

Effect of phosphorous and vermicompost on growth characteristics and yield of chickpea (*Cicer arietinum* L.)

Abstract

A field experiment was conducted on sandy clay loam soil having low status of organic carbon and available nitrogen, medium in available phosphorous and high in available potassium 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 $P_2O_5 @ 75 \text{ kg ha}^{-1} + V @ 5.0 \text{ t ha}^{-1}$ 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 $P_2O_5 @ 75 \text{ kg ha}^{-1} + V @ 5.0 \text{ t ha}^{-1}$.

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 staple cereals in the diets with proteins, essential amino acids, vitamins and minerals (Pingoliya *et al.* 2013).

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**).

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/100g), high amount of minerals such as calcium (57mg/100g), magnesium (79mg/100g), iron (4.31mg/100g) 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.

Method and Material

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 vermicompos5 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	P ₀ V ₀	Control
T ₂	P ₀ V ₁	P ₂ O ₅ @ 0 kg ha ⁻¹ + V @ 2.5 t ha ⁻¹ (300 g)

T ₃	P₀V₂	P ₂ O ₅ @ 0 kg ha ⁻¹ + V @ 5 t ha ⁻¹ (600 g)
T ₄	P₁V₀	P ₂ O ₅ @ 45 kg ha ⁻¹ + V @ 0 t ha ⁻¹ (0 g)
T ₅	P₁V₁	P ₂ O ₅ @ 45 kg ha ⁻¹ + V @ 2.5 t ha ⁻¹ (300 g)
T ₆	P₁V₂	P ₂ O ₅ @ 45 kg ha ⁻¹ + V @ 5 t ha ⁻¹ (600 g)
T ₇	P₂V₀	P ₂ O ₅ @ 60 kg ha ⁻¹ + V @ 0 t ha ⁻¹ (0 g)
T ₈	P₂V₁	P ₂ O ₅ @ 60 kg ha ⁻¹ + V @ 2.5 t ha ⁻¹ (300 g)
T ₉	P₂V₂	P ₂ O ₅ @ 60 kg ha ⁻¹ + V @ 5 t ha ⁻¹ (600 g)
T ₁₀	P₃V₀	P ₂ O ₅ @ 75 kg ha ⁻¹ + V @ 0 t ha ⁻¹ (0 g)
T ₁₁	P₃V₁	P ₂ O ₅ @ 75 kg ha ⁻¹ + V @ 2.5 t ha ⁻¹ (300 g)
T ₁₂	P₃V₂	P ₂ O 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 weighed and 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).

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) are associated with the treatment T₁₂ [P₂O₅ @ 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) are 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 is 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 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 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 T₁₂ [P₂O₅ @ 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 T₁₂ [P₂O₅ @ 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 ₀ V ₀	34.4	22.1	10.1
T ₂	P ₀ V ₁	35.3	22.9	10.5
T ₃	P ₀ V ₂	35.8	23.4	10.8
T ₄	P ₁ V ₀	36.6	23.8	11.0
T ₅	P ₁ V ₁	37.2	24.2	11.2
T ₆	P ₁ V ₂	37.7	24.7	11.5
T ₇	P ₂ V ₀	38.2	25.1	11.8
T ₈	P ₂ V ₁	38.9	25.6	12.1
T ₉	P ₂ V ₂	39.4	26.0	12.5
T ₁₀	P ₃ V ₀	40.6	26.5	12.9
T ₁₁	P ₃ V ₁	41.8	26.9	13.2
T ₁₂	P ₃ V 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 ₀ V ₀	31.2	30.7	19.03
T ₂	P ₀ V ₁	34.4	32.9	20.71
T ₃	P ₀ V ₂	36.4	36.4	21.90
T ₄	P ₁ V ₀	38.2	39.4	22.76
T ₅	P ₁ V ₁	41.6	42.9	23.41
T ₆	P ₁ V ₂	44.2	47.4	23.88

T ₇	P ₂ V ₀	47.4	49.7	24.15
T ₈	P ₂ V ₁	50.1	52.3	24.89
T ₉	P ₂ V ₂	53.2	55.6	25.84
T ₁₀	P ₃ V ₀	56.4	58.5	26.24
T ₁₁	P ₃ V ₁	58.2	61.6	26.49
T ₁₂	P ₃ V 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 ₀ V ₀	12.5
T ₂	P ₀ V ₁	13.4
T ₃	P ₀ V ₂	13.9
T ₄	P ₁ V ₀	14.3
T ₅	P ₁ V ₁	14.7
T ₆	P ₁ V ₂	15.1
T ₇	P ₂ V ₀	15.3
T ₈	P ₂ V ₁	15.8
T ₉	P ₂ V ₂	16.0
T ₁₀	P ₃ V ₀	16.5
T ₁₁	P ₃ V ₁	16.9
T ₁₂	P ₃ V 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.

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