Article type:original research article

Influence of Spacing and Phosphorus Management on Growth and Yield of Chickpea (*Cicer Arietinum L.*)

ABSTRACT

A field experiment was conducted at the crop research farm, Department of agronomy, Naini agriculture institute, Sam Higginbottom university of agriculture, Technology and sciences, Prayagraj (U.P) India during Rabi season of 2022 to "study the influence of spacing and phosphorus management on growth and yield of chickpea". The experiment was laid out in randomized block design with 10 treatments replicated thrice. Thetreatments consisting of three spacing 25 cm × 25 cm,35 cm× 20 cm, 45 cm × 20 cm and three levels of Recommended dose of phosphorus (RDP) viz., 50% RDP(20 kg/ha), 75% RDP(30 kg/ha), 100% RDP (40 kg/ha). The soil of the experimental plot was sandy loamy in texture, neutral in soil reaction (pH-7.0), available N (278.93 kg/ha), available P (26.3 kg/ha), available K (223.6 kg/ha).Results revealed that the significantly higher plant height (54.77 cm), dry weight (11.97 g), number of nodules (40.77), number of pods /plant (39.87), number of seeds/pod(1.81), seed index (26.33), harvest index (40.22), seed yield (1.71 t/ha) and stover yield (3.99 t/ha) were recorded with the treatment 35 cm × 20 cm+ 100% RDP. Higher gross returns (1,41,646.67 INR/ha),Net returns (99,975.67 INR/ha) and Benefit cost ratio (2.40) were also recorded in the same.

Keywords: *Chickpea, Economics, growth parameters, Phosphorus, Spacing and yield attributes.*

INTRODUCTION

Chickpea (*Cicer arietinum L.*) is belongs to the family of Fabaceae, major *rabi* pulse crop which as high digestible dietary protein (21%). Chickpea is rich in calcium, iron and niacin. Used as blood purifier and germinated seeds are recommended to cure scurvy disease. The sour taste of leaves and pods due to presence of maleic acid (90-96%) and oxalic acid (4-10%), about 4-10 kg of these acids can be obtained from one ha crop (Sunda,

2021).Chickpeacommonly known as Bengal gram and locally chana is an important and unique food legume because of its use in variety of food products like snacks and sweets etc. Bengal gram is source of protein (18-22 %), carbohydrates (52-70 %), fat (4-10 %), mineral and vitamins. (Arun and Debbarma, 2022). In India chickpeatotal coverage area about 98.86 Lakh ha. The country harvested crop was record production of 107 Lakh tons at a highest productivity level of 1086 kg/ha (DES, Ministry of Agri. & FW (DA &FW), GOI, 2020-21). In India Madhya Pradesh is leading state in area and production of chickpea followed by Uttar Pradesh, it is a cover 8.24 million hectare and production 9.97 million tonnes with the productivity 1.08 t/ha in 2020-2021 (GOI, 2020-2021).

Optimum plant population is an important factor to realize the potential yields as it directly affects plant growth and development of chickpea. Earlier studies showed that chickpea yields were remarkably stable over a wide range of population densities. The plants are able to fill available space by initiating lateral branches and thus, can compensate for poor emergence and thin stands. Increasing row spacing significantly influenced the growth, yield attributes and yield characters. Number of plants per unit area influenced plant size, yield components and ultimately the seed yield Varshitha*et al*, (2022).

"Sufficient supply of phosphorus to plant, hastens the maturity and increases the rate of nodulation and pod development. Phosphorus also imparts hard-line to shoot, improves the quality and regulates the photosynthesis and covers other physio- biochemical process. Most of the phosphorus present in the soil is unavailable to plants which are made available through the activities of efficient micro-organisms like bacteria, fungi and even cyanobacteria with production of organic acid and increasing phosphatase enzyme activity. Pulses require phosphorus for growth and nitrogen fixation. Since it helps for better root development, phosphorus application is a must for the pulse crops. Recent researches revealed that there is a good response of chickpea to optimum phosphorus fertilization Kumar *et al*, (2022).

MATERIALS AND METHODS

A field experiment was conducted during Rabi season of 2022-2023 at the crop research farm, department of agronomy, NainiAgricultureInstitute, Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS), Prayagraj (U.P.) India. The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.0),medium in available nitrogen, available phosphorus and available in potassium. The experiments was laid out in Randomized Block Design with 10 treatments each replicated

thrice*Viz.*, T1- 25 cm× 20 cm+50% RDP, T2-25 cm× 20 cm+ 75% RDP, T3-45 cm× 20 cm+ 100% RDP, T4-35 cm× 20 cm+ 50% RDP,T5-35 cm× 20 cm+ 75% RDP, T6-35 cm× 20 cm+ 100% RDP,T7-45 cm × 20 cm+ 50%RDP, T8-45 cm × 20 cm + 75% RDP, T9-45 cm× 20 cm + 100% RDP,T10-35 cm× 20 cm + RDF (20,40,20 kg NPK /ha) (Control).The observations was recorded for plant height (cm), Dry weight (g), Number of nodules, Crop growth rate (g/m^2/day), Relative growth rate(g/g/day), Number of pods /plant (no.) ,No of seeds/pod, Seed index(g), Seed yield (t/ha), Stover yield(t/ha), Harvest index(%). The data were subjected to statistical analysis by analysis of variance method (Gomez and Gomez, 1976).

RESULT AND DISCUSSION

GROWTH PARAMETERS

Plant height: At 100 DAS, significantly highest plant height (54.77cm) was recorded with the treatment 35 cm × 20 cm + 100% RDP. However, the treatment 35 cm × 20 cm + 75% RDP (53.93 cm) were found to be statistically at par with 35 cm × 20 cm + 100% RD. The increase in plant height is result of the row spacing, the competition between the plants for sunlight, moisture, nutrients and for photosynthesis is reduced. Individual plants from the plot with narrow spacing did not get the opportunity to proliferate laterally due to less space. Hence, plants were compelled to grow for the fulfilment of the light requirement for photosynthesis. Similar observations also recorded by the Kantara *et al.* (2022) and Farjam*et al.* (2014).

Plant dry weight: At 100 DAS, significantly higher plant dry weight (11.97 g/plant)) was recorded with the treatment 35 cm × 20 cm +100% RDP. However, the treatment 35 cm × 20 cm +75% RDP (10.80 g/plant) were found to be statistically at par with 35 cm × 20 cm +100% RDP. Phosphorus was found to be useful in utilizing the radiant energy more effectively, thereby increasing photosynthetic efficiency and in wider spacing the crop canopy was increased which contributed to more biomass and thus, increased the production for more dry matter Prajapati *et al.* (2017).

Plant root nodules:At 80 DAS, significantly higher nodules/plant (40.77) was recorded with the treatment 35 cm × 20 cm + 100% RDP. The number of root nodules per plant was increased is due to the effect of spacing and also the application of phosphorus. The plants grown with wider spacing got better opportunity for more root proliferation and the higher doses of phosphorus showed beneficial effect on root growth provided more root surface for

bacterial infection and enhanced the root nodulation. Similar observations recorded by Prajapati *et al.* (2017) and Patel (2020).

Crop growth rate: During 80-100 DAS, significantly highest crop growth rate (6.70 $g/m^2/day$) was recorded with the treatment T_{10} (control). The CGR was significantly highest with closer crop spacing at all growth stages, which was mainly due to more population per unit area and higher availability of phosphorus enhanced the metabolic activities and facilitate more photosynthesis increased vigour and vitality of plant which ultimately increased the growth of the plant.

Yield attributes

Pods/plant: Significantly maximum pods/plant (39.87) was recorded with the treatment of application of 35 cm × 20 cm + 100% RDP.

Seeds/pod: Significantly maximum seeds/pod (1.81) was recorded with the treatment of application of 35 cm + 20 cm + 100% RDP. However, the treatment 45 cm × 20 cm + 100% RDP (1.71) were found to be statistically at par with 35 cm × 20 cm +100% RDP.

Seed index: Significantly maximum seed index (26.33 g) was recorded with the treatment of application of 35 cm × 20 cm + 100% RD. There is a significant increase in the yield attributes due to the row spacing. This is because efficient utilization of nutrients, water and solar radiation at wider space. Phosphorus plays primary role in photosynthesis by the way of energy transfer and thereby increase photosynthetic efficiency resulting in increased availability of photosynthates and more availability of phosphorus resulted in pronounced growth of the plant. Similar finding was reported by Farjam*et al*. (2014), Hussen *et al.* (2015) and Patel (2020).

Seed yield: Significantly maximum seed yield (2.71 t/ha) was recorded with the treatment of 35 cm × 20 cm +100% RDP. However, the treatment 30 cm × 10 cm+ RDF (control) (2.67 t/ha) and 45 cm × 20 cm + 100% RDP (2.53 t/ha) were found to be statistically at par with 35 cm × 20 cm +100% RDP. The results might be due the spacing and phosphorus levels improved the vegetative characters such as growth and yield attributes. High doses of nutrients and proper spacing would give more capability for plants for photosynthesis and produce carbohydrates, proteins, sugar, starch formation of amino acids, which helps in pod formation and seed production. These, all will help in increasing the seed yield. Similar findings were reported by Shukla *et al.* (2017) and Patel (2020).

Stover yield: Significantly maximum stover yield (3.99 t/ha) was recorded with the treatment of application of 35 cm × 20 cm +100% RDP. However, the treatment 30 cm × 10 cm + RDF (control) (3.98 t/ha) and 45 cm × 20 cm +100% RDP (3.77 t/ha) were found to be statistically at par with 35 cm × 20 cm + 100% RDP. This might be due to plants grown at wider spacing has improved vegetative growth characters and higher doses phosphorus results in photosynthetic activity as phosphorus is major constituent of ATP and which utilizes dark reaction of photosynthesis and there by increased the biomass production. Similar findings were reported by Kumar *et al.* (2022) and Rabish*et al.* (2017).

Harvest index: Significantly maximum harvest index (40.22%) was recorded with the treatment of application of 35 cm × 20 cm + 100% RDP. However, the treatment 45 cm × 20 cm + 100% RDP (40.08) and treatment T_{10} (40.18%) were found to be statistically at par with 35 cm × 20 cm + 100% RDP. Harvest index is directly correlated to the seed yield and haulm yield. Increased harvest index was due to better crop growth from early stages to at harvest. Better performance of crop from vegetative to reproductive stage is due to optimum spacing and higher dose of phosphorus which increased the nutrient uptake of the crop. Similar findings were reported by Kumar *et al*. (2022) and Shukla *et al.* (2017).

Economic

Cost of cultivation: The cost of cultivation of chickpea was discussed in Table 4.3. The cost of cultivation (43,471.00 INR/ha) was found to be highest in 25 cm × 20 cm +100% RDP.

Gross returns: Significantly higher gross return (1,41,646.67 INR/ha) was recorded with treatment 35 cm × 20 cm + 100% RDP.

Net returns: Significantly higher net return (99,975.67 INR/ha) was recorded under treatments 35 cm × 20 cm + 100% RDP

Benefit-cost ratio: Significantly higher benefit-cost ratio (2.40) was recorded under treatment 35 cm × 20 cm + 100% RDP.

CONCLUSION

It can be concluded that the application 35 cm × 20 cm + 100% RDP (Treatment 6) recorded higher yield and benefit cost ratio in chickpea.

REFERENCE

Anonymous (2020). Economic Survey, Government of India.

Anonymous (2021). Ministry of Agriculture and Farmers Welfare, Government of India.

Akshay, R.K., Prerak, M. P., Rutul, S.P. and Kumar, G.V.S. (2022). Effect of spacing and fertilizer management on growth and yield of Kabuli chickpea. *The Pharma Innovation Journal*; **11**(4): 550-553

Arun, K and Debbarma, V. (2022).Effect of Spacing and Panchagavya on Growth and Yield Attributes of Chickpea (Cicer arietinum L.). *International Journal of Environment and Climate Change*; **12**(11): 2890-2895.

Bavalgave, V.G., Gokhale, D.N., Waghmare, M.S., and Jadhav, P., J. (2009). Growth and yield of Kabuli chickpea varieties as influenced by different spacing. *International Journal of Agricultural Sciences*, (5)**1**.

Farjam, S., Kenarsari, M.J., Rokhzadi, A., Yousefi, B. (2014). Effects of inter-row spacing and superabsorbent polymer application on yield and productivity of rainfed chickpea. *Journal of Biodiversity and Environmental Sciences (JBES).* (5)**3**: 316-320

Gulpadiya, V. K. and Chhonkar, D.S. (2014). Effect of phosphorus on growth, productivity and economics of chickpea varieties. *Annals of Plant and Soil Research***16**(4): 334-337

Krishna, K. S. S. R. and George, P.J. (2017.) Effect of levels of phosphorus and zinc on growth and yield of Kabuli chickpea (Cicerkabulium L.). *Journal of Pharmacognosy and Phytochemistry;***6**(4): 1013-1016

Kumar, K. A., Umesha, C. and Raju, G.V. (2022). Effect of Phosphorus and Boron Levels on Growth and Yield of Chickpea (Cicer arietinum L.) *International Journal of Plant & Soil Science***34**(21): 266-271.

Patel, S. (2020). To Study the Effect of different Spacing and Phosphorus level on Growth and Yield of Chickpea (Cicer arietinum Var. Kabulium L). *Indian Journal Plant and Soil*. ;**7**(1):13–16.

Prajapati, B. J., Gudadhe, N., Gamit, V. R. and Chhaganiya, H. J. (2017). Effect of integrated phosphorus management on growth, yield attributes and yield of chickpea. *Fmg. &Mngmt*; **2** (1): 36-40.

Pujitha, J., Singh, V., George, S.G and Vivek. (2022). Effect of spacing and sulphur levels on growth and yield of chickpea (Cicer arietinum L.) *The PharmaInnovation Journal* ,**11**(3): 1611-1613.

Rathour, D.K., Gupta, A.K., Choudhary, R.R and Sadhu, A.C. (2015). Effect of integrated phosphorus management on growth, yield attributes and yield of summer green gram (Vigna radiata l.) *The Bioscan*.**10**(1): 05-07.

Shukla, R.D., Singh, A., Verma, S., Singh, A.K., Dubey, D. and Kumar, S. (2017). Effect of crop geometry and phosphorus levels on growth and productivity of chickpea (Cicer arietinum L.). *Journal of Pharmacognosy and Phytochemistry*; **6**(5): 659-661.

Tripathi, L.K., Thomas, T. and Kumar, S. (2013). Impact of nitrogen and phosphorus on growth and yield of chickpea (Cicer arietinum L.). *Asian Journal of Soil Science*. **8**(2): 260-263.

Ullah, S., Jan, S. A., Ali, M., Ahmad, W., Rehman, H. U., Ishaq, M. and Ahamd, B. (2018). Response of chickpea (Cicer Arietinum L.) to phosphorus and zinc levels and their application methods. *Sarhad Journal of Agriculture;* **34**(3): 575-582.

Varshitha, K. M., Singh, V., George, S.G. and A. C. Singh. (2022). Effect of Plant Growth Regulators and Spacing on Growth and Yield of Chickpea (Cicer arietinum L.). *International Journal of Environment and Climate Change* **12**(10): 614-619.

Table :1. Effect of spacing and phosphorus management on growth attributes of chickpea

S. No	Treatments	Plant height	Dry weight	No. of nodules	Crop growth rate
1.	25 cm ×20 cm + 50% RDP	52.95	10.19	35.33	4.32
2.	25 cm ×20 cm + 75% RDP	52.73	10.39	37.77	4.42
3.	25 cm ×20 cm + 100% RDP	52.68	9.66	35.11	3.24
4.	35 cm ×20 cm + 50% RDP	53.26	9.82	34.66	2.71
5.	35 cm ×20 cm + 75% RDP	53.93	10.80	35.99	3.12
6.	35 cm ×20 cm + 100% RDP	54.77	11.97	40.77	3.87
7.	45 cm ×20 cm + 50% RDP	52.97	9.46	37.22	1.89
8.	45 cm ×20 cm + 50% RDP	52.25	9.49	36.55	1.97
9.	45 cm ×20 cm + 50% RDP	52.98	10.61	37.78	2.36
10.	35 cm ×10 cm + RDF (Control)	53.37	10.05	36.44	6.70
	S. Em (±)	0.42	0.46	0.94	0.47
	CD (p = 0.05)	1.26	1.39	2.81	1.42

Table:2. Effect of spacing and phosphorus management on yield attributes and yield of chickpea

Treatments	At harvest					
	Pods/plant	**Seed/pod**	**Seed index (g)**	**Seed yield (t/ha)**	**Stover yield (t/ha)**	**Harvest index (%)**
1. 25 cm ×20 cm + 50% RDP	28.13	1.45	24.67	1.93	3.35	36.55
2. 25 cm ×20cm + 75% RDP	27.67	1.49	25.00	1.89	3.45	35.39
3. 25 cm ×20cm + 100% RDP	32.13	1.59	25.33	2.10	3.47	37.78
4. 35 cm ×20cm + 50% RDP	29.20	1.39	24.00	1.57	3.44	31.40
5. 35 cm ×20cm + 75% RDP	32.60	1.48	24.67	1.59	3.33	32.44
6. 35 cm ×20 cm + 100% RDP	39.87	1.81	26.33	2.71	3.99	40.22
7. 45 cm ×20 cm + 50% RDP	31.07	1.41	24.67	1.61	3.41	32.04
8. 45 cm ×20 cm + 75% RDP	32.87	1.51	25.00	1.78	3.35	34.67
9. 45 cm ×20 cm + 100% RDP	37.20	1.71	25.67	2.53	3.77	40.08
10. 30 cm × 10 cm + RDF (control)	26.80	1.45	25.33	2.67	3.98	40.18
S. Em (±)	0.88	0.05	0.05	0.064	0.080	0.998
CD (p = 0.05)	2.64	0.18	0.18	0.19	0.24	2.97

S.no	Treatment combination	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C

Table:3.Effect of spacing and phosphorus management on economics of chickpea

1.	25 cm × 20 cm + 50% RDP	42,346.00	1,01,353.33	59,007.33	1.39
2.	25 cm × 20 cm + 75% RDP	42,908.50	99,675.00	56,766.50	1.32
3.	25 cm × 20 cm + 100% RDP	43,471.00	1,10,366.67	66,895.67	1.54
4.	35 cm × 20 cm + 50% RDP	40,546.00	83,821.67	43,275.67	1.07
5.	35 cm × 20 cm + 75% RDP	41,108.50	84,661.67	43,553.17	1.06
6.	35 cm × 20 cm + 100% RDP	41,671.00	1,41,646.67	99,975.67	2.40
7.	45 cm × 20 cm + 50% RDP	39,586.00	85,443.33	45,857.33	1.16
8.	45 cm × 20 cm + 75% RDP	40,148.50	93,853.33	53,704.83	1.34
9.	45 cm × 20 cm + 100% RDP	40,711.00	1,31,988.33	91,277.33	2.24
10.	30 cm × 10 cm + RDF (control)	47,431.00	1,39,636.67	92,205.67	1.94

*Data not subjected to statistical analysis