ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2025): 4.97
IJAFS 2025; 7(9): 837-840
www.agriculturaljournals.com
Received: 24-07-2025
Accepted: 28-08-2025

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Standardization of Plant Spacing and Nutrients on Growth and Yield of Newly Developed Kabuli chickpea variety PDKV Kabuli-5

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DOI: https://www.doi.org/10.33545/2664844X.2025.v7.i9k.834

Abstract
A field experiment was conducted at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra during *rabi* season 2024-25 to evaluated the effect of plant spacings and nutrients on growth and yield parameters of Kabuli Chickpea. The experiment was carried out in Factorial Randomized Block Design with three replications and nine treatments combinations. It consists of three plants spacing (S_1- 22.5 cm × 10 cm, S_2- 30 cm × 10 cm and S_3 - 45 cm × 10 cm) and three levels of nutrients (N_1 – 100% RDF, N_2 – 125% RDF and N_3 – 150% RDF). Full dose of nutrients applied as basal at the time of sowing. Result of the study revealed that sowing the newly developed chickpea variety PDKV Kabuli-5 at wider spacing of 45 cm × 10 cm boosted the growth and yield contributing parameters of Kabuli chickpea crop. However, yield per hectare was higher with spacing of 30 cm × 10 cm. Fertilizer regime significantly influenced the performance of chickpea. However, the application of 50% more fertilizer dose than recommended dose of fertilizer improved the yield ha^{-1} of newly developed Kabuli chickpea variety PDKV Kabuli-5.

Keywords: Kabuli chickpea, Fertilizer regime, spacing, growth, yield, *Cicer aritinum* L

Introduction
Chickpea (*Cicer arietinum* L.) is commonly known as gram or Bengal gram a member of family Fabaceae. It is the most important protein rich *rabi* pulse crop in India. It is self-pollinating legume that require a cool climate during its initial growth period with optimum temperatures ranging between 15 ^{0}C to 25 ^{0}C and a warmer climate as it matures (Singh *et al.* 2003) [10]. Chickpea contains high protein and starch percentage and it is very important for in human nutrition. Chickpea suitable for region with warm weather and semi dry conditions, in addition to having high protein content (20–22%) and rich in fibre and minerals (Abdullah *et al.* 2019) [1].

Chickpea is of two types: Desi and Kabuli. The seed size of the Kabuli chickpea is larger than desi chickpea. The desi types have pigmented vegetative parts and pink flowers and the seeds are generally small and coloured (mostly dark) with a thick seed coat. The desi chickpeas occupy about 80–85% of the chickpea cultivation areas in the world. The Kabuli types have non-pigmented vegetative parts, white flowers and relatively large, cream-colored seeds with a thin seed coat. The Kabuli types have traditionally been grown in the Mediterranean Basin and Central Asia, while desi types is mainly confined to the Indian Sub-continent, East Africa, Central Asia and to a limited extent in the Mediterranean basin (Iruela *et al.* 2002) [7].

India ranks first in the world in respect of production as well as acreage. In India, chickpea was cultivated in an area of 9.59 million ha with a production of 11.04 million tonnes and average productivity was 1151 kg ha^{-1}. The largest gram producing states in India with respect to area are Maharashtra, Madhya Pradesh, Rajasthan, Gujarat, Uttar Pradesh, Karnataka and Maharashtra rank first in chickpea production (Anonymous,2024^a) [3].

In Maharashtra area under chickpea crop was 26.87 lakh hectares with a production of 28.36 lakh tonnes and an average productivity of 1055 kg ha^{-1}. Whereas, in Vidarbha, chickpea was cultivated on 9.53 lakh ha with a production of 11.23 lakh tonnes and an average productivity of 1178 kg ha^{-1} (Anonymous, 2024^{b}) [4].

Low crop yields are primarily caused by improper plant population. Too low and high plant population beyond a specific limit often adversely affects crop yield. The number of plants per unit area influences plants vegetative growth, yield components and ultimately seed yield (Agajie, 2018) [2]. The principal objective of optimizing crop geometry is to configure the plant stand in a manner that maximizes the interception and utilization of solar radiation and other resources, while simultaneously minimizing the deleterious effects of inter-plant competition. Proper spacing facilitates better sunlight interception, air circulation and intercultural operations, thereby influencing the plant's physiological efficiency. Crop's response to spacing is highly dependent on the specific genotype's growth habit, with less-branchy, more erect varieties often being more sensitive to changes in plant density than profusely branching types.

A high-fertility environment may stimulate variety performance to produce excessive vegetative growth at high densities, potentially leading to lodging and a reduced harvest index**.** In addition to spatial arrangement, fertilizer regimes plays a pivotal role in chickpea productivity. Among various reasons for low yield, insufficient and non-judicious use of fertilizer is of prime importance (Giri *et al.* 2020) [6]. To get the best results from fertilizer, combining fertilizer with other improved agricultural practices must be introduced simultaneously to make fertilizer a helpful input (Sandhya Rani and Krishna, 2016) [9].

PDKV Kabuli-5 is a variety of Kabuli chickpea developed by Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola, Known for its high yield, tall and erect growth habit and suitable for mechanical harvesting. Plant spacing and suboptimal nutrient application could affect farm profitability and regional production targets. The limited studies have explored the combined effects of different fertility levels and plant densities for Kabuli chickpea variety. Therefore, this study was designed to determine the optimal plant spacing and fertilizer dose for the newly developed Kabuli chickpea variety PDKV Kabuli-5.

Materials and Methods

A field experiment was conducted during *rabi* season of 2024-25 at research farm of Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola. The soil of the experimental plot was medium in organic carbon and alkaline in nature with low in available nitrogen and phosphorous and high in available potassium.

The experiment was laid out in Factorial Randomized Block Design with two factors (plant spacing and fertilizer regimes) with three replications. Three plant spacing [S_1: 22.5 cm × 10 cm (44 plants m^2), S_2: 30 cm × 10 cm (33 plants m^2), S_3: 45 cm × 10 cm (22 plants m^2)] and three fertilizer regimes [N_1: 100% RDF (25:50:30 NPK kg ha^{-1}), N_2: 125% RDF (31.25: 62.50: 37.50 NPK kg ha^{-1}), N_3: 150% RDF (37.5: 75: 45 NPK kg ha^{-1})] were tested. The plot size was 3.0 m × 3.6 m. The chickpea seeds of the genotype PDKV Kabuli-5 were densely planted and thinned to maintain the distance between plants of 10 cm. The fertilizers were applied as per the treatments. Sprinkler irrigation immediately after the sowing of the chickpea crop was scheduled for uniform germination. Subsequently, two sprinkler irrigations were scheduled for entire experimental plots during the chickpea crop's flowering and pod development stages. This plan ensures judicious and effective use of water resources in the micro watershed, enhancing productivity and mitigating drought (Patode *et al*., 2016) [11].

The five representative plants were selected at random and labelled in net plot area to study chickpea growth and yield components (plant height, number of branches plant^{-1}, number of pods plant^{-1} and seed yield plant^{-1}). At maturity, the entire plants were harvested by cutting the plant at the base close to the ground surface. The harvested plants were sun-dried in the field for two days and manually threshed for final yield.

Result and Discussion

Effect of plant spacing on growth and yield of chickpea

The plant height, number of branches plant^{-1}, number of pods plant^{-1} and seed yield plant^{-1} were significantly improved by the plant spacing. Closer plant spacing of 22.5 cm x 10 cm resulted in significantly taller plants (62.55 cm) compared to a wider spacing of 45 cm x 10 cm (57.69 cm). However, the wider spacing resulted in significantly more number of branches plant^{-1} (6.82 branches plant^{-1}), number of pods plant^{-1} (26.89 pods plant^{-1}) and seed yield plant^{-1} (10.09 g plant^{-1}) than a relatively close spaced plant spacing of 22.5 cm x 10 cm (4.41 branches plant^{-1}, 14.89 pods plant^{-1} and 6.44 g seed yield plant^{-1}) and 30 cm x 10 cm (5.29 branches plant^{-1}, 21.33 pods plant^{-1} and 8.20 g plant^{-1} seed yield).

The sowing at a spacing of 30 cm x 10 cm resulted in a significantly higher seed yield of the newly developed chickpea variety PDKV Kabuli-5 (1853 kg ha^{-1}) than a ultra-narrow spacing of 22.5 cm x 10 cm (1358 kg ha^{-1}) but it was at par with wider spacing of 45 cm x 10 cm (1809 kg ha^{-1}). Sowing at a spacing of 30 cm x 10 cm resulted in 2.37 per cent more seed yield ha^{-1} than the wider spacing of 45 cm x 10 cm and 36.45 percent more seed yield ha^{-1} compared to a narrow spacing of 22.5 cm x 10 cm.

The 33 per cent increase in plant population under 30 cm x 10 cm plant spacing instead of a widely spaced chickpea crop (45 cm x 10 cm) might explain the higher productivity per unit area. The similar result reported by Chala *et al.* (2020) [5].

Effect of fertilizer regimes on growth and yield of chickpea

Application of 150% RDF resulted in significantly taller plants (62.32 cm) compared to 100% RDF (58.04 cm); However, it was at par with the 125% RDF (59.76 cm). Similarly, the application of 150% RDF resulted in more branches (6.00 branches plant^{-1}) and pods (23.00 pods plant^{-1}) than the application of 100% RDF (4.98 branches plant^{-1} and 19 pods plant^{-1}) and 125% RDF (21.11 pods plant^{-1}). However, at number of branches plant^{-1} it was at par with the 125% RDF.

Table 1: Effect of plant spacing and fertilizer regimes on Kabuli chickpea

Treatments	Plant height (cm)	Number of branches plant^{-1}	Number of pods plant^{-1}	Seed yield plant^{-1}(g)
Plant spacing (S)				
S_1-22.5 cm × 10 cm	62.55	4.41	14.89	6.44
S_2- 30 cm × 10 cm	59.88	5.29	21.33	8.20
S_3- 45 cm × 10 cm	57.69	6.82	26.89	10.09
S.E. (m)	1.12	0.15	0.49	0.36
CD at 5%	3.36	0.46	1.49	1.09
Fertilizer regimes (N)				
N_1- 100% RDF (25:50:30 NPK kg ha^{-1})	58.04	4.98	19.00	7.31
N_2- 125% RDF (31.25: 62.50:37.50 NPK kg ha^{-1})	59.76	5.54	21.11	8.31
N_3- 150% RDF (37.5: 75: 45 NPK kg ha^{-1})	62.32	6.00	23.00	9.11
S.E. (m)	1.12	0.15	0.49	0.36
CD at 5%	3.36	0.46	1.49	1.09
Interaction (S × N)				
S.E. (m) ±	1.94	0.27	0.86	0.63
CD at 5%	NS	NS	NS	NS

Application of 150% RDF also resulted in significantly higher seed yield plant^{-1} of chickpea crop (9.11 g plant^{-1}) compared to the application of 100% RDF (7.31 g plant^{-1}). However, it was at par with 125% RDF (8.31 g plant^{-1}). An improvement of 24.62 percent and 9.62 percent in seed yield plant^{-1} was observed with a 50 percent higher recommended dose of fertilizers compared to 100% RDF and 125% RDF. The effect of fertilizer doses on the chickpea seed yield ha^{-1} was significant. Application of 150% RDF (1805 kg ha^{-1}) recorded the significantly higher seed yield ha^{-1} compare to the 100% RDF (1526 kg ha^{-1}). However, it was at par with the 125% RDF (1688 kg ha^{-1}). The 50% higher dose than the recommended dose of fertilizer increased the seed yield of the Kabuli chickpea variety PDKV Kabuli-5 by 18.28 and 6.93 per cent compared to 100% RDF and 125% RDF.

Table 2: Effect of plant spacing and fertilizer regimes on seed, straw yield (kg ha^{-1}) and harvest index (%) of Kabuli chickpea

Treatment	Seed Yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
Plant spacing (S)			
S_1 – 22.5 cm X 10 cm	1358	3157	43.08
S_2 – 30 cm X 10 cm	1853	4061	45.81
S_3 – 45 cm X 10 cm	1809	3660	49.66
S.E. (m)±	41.23	85.15	-
CD at 5%	123.62	255.29	-
Fertilizer regimes (N)			
N_1- 100% RDF (25:50:30 NPK kg ha^{-1})	1526	3370	45.67
N_2- 125% RDF (31.25: 62.50:37.50 NPK kg ha^{-1})	1688	3634	46.28
N_3- 150% RDF (37.5: 75: 45 NPK kg ha^{-1})	1805	3874	46.60
S.E. (m)±	41.23	85.15	-
CD at 5%	123.62	255.29	-
Interaction (S × N)			
S.E. (m)±	71.42	147.49	-
CD at 5%	NS	NS	-

Increased vigour and growth with optimum level of nitrogen and phosphorous application, thus lead to better development of yield attributes and subsequently the seed yield. The increase in yield is in accordance with fulfilment of essential requirement of phosphorous and potassium in plant biochemistry and physiology, also there was increased in leaf area which provides more place for photosynthetic activity leads to increased photosynthetic production resulted in increased seed yield ha^{-1}. These results are in accordance with Jadeja *et al.* (2016) [8]. All the interaction effects were found non-significant.

Conclusion

The study revealed that optimum productivity of Kabuli chickpea (PDKV Kabuli-5) was achieved at 30 cm × 10 cm spacing with 150% RDF (37.5: 75: 45 NPK kg ha^{-1}) due to the most efficient use of resources like sunlight, water, and space and fertilizer regimes is unlocking the crop's full yield potential. Therefore, the most effective approach is an integration of plant spacing with balanced nutrition to ensure efficient resource use and the highest productivity

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