



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

D. Sai Chandana^{a++*}, Shikha Singh^{b#} and Anu Nahwal^{b†}

^a Department of Agronomy, SHUATS, Prayagraj- 211007, Uttar Pradesh, India.

^b Department of Agronomy, Naini Agriculture Institute, SHUATS, Prayagraj- 211007, Uttar Pradesh, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2023/v13i92470

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/103615>

Original Research Article

Received: 21/05/2023

Accepted: 24/07/2023

Published: 29/07/2023

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. The treatments consisting of three spacing 25 cm x 25 cm, 35 cm x 20 cm, 45 cm x 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),

⁺⁺ M.Sc Scholar;

[#] Assistant Professor;

[†] Ph. D Scholar;

*Corresponding author: E-mail: saichandana666@gmail.com;

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 x 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.

1. 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). “Chickpea commonly 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” [1]. In India chickpea total 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) [2]. 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. [3].

“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. [4].

2. MATERIALS AND METHODS

A field experiment was conducted during Rabi season of 2022-2023 at the crop research farm, department of agronomy, Naini Agriculture Institute, 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 x 20 cm + 50% RDP, T2- 25 cm x 20 cm + 75% RDP, T3- 45 cm x 20 cm + 100% RDP, T4- 35 cm x 20 cm + 50% RDP, T5- 35 cm x 20 cm + 75% RDP, T6- 35 cm x 20 cm + 100% RDP, T7- 45 cm x 20 cm + 50%RDP, T8- 45 cm x 20 cm + 75% RDP, T9- 45 cm x 20 cm + 100% RDP, T10- 35 cm x 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/m²/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).

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Plant height: At 100 DAS, significantly highest plant height (54.77 cm) 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 Akshay et al. [5] and Farjam et al. [6].

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. [7].

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. [7] and Patel [8].

Crop growth rate: During 80-100 DAS, significantly highest crop growth rate (6.70 g/m²/day) was recorded with the treatment T₁₀ (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.

3.2 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. [6], Hussien et al. [9] and Patel [8].

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. [10] and Patel [8].

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

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 x20 cm + 50% RDP	52.95	10.19	35.33	4.32
2.	25 cm x20 cm + 75% RDP	52.73	10.39	37.77	4.42
3.	25 cm x20 cm + 100% RDP	52.68	9.66	35.11	3.24
4.	35 cm x20 cm + 50% RDP	53.26	9.82	34.66	2.71
5.	35 cm x20 cm + 75% RDP	53.93	10.80	35.99	3.12
6.	35 cm x20 cm + 100% RDP	54.77	11.97	40.77	3.87
7.	45 cm x20 cm + 50% RDP	52.97	9.46	37.22	1.89
8.	45 cm x20 cm + 50% RDP	52.25	9.49	36.55	1.97
9.	45 cm x20 cm + 50% RDP	52.98	10.61	37.78	2.36
10.	35 cm x10 cm + RDF (Control)	53.37	10.05	36.44	6.70
	S. Em (\pm)	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 x20 cm + 50% RDP	28.13	1.45	24.67	1.93	3.35	36.55
2.	25 cm x20cm + 75% RDP	27.67	1.49	25.00	1.89	3.45	35.39
3.	25 cm x20cm + 100% RDP	32.13	1.59	25.33	2.10	3.47	37.78
4.	35 cm x20cm + 50% RDP	29.20	1.39	24.00	1.57	3.44	31.40
5.	35 cm x20cm + 75% RDP	32.60	1.48	24.67	1.59	3.33	32.44
6.	35 cm x20 cm + 100% RDP	39.87	1.81	26.33	2.71	3.99	40.22
7.	45 cm x20 cm + 50% RDP	31.07	1.41	24.67	1.61	3.41	32.04
8.	45 cm x20 cm + 75% RDP	32.87	1.51	25.00	1.78	3.35	34.67
9.	45 cm x20 cm + 100% RDP	37.20	1.71	25.67	2.53	3.77	40.08
10.	30 cm x 10 cm + RDF (control)	26.80	1.45	25.33	2.67	3.98	40.18
	S. Em (\pm)	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

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

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

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. [4] 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 T₁₀ (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. [4] and Shukla et al. [10].

3.3 Economic

Cost of cultivation: The cost of cultivation of chickpea was discussed in Table 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.

4. 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Arun K, Debbarma V. Effect of Spacing and Panchagavya on Growth and Yield Attributes of Chickpea (*Cicer arietinum* L.). International Journal of Environment and Climate Change; 2022;12(11):2890-2895.
2. DES, Ministry of Agriculture and Farmers Welfare, Government of India; 2021.
3. Varshitha KM, Singh V, George SG, Singh AC. Effect of Plant Growth Regulators and Spacing on Growth and Yield of Chickpea (*Cicer arietinum* L.). International Journal of Environment and Climate Change. 2022;12(10):614-619.
4. Kumar KA, Umesha C, Raju GV. Effect of Phosphorus and Boron Levels on Growth and Yield of Chickpea (*Cicer arietinum* L.) International Journal of Plant & Soil Science. 2022;34(21):266-271.
5. Akshay RK, Prerak MP, Rutul SP, Kumar GVS. Effect of spacing and fertilizer management on growth and yield of Kabuli chickpea. The Pharma Innovation Journal. 2022;11(4):550-553.
6. Farjam S, Kenarsari MJ, Rokhzadi A, Yousefi B. Effects of inter-row spacing and superabsorbent polymer application on yield and productivity of rainfed chickpea. Journal of Biodiversity and Environmental Sciences (JBES). 2014;(5)3: 316-320.
7. Prajapati BJ, Gudadhe N, Gamit VR, Chhaganiya HJ. Effect of integrated phosphorus management on growth, yield attributes and yield of chickpea. Fmg. & Mngmt. 2017;2(1):36-40.
8. Patel S. 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. 2020;7(1):13–16.
9. Hussen S, Yirgabs F, Tibebu FW. Effect of Phosphorus Fertilizer on Yield and Yield Components of Chickpea/ *Cicer Arietinum*) at Kelemeda, South Wollo, Ethiopia. International journal of agriculture extension and rural development studies. 2015;1(1):29-35.

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

© 2023 Chandana et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/103615>