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Effect of Row Spacing and Gibberellic Acid on Growth and Yield of Chickpea (*Cicer arietinum* L.) under Rainfed Conditions

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment on chickpea was conducted during Rabi, 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). INDIA. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.9), organic carbon (0.71%), available N (273.54 kg/ha), available P (31.14 kg/ha), and available K (327 kg/ha). The treatments comprised of spacing (25cm x 10cm, 35cm x 10cm, 45cm x 10cm), and foliar application of Gibberellic acid (15, 30, & 45ppm/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated three times. The results showed that viz: Plant height (68.91 cm), number of branches per plant (28.19), plant dry weight (27.48 g/plant) were recorded significantly higher with 35 x10 cm + GA3 45ppm/ha. Whereas, crop growth rate (17.68 g/m2/day), relative growth rate (0.023 g/g/day) recorded higher in 25 x 10cm + GA3 30ppm/ha. Number of pods per plant (60.04), number of seeds per pod (1.93), seed yield (246.67 kg/ha), haulm yield (5064.53 kg/ha) were recorded significantly higher.

Higher gross returns (1,08,022.50 □/ha), net returns (75,676.47 □/ha), and benefit-cost ratio (3.33) were obtained with the application of 35 x10 cm + GA3 45ppm/ha. Thus, spacing with foliar application of Gibberellic acid (15,30 and 45ppm) could be a promising option for yield enhancement in chickpea.

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1. INTRODUCTION

Pulses are an important part of the Indian diet and provide a significant amount of protein. It is the dried seeds of leguminous plants that are edible. They are nutritionally and economically significant since they contribute to the diets of millions of people around the world. Chickpea (*Cicer arietinum*) is a diploid (2n=16) grain legume crop that grows in a variety of locations, including the Mediterranean, South and West Asia, North America, and North and East Africa. "Chickpea is the fourth largest grain legume crop in the world. In India with a total production of 11.09 million tons from an area of 14.56 million ha and a productivity of 1.31 t/ha. Major producing countries include India, Pakistan, and Iran" (FAO, 2019). Chickpea requirement in India is projected to be around 10.18 million tones by the year 2030, which needs a 4.2% increase in the annual growth rate.

Chickpeas have a specific place in the diet and are used in a range of dishes. It is used in a variety of food dishes as "whole seed," "dal" (decorticated dry split cotyledons), and flour powdered (Besan). Boiling or roasting the whole grain is also an option. Vegetables are made from tender leaves. Cattle feed is made up of the husk and shattered fragments of dried chickpea. The glandular hairs are gathered in an unpleasant liquid state by draping a cloth over the crop at night to absorb the dew; it contains malic and oxalic acid and is used therapeutically and as vinegar. Due to its high protein content, health benefits, and various domestic uses, there is a wide scope for the production of chickpea for small-scale industries.

"To get rid of protein malnutrition a minimum of 50 g pulses per capita per day should be available in addition to other sources of proteins. To make the nation pulse sufficient, productivity level of pulses, should be increased substantially to 1200 kg per ha" [1].

Row spacing is one of the important that ultimately affect- nutrient uptake growth and yield of plants. An increase in spacing decreases the total population, but with more nutrition, the individual plants grow better and yield more and vice-versa. The increases or decreases of plant population have a definite pattern about the yield. Row spacing is one of the important characters which can be manipulated to attain the maximum production per unit land area. The optimum row spacing with proper geometry of planting is dependent on variety, its growth habit, and Agro-climatic condition.

"Plant growth regulators are organic compounds which, in small amounts, somehow modify a given physiological plant process. *Gibberellins* (GAs) play an essential role in many aspects of plant growth and development, such as seed germination, stem elongation and flower development" [2]. "GA treatments showed an increase in shoot and root length, fresh and dry weight of chickpea, and most florigenic of known plant growth regulators. Plant growth regulators play vital roles in drought tolerance of plants. Under water stress conditions, internal contents of gibberellins, auxins, and cytokinin usually decrease, while those of abscisic acid and ethylene increase" [3]. Gibberellic acids (Gibberellins) are naturally occurring plant hormones that are used as plant growth regulators to stimulate both cell division and elongation that affects leaves and stems. Gibberellic acid is a simple gibberellin, a pentacyclic diterpene acid promoting growth and elongation of cells. It affects decomposition of plants and helps plants grow if used in small amounts, but eventually plants develop tolerance to it.

2. MATERIALS AND METHODS

The experiment was conducted during the *Rabi* season 2021, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) India which is located at 250 30' 42''N latitude, 810 60' 56" E longitude and 98 m altitude above the mean sea level. during *rabi* season 2021 on sandy loam soil, having nearly neutral in soil reaction (pH 7.7), organic carbon (0.44), available nitrogen (171.48 kg/ha K), available phosphorus (27 kg/ha) and available potassium (291.2 kg/ha). The climate of the region is semi- arid subtropical. Under rainfed conditions Treatments comprised of T1– 25 x 10 cm + GA_3 15 ppm/ha, T2 – 25 x 10 cm + GA_3 30 ppm/ha, T3 – 25 x 10 cm + GA_3 45 ppm/ha, T4 – 35 x 10 cm + + GA_3 15 ppm/ha, T5 - 35 x 10 cm + GA_3 30 ppm/ha, T6 – 35 x 10 cm + + GA_3 45 ppm/ha, T7 – 45 x 10 cm + + GA_3 15 ppm/ha, T8– 45 x 10 cm + GA_3 30 ppm/ha and T9 – 45 x 10 cm + + GA_3 45

ppm/ha. These were replicated three times in Randomized Block Design. The recommended dose of fertilizer is 20-40-20 kg/ha NPK. Recommended dose of fertilizer was applied at the time of sowing in the form of Urea, SSP and MOP. The recommended dosages of urea, ssp and mop at the of sowing is 14.99gms, 86.25gms,11.48gms.

2.1 Chemical Analysis of Soil

"Composite soil samples are collected before layout of the experiment to determine the initial soil properties. The soil samples are collected from 0-15 cm depth and were dried under shade, powdered with wooden pestle and mortar, passed through 2 mm sieve and were analyzed for organic carbon by rapid titration method" by Nelson [4]. Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asija [5], available phosphorus by Olsen's method as outlined by Jackson [6], available potassium was determined by using the flame photometer normal ammonium acetate solution and estimating by using flame photometer (ELICO Model) as outlined by Jackson [6] and available $ZnSO_4$ was estimated by Atomic Absorption Spectrophotometer method as outlined by Lindsay and Norvell (1978).

2.2 Statistical Analysis

"The data recorded were subjected to statistical analysis by adopting Fishers the method of analysis of variance (ANOVA) as described" by Gomez and Gomez [7].

Critical difference (CD) values were calculated the 'F' test was found significant at 5% level.

3. RESULTS AND DISCUSSION

3.1 Plant Height

There was an increasing in plant height was recorded 20,40,60,80,100 DAS and at harvest (Table 1) was progressively increased with the advancement during the experimentation. The analysis on plant height was significantly higher in all the different growth intervals with the application of row spacing and gibberellic acid. At harvest, maximum plant height (68.91 cm) was recorded with the application of 35×10 cm + GA_3 45 ppm/ha. which was significantly superior over all other treatments and statistically at par with treatment of spacing 35 x 10 cm + GA_3 30 ppm/ha (68.82 cm) [8] Nabi et al.(2006) on spraying with gibberellic acid in chickpea support the result of the present study regarding plant height.

3.2 Number of Branches Per Plant

There was an increasing in plant height recorded 20,40,60,80,100 DAS and at harvest (Table 1) was progressively increased with the advancement during the experimentation. The analysis on number of branches per plant was significantly higher in all the different growth intervals with the application of row spacing and gibberellic acid. At harvest, maximum branches per plant (28.19) was recorded with application of 35×10 cm + GA_3 45 ppm/ha. which was significantly superior over all other treatments and statistically at par with treatment of spacing 25 x 10 cm + GA_3 45 ppm/ha (28.00).

Table 1. Effect of row spacing and gibberellic acid on growth attributes of chickpea

		At Harvest	
Treatments	**Plant height**	**Branches/plant**	**Nodules/plant**
25 x 10cm + GA3 15ppm/ha	64.38	23.64	3.17
25 x 10cm + GA3 30ppm/ha	67.24	27.31	3.56
25 x 10cm + GA3 45ppm/ha	68.02	28.00	4.49
35 x 10cm + GA3 15ppm/ha	65.54	25.30	2.92
35 x 10cm + GA3 30ppm/ha	68.82	27.53	3.78
35 x 10cm + GA3 45ppm/ha	68.91	28.19	3.17
45 x 10cm + GA3 15ppm/ha	61.15	21.93	2.76
45 x 10cm + GA3 30ppm/ha	62.94	22.38	3.06
45 x 10cm + GA3 45ppm/ha	67.18	26.87	2.92
F test	S	S	S
SEm±	1.04	0.93	0.771
CD (P = 0.05)	3.08	2.68	0.26

Table 2. Effect of row spacing and gibberellic acid on yield attributes and yield of chickpea

	At Harvest				
Treatments	**Pods/plant**	**Seeds/pod**	**Seed index**	**Seed yield kg/ha**	**Haulm yield kg/ha**
25 x 10cm + GA3 15ppm/ha	52.81	1.32	165.88	2498.90	4842.47
25 x 10cm + GA3 30ppm/ha	58.19	1.52	212.00	2827.53	4919.45
25 x 10cm + GA3 45ppm/ha	59.83	1.71	246.67	2914.08	5064.53
35 x 10cm + GA3 15ppm/ha	55.03	1.38	186.38	2568.12	4852.81
35 x 10cm + GA3 30ppm/ha	58.62	1.67	235.19	2871.50	4955.03
35 x 10cm + GA3 45ppm/ha	60.04	1.93	241.55	2972.69	4983.94
45 x 10cm + GA3 15ppm/ha	44.88	1.15	144.33	2316.51	4810.52
45 x 10cm + GA3 30ppm/ha	47.50	1.25	157.92	241.10	4793.06
45 x 10cm + GA3 45ppm/ha	56.42	1.44	201.03	2784.61	4870.00
F test	S	S	S	S	S
SEm±	1.12	0.07	4.01	56.30	59.99
CD (P = 0.05)	3.33	0.20	11.92	167.27	178.23

3.3 Number of Nodules Per Plant

There was an increasing in crop age plant height recorded 20,40,60,80,100 DAS and at harvest (Table 1) was progressively increased with the advancement during the experimentation. The analysis on nodules per plant was significantly higher in all the different growth intervals with the application of row spacing and gibberellic acid. At harvest, maximum nodules per plant (3.78) was recorded with application of 35×10 cm + GA_3 30 ppm/ha. which was significantly superior over all other treatments and statistically at par with treatment of spacing 25 x 10 cm + GA_3 30 ppm/ha (3.56).

3.4 Yield Attributes and Yield

Observations regarding the response of spacing 25 × 10 cm, 35 × 10 cm and 45 × 10 cm and gibberellic acid on yield and yield attributes of chickpea. The observation showed that the yield and yield attributes there was significant difference between treatments (Table 2).

3.4.1 Number of pods/plant

At harvest, significantly higher pods per plant (60.04) was recorded in 35 x10 cm + GA3 45ppm/ha. However, 25 x 10cm + GA3 30ppm/ha, 25 x 10cm + GA3 45ppm/ha, 35 x 10cm + GA3 30ppm/ha statistically at par with 35 x 10cm + GA3 45ppm/ha. Minimum pods per plant (44.88) was recorded in 45 x10 cm + GA3 15ppm/ha [9].

3.4.2 Number of seeds/ pod

At harvest, significantly higher seeds per pod (1.93) was recorded in 35 x10 cm + GA3 45ppm/ha. Minimum seeds per pod (1.15) was recorded in 45 x10 cm + GA3 15ppm/ha.

3.4.3 Seed Index

At harvest, significantly higher pods per plant (246.67) was recorded in 25 x10 cm + GA3 45ppm/ha. However, 35 x 10cm + GA3 30ppm/ha, 35 x 10cm + GA3 45ppm/ha statistically at par with 25 x 10cm + GA3 45ppm/ha. Minimum pods per plant (144.33) was recorded in 45 x10 cm + GA3 15ppm/ha Singh et al.(2013); [10] (Table 2).

3.4.4 Seed yield (kg/ha)

At harvest, significantly higher pods per plant (2972.69) was recorded in 35 x10 cm + GA3 45ppm/ha. However, 25 x 10cm + GA3 30ppm/ha, 25 x 10cm + GA3 45ppm/ha, 35 x 10cm + GA3 30ppm/ha statistically at par with 35 x 10cm + GA3 45ppm/ha. Minimum pods per plant (2316.51) was recorded in 45 x10 cm + GA3 15ppm/ha (Table 2).

3.4.5 Haulm yield (kg/ha)

At harvest, significantly higher pods per plant (5064.53) was recorded in 25 x10 cm + GA3 45ppm/ha. However, 25 x 10cm + GA3 30ppm/ha, 35 x 10cm + GA3 45ppm/ha, 35 x 10cm + GA3 30ppm/ha statistically at par with 35 x 10cm + GA3 45ppm/ha. Minimum pods per plant (4810.52) was recorded in 45 x10 cm + GA3 15ppm/ha (Table 2).

4. CONCLUSION

It is concluded that the treatment combination of row spacing 35 x10 cm along with GA3 45ppm/ha along with recommended doses was found to be the best that recorded highest plant height, number of branches, number of nodules per plant, more number of pods per plant, number of seeds per pods, highest test weight, seed yield, stover yield. It also fetched the maximum gross return, net return, and benefit cost ratio [11].

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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