

## Original Research Article

### EFFECT OF ROW SPACING AND GIBBERELIC ACID ON GROWTH AND YIELD OF CHICKPEA (*Cicer arietinum* L.)

**ABSTRACT**- A field experiment on chickpea was conducted during *Rabi, 2021* at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). 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 *Gibberllic acid* (15, 30, & 45ppm/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice. 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/m<sup>2</sup>/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 *Gibberllic acid* could be a promising option for yield enhancement in cowpea.

**Keywords:** Row Spacing, *Gibberllic acid*, Chickpea, Growth, and Yield.

### INTRODUCTION

Pulses are valuable constituents of the Indian diet and supply a major part of the protein requirement. It is edible dry seeds of leguminous plants. They are of special nutritional and economic importance due to their contribution to the diets of millions of people worldwide. Chickpea (*Cicer arietinum*) is an annual, self-pollinated, diploid ( $2n=16$ ) grain legume crop grown in a wide range of environments 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 tonnes by the year 2030, which needs a 4.2% increase in the annual growth rate.

Chickpea has got special importance in diet and is consumed in a variety of ways. It is used as "Whole seed", 'dal' (decorticated dry split cotyledons), and flour powdered (*Besan*) which are used in a variety of food preparations. The whole grain is also eaten either boiled or roasted. Tender leaves are used as a vegetable. The husk and broken bits of dried chickpea are used as cattle feed. An acrid liquid-form the glandular hairs are collected by spreading a cloth

**Comment [IGKA1]:** I would suggest to add a brief description on the aim and research problems in this abstract. Why addition of GA is regarded important. What problem has been found in agricultural practice which leads the authors to add GA.

**Comment [IGKA2]:** Please show the main results by presenting the highest

over the crop at night, which absorbs the with the dew; it contains malic and oxalic acid and is used medically 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 (**Ali and Kumar, 2005**).

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 (**Yamaguchi and Kamiya, 2000**). 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 (**Nilsen and Orcutte, 1996**).

## **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.) which is located at 25° 30' 42''N latitude, 81° 06' 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. **Treatments** comprised of T1– 25 x 10 cm + GA<sub>3</sub> 15 ppm/ha, T2 – 25 x 10 cm + GA<sub>3</sub> 30 ppm/ha, T3 – 25 x 10 cm + GA<sub>3</sub> 45 ppm/ha, T4 – 35 x 10 cm + + GA<sub>3</sub> 15 ppm/ha, T5 - 35 x 10 cm + GA<sub>3</sub> 30 ppm/ha, T6 – 35 x 10 cm + + GA<sub>3</sub> 45 ppm/ha, T7 – 45 x 10 cm + + GA<sub>3</sub> 15 ppm/ha, T8– 45 x 10 cm + GA<sub>3</sub> 30 ppm/ha and T9 – 45 x 10 cm + + GA<sub>3</sub> 45 ppm/ha. These were replicated thrice 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.

**Comment [IGKA3]:** Please add the timing of foliar application of GA

**Comment [IGKA4]:** Which treatment is used for the control treatment.

### 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 (1975). Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asija (1956), available phosphorus by Olsen's method as outlined by Jackson (1967), 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 (1973) and available ZnSO<sub>4</sub> was estimated by Atomic Absorption Spectrophotometer method as outlined by Lindsay and Norvell (1978).

### Statistical analysis

The data recorded were different characteristics were subjected to statistical analysis by adopting Fishers the method of analysis of variance (ANOVA) as described by Gomez and Gomez (2010). Critical difference (CD) values were calculated the 'F' test was found significant at 5% level.

## RESULTS AND DISCUSSION

### Plant Height:

There was an increasing in ~~crop age~~ 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<sub>3</sub> 45 ppm/ha. which was significantly superior over all other treatments and statistically at par with treatment of spacing 35 x 10 cm + GA<sub>3</sub> 30 ppm/ha (68.82 cm).

### Number of branches 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 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<sub>3</sub> 45 ppm/ha. which was significantly superior over all other treatments and statistically at par with treatment of spacing 25 x 10 cm + GA<sub>3</sub> 45 ppm/ha (28.00).

### 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

**Comment [IGKA5]:** There is no discussion was found in this section. Discussion should be made by comparing the current results and the previously published article.

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<sub>3</sub> 30 ppm/ha. which was significantly superior over all other treatments and statistically at par with treatment of spacing 25 x 10 cm + GA<sub>3</sub> 30 ppm/ha (3.56).

### **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.

### **Number of pods/plant**

At harvest, significantly higher pods per plant (60.04) was recorded in 35 x10 cm + GA<sub>3</sub> 45ppm/ha. However, 25 x 10cm + GA<sub>3</sub> 30ppm/ha, 25 x 10cm + GA<sub>3</sub> 45ppm/ha, 35 x 10cm + GA<sub>3</sub> 30ppm/ha statistically at par with 35 x 10cm + GA<sub>3</sub> 45ppm/ha. Minimum pods per plant (44.88) was recorded in 45 x10 cm + GA<sub>3</sub> 15ppm/ha.

### **Number of seeds per pod**

At harvest, significantly higher seeds per pod (1.93) was recorded in 35 x10 cm + GA<sub>3</sub> 45ppm/ha. Minimum seeds per pod (1.15) was recorded in 45 x10 cm + GA<sub>3</sub> 15ppm/ha.

### **Seed Index**

At harvest, significantly higher pods per plant (246.67) was recorded in 25 x10 cm + GA<sub>3</sub> 45ppm/ha. However, 35 x 10cm + GA<sub>3</sub> 30ppm/ha, 35 x 10cm + GA<sub>3</sub> 45ppm/ha statistically at par with 25 x 10cm + GA<sub>3</sub> 45ppm/ha. Minimum pods per plant (144.33) was recorded in 45 x10 cm + GA<sub>3</sub> 15ppm/ha.

### **Seed yield (kg/ha)**

At harvest, significantly higher pods per plant (2972.69) was recorded in 35 x10 cm + GA<sub>3</sub> 45ppm/ha. However, 25 x 10cm + GA<sub>3</sub> 30ppm/ha, 25 x 10cm + GA<sub>3</sub> 45ppm/ha, 35 x 10cm + GA<sub>3</sub> 30ppm/ha statistically at par with 35 x 10cm + GA<sub>3</sub> 45ppm/ha. Minimum pods per plant (2316.51) was recorded in 45 x10 cm + GA<sub>3</sub> 15ppm/ha.

### **Haulm yield (kg/ha)**

At harvest, significantly higher pods per plant (5064.53) was recorded in 25 x10 cm + GA<sub>3</sub> 45ppm/ha. However, 25 x 10cm + GA<sub>3</sub> 30ppm/ha, 35 x 10cm + GA<sub>3</sub> 45ppm/ha, 35 x 10cm + GA<sub>3</sub> 30ppm/ha statistically at par with 35 x 10cm + GA<sub>3</sub> 45ppm/ha. Minimum pods per plant (4810.52) was recorded in 45 x10 cm + GA<sub>3</sub> 15ppm/ha.

## 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.

**Comment [IGKA6]:** Is this treatment has been used in the agricultural practice in this area ?

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

**Comment [IGKA7]:** Very important to show statistical result in each value, indicate the significance of difference on top of each value by a, b, c etc. Then it would be easier how statistically different the results are

TREATMENTS	Plant height	AT HARVEST	
		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.

Comment [IGKA8]: See comment on table 1

TREATMENTS	AT HARVEST				
	Pods/plant	seeds/pod	Seed index	Seed yield	Haulm yield
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

UNDER PEER REVIEW