The crop was harvested on 28th march, 2022 when it reached to its physiological maturity i.e. when the leaves were turned yellow and more than 70% pod were full matured. Threshing of 30th march, 2021 plot wise produce was done manually. The seed weight was recorded after sun drying the seed for three days. The seed weight thus obtained were converted into quintals per hectare on the basis of net plot size.

Statistical analysis:

The growth parameters and yields were recorded and analyzed as per Gomez and Gomez (1984) the tested at 5% level of significance to interpret the significant differences.

Result and Discussion

Growth Parameters

The data given in Table-2 clearly illustrated that among the growth parameters such as plant height, number of branches and number of nodule plant^{-1} are significantly affected by application of different levels of phosphorous and vermicompost. It is also clear from the data is that the interaction of phosphorous and vermicompost significantly affected all the growth parameters. Plant height at 90 days varied from 34.4-42.7 cm, number of branches at 60 days varied from 22.1-27.2 and number of nodules plant^{-1} varied from 10.1-13.4. Maximum plant height (42.7 cm) at 90 days, number of branches (27.2) and number of nodules plant^{-1} (13.4) were associated with the treatment T_{12} [P_2O_5 @ 75 kg ha^{-1} + V @ 5.0 t ha^{-1}]. Minimum plant height (34.4 cm) at 90 days, number of branches (22.1) and number of nodules plant^{-1} (10.1) were associated with the control treatment. Similar findings were reported by **Singh and Ahlawat (2007)**, **Singh *et al.* (2018) and Yadav *et al.* (2022)**

Yield attributes

It was obvious from the data given in Table-3 that among the yield components of chickpea such as number of pod plant^{-1}, number of seed plant^{-1} and seed index were significantly affected by application of different levels of phosphorous and vermicompost. It was also clear from the data is that the interaction of phosphorous and vermicompost significantly affected all the yield attributing parameters. Number of pod plant^{-1} varied from 31.2-60.8, number of seed plant^{-1} varied from 30.7-64.4 and seed index varied from 19.03-27.56 g. Maximum number of pod plant^{-1} (60.8), number of seed plant^{-1} (64.4) and seed index (27.56 gm) were recorded under the treatment T_{12} [P_2O_5 @ 75 kg ha^{-1} + V @ 5.0 t ha^{-1}] while the minimum number of pod plant^{-1} (31.2), number of seed plant^{-1} (30.7) and seed index (19.03 gm) were recorded under the treatment. The consequences of the current investigation are additionally in concurrence with the investigation of **Pal *et al. (*2021), Yadav *et al.* (2022) and Nema *et al.* (2022)**

Seed Yield

The data presented in Table-4 clearly shows that the seed yield was significantly affected by the application of different levels of phosphorous and vermicompost levels. The surge in seed yields under adequate nutrients supply might be attributed to mainly to the collective effect of a greater number of pods plant^{-1}, seed plant^{-1} and higher test weight, which was the result of improved translocation of photosynthates from source to sink ultimately yield is increased. The increase in grain yield under adequate nutrients supply mainly due to more yield attributes ultimately resulted more grain yield. Maximum seed yield (17.2 q ha^{-1}) was recorded under the treatment T_{12} [P_2O_5 @ 75 kg ha^{-1} + V @ 5.0 t ha^{-1}] while minimum seed yield was recorded under the control treatment. These results also confirms the findings of **Bhosale *et al.* (2017)**, **Kumar *et al.* (2018), Singh *et al.* (2022) and Patel *et al.* (2022)**

Table-2: Effect of different treatment combinations of growth parameters.

Treatments	Combinations	Plant Height (cm) 90 DAS	Number of Branches 60 DAS	Number of Nodules Plant^{-1}
T_1	P_0V_0	34.4	22.1	10.1
T_2	P_0V_1	35.3	22.9	10.5
T_3	P_0V_2	35.8	23.4	10.8
T_4	P_1V_0	36.6	23.8	11.0
T_5	P_1V_1	37.2	24.2	11.2
T_6	P_1V_2	37.7	24.7	11.5
T_7	P_2V_0	38.2	25.1	11.8
T_8	P_2V_1	38.9	25.6	12.1
T_9	P_2V_2	39.4	26.0	12.5
T_{10}	P_3V_0	40.6	26.5	12.9
T_{11}	P_3V_1	41.8	26.9	13.2
T_{12}	P_3V_2	42.7	27.2	13.4
C.D. at 5%	**P**	**0.70**	**0.67**	**0.22**
	V	**0.60**	**0.58**	**0.19**
	P×V	**1.21**	**1.18**	**0.37**
S.E(m)±	**P**	**0.23**	**0.23**	**0.07**
	V	**0.20**	**0.19**	**0.06**
	P×V	**0.40**	**0.39**	**0.12**

Table-3 Effect of different treatment combinations on yield components.

Treatments	Combinations	No. of Pod Plant^{-1}	No. of Seed Plant^{-1}	Seed Index (g)
T_1	P_0V_0	31.2	30.7	19.03
T_2	P_0V_1	34.4	32.9	20.71
T_3	P_0V_2	36.4	36.4	21.90
T_4	P_1V_0	38.2	39.4	22.76
T_5	P_1V_1	41.6	42.9	23.41
T_6	P_1V_2	44.2	47.4	23.88

T_7	**P_2V_0**	47.4	49.7	24.15
T_8	**P_2V_1**	50.1	52.3	24.89
T_9	**P_2V_2**	53.2	55.6	25.84
T_{10}	**P_3V_0**	56.4	58.5	26.24
T_{11}	**P_3V_1**	58.2	61.6	26.49
T_{12}	**P_3V_2**	60.8	64.4	27.56
C.D. at 5%	**P**	**1.28**	**1.15**	**0.46**
	V	**1.12**	**1.00**	**0.40**
	P×V	**2.38**	**2.04**	**0.52**
S.E(m)±	**P**	**0.43**	**0.39**	**0.15**
	V	**0.37**	**0.34**	**0.13**
	P×V	**0.75**	**0.68**	**0.27**

Table-4: Effect of different treatment combinations on seed yield (q ha^{-1})

Treatments	**Combinations**	**Seed Yield (q ha^{-1})**
T_1	**P_0V_0**	12.5
T_2	**P_0V_1**	13.4
T_3	**P_0V_2**	13.9
T_4	**P_1V_0**	14.3
T_5	**P_1V_1**	14.7
T_6	**P_1V_2**	15.1
T_7	**P_2V_0**	15.3
T_8	**P_2V_1**	15.8
T_9	**P_2V_2**	16.0
T_{10}	**P_3V_0**	16.5
T_{11}	**P_3V_1**	16.9
T_{12}	**P_3V_2**	17.2
C.D. at 5%	**P**	**0.39**
	V	**0.33**
	P×V	**0.69**
S.E(m)±	**P**	**0.13**
	V	**0.11**
	P×V	**0.23**

Conclusion

The study showed that the application of phosphorous along with vermicompost resulted in higher growth parameters, yield components consequently seed yield of chickpea. It will help in uplifting the socioeconomic status of the farmers. Application of phosphorous along with vermicompost deserves a special attention for increasing of chickpea.

References

Anonymous. (2021). Agricultural Statistics at a Glance 2020. Directorate of Economics & Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India, New Delhi, p. 63.

Balai, K., Jajoria, M., Verma, R., Deewan, P. and Bairwa, S.K. (2017). Nutrient content, uptake, quality of chickpea and fertility status of soil as influenced by fertilization of Phosphorus and Zinc. *Journal of Pharmacognosy and Phytochemistry*.**6** (1):392- 398.

Barik, A. K.; Arindam, Das; Giri, A. K. and Chattopadhyaya G. N., (2006). Effect of integrated plant nutrient management on growth, yield and production economics of wet season rice. Indian J. Agric. Sci., 76(1): 657-660.

Edwards, C.A.; Subler, S. and Arancon, N. (2011). Quality criteria for vermicompost. In: Edwards CA, Arancon NQ, Sherman RL (eds.) Vermiculture technology: earthworms, organic waste and environmental management. *CRC Press*, Boca Raton, pp 287–301

Gomez, K. A., & Gomez, A. A. (1984). *Statistical procedures for agricultural research*. John wiley & sons.

Hanway, J.J; and Heidel, H. (1952). Soil analysis methods as used in Iowa State College, Soil Testing Laboratory. *Iowa Agriculture* **54**: 1-31.

Islam, M., Mohsan, S., & Ali, S. (2012). Effect of different phosphorus and sulfur levels on nitrogen fixation and uptake by chickpea (Cicer arietinum L.). *Agrociencia*, *46*(1), 1-12.

Ismail, S.A. (2005). The earthworm book. Other India Press, Mapusa, pp 101.

Jackson, M.L. (1973). Soil chemical analysis. Prentice Hall of India Pvt. Ltd, New Delhi.

Kumar, S., Tripathi, D.K., Bharose, R., Kumar, M. and Kumar, R. (2016). Effect of different fertility level and micronutrients on nodulation and nutrient uptake by chickpea. *An Asian Journal of Soil Sci.***11** (1): 62-66.

Nema, S., Pandey, S. B., Kumar, A., Sachan, R., Sirohiya, A., & Singh, A. K. (2022). Interaction Effect of Phosphorus and Boron on Yield Components, Productivity Parameters and Quality Traits of Lentil (Lens culinaris L.). *International Journal of Environment and*

Climate Change 12(11): 1426-1433, 2022; Article no.IJECC.90192 ISSN: 2581-8627

Mhango, W.G., Mughogho, S.K., Sakala, W.D. and Saka A.R. (2008). The effect of phosphorus and sulphur fertilizers on grain Legumes and maize productivity in Northern Malawi. *Bunda Journal of Agriculture, Environmental Science and Technology* **3**: 20-27.

Olsen, S.R, Cole, C.V., Watanable, F. S. and Dean, L. A. (1954). Estimation of available phosphorous in soil by extraction with sodium bicarbonate. *USDA, Cric.* **930**:19- 23

Pal, S., Pandey, S. B., Singh, A., Singh, S., Sachan, R., & Yadav, A. (2021). Effect of Phosphorus, Boron and Rhizobium inoculation on productivity and profitability of chickpea. The Pharma Innovation Journal 2021; 10(12): 1810-1814

Pandey, N.; Verma, A. K.; Anurag and Tripathi, R. S. (2007). Integrated nutrient management in transplanted hybrid rice (*Oryza sativa* L.). *Indian Journal of Agronomy* **52**(1): 40–2.

Patel, K. K., Pandey, A. K., Baheliya, A. K., Rai, R., Bhadauria, S., & Sachan, R. (2022). Production and Economic Feasibility of Chickpea (Cicer arietinum L.) by the Diverse Bioinputs and Soil Nutrients Amendments. *International Journal of Plant & Soil Science 34(21): 15-24, 2022; Article no.IJPSS.89048 ISSN: 2320-7035*

Pingoliya, K, K., Dotaniya, M, L., Mathur, A, K. (2013). Role of phosphorus and iron in chickpea (Cicer arietinum L.). *Lap Lambert Academic Publisher, Germany*.

Ramesh, P.; Panwar, N. R.; Singh, A. B. and Ramana, S. (2008). Effect of organic manures on productivity, nutrient uptake and soil fertility of maize–linseed cropping system. *Indian Journal of Agricultural Sciences* **78** (4): 351–4.

Redden, B., furman, B, J., Upadhyaya, H, D., Pundir R, P, S., Gowda, C, L, L., Coyne, C., Enne King, D., (2007). Biodiversity Management in Chickpea. In: Yadav, S, S., Redden R., Chen, W., Sharma, B., editors. Chickpea Breeding & Management. CABI, Walling ford, UK. Pp 355-368.

Rehan, W., Jan, A., Liaqat, W., Jan, F.M., Ahmadzai, M.D., Ahmad, H., Haroon, J., Anjum, M.M. and Ali, N. (2018). Effect of phosphorous, rhizobium inoculation and residue types on chickpea productivity. *Pure Appl. Biol.,* **7**(4): 1203-1213.

Saxena, M, C. (1990). Problems and potential of chickpea production in the nineties. In: Chickpea in the nineties. Proc Second Int. Workshop on chickpea Imp, 4-8th December, 1989, ICRISAT Centre, Patancheru, Andhra Pradesh, India, pp. 13-25.

Shukla, M., Patel, R, H., Verma, G., Deewan, P., Dotaniya, M, L. (2013). Effect of bio-organics and chemical fertilizers on growth and yield of chickpea (*Cicer arietinum* L.) under middle Gujrat condition. *Vegetos*. **26**(1): 183-187

Singh, A. K., Dimree, S., Kumar, A., Sachan, R., Sirohiya, A., & Nema, S. (2022). Effect of Rhizobium Inoculation with Different Levels of Inorganic Fertilizers on Yield, Nutrient Content & Uptake of Chickpea (Cicer arietinum L.). *International Journal of Plant & Soil Science 34(22): 262-268, 2022; Article no.IJPSS.90247 ISSN: 2320-7035*

Subbiah, B.V. and Asija, C.L. (1956). A rapid procedure for the estimation of available N in Soil. *Curr. Sci.* **25**:259-260.

Wallace, T. C., Murray, R., Kathleen, M. and Zelman, K. (2016). The nutritional value and health benefits of chickpeas and humus. *Nutrients*. **8**(12): 766.

Walkley, A. and Black, C. S.A. (1934). Old piper, S.S. soil and plant analysis. Soil Sci. 37:29- 38.

Yadav, P., Yadav, D. D., Pandey, H. P., Yadav, A., Sachan, R., & Yadav, S. (2022). Effect of Fertility Levels and Biofertilizers on Growth Parameters, Root Architecture and Quality of Chickpea (Cicer arietinum L.). *International Journal of Plant & Soil Science 34(17): 61-67, 2022; Article no.IJPSS.86643 ISSN: 2320-7035*

Yadav, P., Yadav, D.D., Kumar, A., Sachan, R., &Yadav, S. (2022). Effect of Fertility Levels and Bio-fertilizers Application on Yield, Yield Attributes, and Economics of Chickpea (Cicer arietinum L.). *International Journal of Plant & Soil Science 34(13): 65-69, 2022; Article no.IJPSS.85129 ISSN: 2320-7035*

Kumar D, Kumar R, Pandey AK, Yadav A, Singh V, Sachan R, Tiwari T. Interaction Effect of Phosphorous and Zinc on Yield Attributes, Yield and Quality Characteristics of Chickpea under the Central Plain Zone of Uttar Pradesh. International Journal of Plant & Soil Science. 2022 Dec 20;34(24):81-9.