

# Effect of Sowing Time and Seed Treatment on Growth, Yield and Quality Seed Production of Chickpea (Bari Chola-6)

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## ABSTRACT

A field experiment was conducted at the Agronomy research field of Sher-e-Bangla Agricultural University, Dhaka, during the period from November 2013 to March 2014 to study the response of sowing time and seed treatment on growth, yield and quality seed production of chickpea. The experiment comprised as two factors: sowing date - 3 times: 1<sup>st</sup> sowing date: 19<sup>th</sup> November - S<sub>1</sub>, 2<sup>nd</sup> sowing date: 29<sup>th</sup> November - S<sub>2</sub> and 3<sup>rd</sup> sowing date: 9<sup>th</sup> December - S<sub>3</sub> and seed treatment with gibberellic acid (GA<sub>3</sub>) - 5 levels: GA<sub>3</sub> 75 ppm - T<sub>1</sub>, GA<sub>3</sub> 150 ppm - T<sub>2</sub>, GA<sub>3</sub> 225 ppm - T<sub>3</sub>, GA<sub>3</sub> 300 ppm - T<sub>4</sub> and hydro-priming - T<sub>5</sub>. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The treatment combination on maximum plant height and dry matter content recorded of plant in S<sub>2</sub>T<sub>3</sub> irrespective of growing period. This combination also exhibited maximum number of pods plant<sup>-1</sup>, longest pod length and maximum number of seed pod<sup>-1</sup>, where as required minimum duration for pod maturity. The maximum weight of 1000 seed, height grain yield, harvest index and also maximum found germination percentage and vigor index were found. When chickpea was shown on 29<sup>th</sup> November and treated with 225 ppm GA<sub>3</sub> then ensure the best result.

**Keyword:** chickpea, sowing time, seed treatment, yield and quality seed

## INTRODUCTION

Chickpea (*Cicerarietinum* L.) is one of the major pulses crop in Bangladesh and it is the third most important food legume grown in the world after beans and peas. It is contributes about 3.87 % of total pulses production in Bangladesh. [1] The average

yield of chickpea is 1.32 t ha<sup>-1</sup> but it is very low compared to other countries of the world. Total production of pulse in Bangladesh is 3, 35,470 metric tons and total production of chickpea is 12,460 metric ton. [1] Domestic pulse production satisfies less than half of the other countries

demands. Chickpea plays an important role the agro-economy and human health of Bangladesh. Bangladesh Agricultural Research Institute (BARI) has developed several high yielding varieties of chickpea-BARI chhola 5, BARI chhola 6, BARI chhola 7 and BARI chhola 8. So, we have a great opportunity to increase the production by using these released varieties of chickpea. Chickpea contain 20 % protein, 4.8 % fat, 9.1 % crude fibre, 1.37 % lysine, 195 - 205 mg/g carotene, 89 - 94 mg/g Ca and 9.2 - 9.4 mg/g Fe. Also, it is an important crop for both human consumption and animal feed due to 17 - 31 % protein in seeds and biological activity of its protein ranges between 52 - 78 %. [2,3,4] It supplies about four times as much protein and eight times as riboflavin and the caloric value of it is equal to rice. [5] Moreover, it is known as poor man's meat. It is a versatile source of nutrients for man, animal and soil. [6]

A number of agronomic practices have been found to influence the yield of pulse crop. [7] Sowing time had a marked effect on growth and development of crop. [8] Optimum sowing time provides more time for growth and development of plant which is favorable for higher yield whereas both early and late hinder the growth and development with lowest yield potential. [9] Early sown crop grows luxuriantly followed by less number of pods and seeds production thus limits yield. Late sowing also resulted in lower yield, the growth is hampered and the seed development period is shortened. Similar findings were pointed out by Yadev *et al.* [10] so, proper sowing time, a non monetary input can help getting higher yield of chickpea.

Due to the diversified use of productive land, it is necessary to increase the food production and gibberellic acid (GA<sub>3</sub>) may be a contributor in achieving the desired goal. The plant growth regulator treatments significantly increased all

physiological and yield characters. [11] Plant growth regulators (PGRs) have potential to increase chickpea yield and may also increase protein levels of legume crops. [12] Treatment of seeds with water or different osmotic solutions before sowing is an effective mechanism to increase germination, seedling establishment and uniformity. [13] Seeds treat with GA<sub>3</sub> usually germination and grow faster have more developed root system, increase their tolerance to abiotic stress conditions, bloom and mature earlier and give better yields. [14,15]

Information on the responses of sowing time and seed treatment on growth and yield of chickpea. Considering the present situation, the present research work was carried out with the following objective to obtain combination effect on growth and yield of chickpea.

## MATERIALS AND METHODS

The experiment was conducted at the Agronomy experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November 2013 to March 2014 to study the effect of sowing time and seed treatment on growth and yield of chickpea. The location of the site is 23°74'N latitude and 90°35'E longitude with an elevation of 8.2 m from sea level. The soil belongs to "The Modhupur Tract", AEZ – 28. [16] Top soil was silty clay in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH was 5.6 and has organic carbon 0.45%. The geographical location of the experimental site was under the subtropical climate, characterized by 3 distinct seasons, winter season from November to February and the pre-monsoon period or hot season from March to April and monsoon period from May to October. BARI chhola-6 was collected from Bangladesh Agricultural

Research Institute (BARI), Joydevpur, Gazipur. The experiment comprised as two factors one of them sowing date viz. S<sub>1</sub>: 1<sup>st</sup> sowing date: 19<sup>th</sup> November, S<sub>2</sub>: 2<sup>nd</sup> sowing date: 29<sup>th</sup> November, S<sub>3</sub>: 3<sup>rd</sup> sowing date: 9<sup>th</sup> December and on the other factor seed treatment viz. T<sub>1</sub>: GA<sub>3</sub> 75 ppm, T<sub>2</sub>: GA<sub>3</sub> 150 ppm, T<sub>3</sub>: GA<sub>3</sub> 225 ppm, T<sub>4</sub>: GA<sub>3</sub> 300 ppm and T<sub>5</sub>: hydro-priming. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The size of each unit plot was 4.0 × 2.5 m. The spacing between blocks and plots were 1.0 m and 0.5 m. The plot selected for the experiment was opened in the last week of October, 2013 with a power tiller, and was exposed to the sun for a week, after which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. The fertilizers 50-90-40-10-10@urea, TSP, MP, Gypsum and borax, respectively were applied. The one third amounts of urea and entire amount of TSP, MP, Gypsum, Zinc sulphate and borax were applied during the final preparation of land. Rest urea was applied in two equal installments at vegetative and flowering stage. [17]

After establishment of seedlings, various intercultural operations were accomplished for better growth and development of the chickpea. The crop was harvested at full maturity on 08 March, 2014 and harvesting was done manually from each plot. The harvested crop of each plot was bundled separately, properly tagged and brought to threshing floor. Enough care was taken for harvesting, threshing and also cleaning of chickpea seed. Fresh weight of grain and stover were recorded plot wise. The grains were cleaned and finally the weight was adjusted to a moisture content of 12%. The stover was sun dried and the yields of grain and stover plot<sup>-1</sup> were recorded and converted to t ha<sup>-1</sup>.

Data were collected on date of emergence, date of 1<sup>st</sup> and 50% flowering, plant height (cm), number of branches plant<sup>-1</sup>, total dry matter, number of pods plant<sup>-1</sup>, days to pod maturity, pod length plant<sup>-1</sup>, number of seeds pod<sup>-1</sup>, weight of 1000 seeds (g), grain yield (Kg ha<sup>-1</sup>), stover yield (Kg ha<sup>-1</sup>), biological yield (Kg ha<sup>-1</sup>), harvest index (%), germination (%) and vigor index. The data obtained for different characters were statistically analyzed to observe the significant difference among the treatment by using the MSTAT-C computer package program. The significance of the difference among the treatments means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability. [18]

## RESULTS AND DISCUSSION

**Date of Emergence:** Interaction between sowing time and seed treated with GA<sub>3</sub> along with hydro-priming showed significant variation in data of emergence. The longest period required (6.00 days) for S<sub>1</sub>T<sub>5</sub> and the shortest period (3.00 days) was observed from S<sub>2</sub>T<sub>3</sub> (Table 1). The lowest number of days for emergence was observed on 29<sup>th</sup> November with 225 ppm GA<sub>3</sub> treatment sowing.

**Days of First Flowering:** Combined effect of sowing time and seed treatment with GA<sub>3</sub> showed significant variation in date of first flowering. The highest days of first flowering (64.00 days) was recorded from S<sub>1</sub>T<sub>5</sub> and similar results was found in S<sub>2</sub>T<sub>1</sub>, S<sub>2</sub>T<sub>2</sub>, S<sub>2</sub>T<sub>4</sub>, S<sub>3</sub>T<sub>3</sub> and S<sub>3</sub>T<sub>4</sub>. The lowest days of first flowering (48.00 days) was observed from S<sub>2</sub>T<sub>3</sub> and S<sub>3</sub>T<sub>3</sub>, which the similar to that of (48.33 days) S<sub>1</sub>T<sub>1</sub> (Table 1). The lowest number of days for first flowering was observed on 29<sup>th</sup> November with 225 ppm GA<sub>3</sub> treatment sowing.

**Date Of 50% flowering:** Combined effect of sowing time and seed treatment with GA<sub>3</sub> showed significant variation in date of 50% flowering. The highest days of 50%

flowering (84.00 days) was recorded from S<sub>1</sub>T<sub>5</sub> and the lowest days of 50% flowering (68.00 days) was observed from S<sub>2</sub>T<sub>3</sub> and S<sub>3</sub>T<sub>3</sub>, which the similar to that of (68.33 days) S<sub>1</sub>T<sub>1</sub> (Table 1). The lowest number of days for 50% flowering was observed on 29<sup>th</sup> November with 225 ppm GA<sub>3</sub> treatment sowing.

**Table 1. Interaction effect of sowing time and seed treatment with GA<sub>3</sub> on date of emergence (days), date of first flowering (days) and date of 50% flowering (days) of chickpea**

Treatment	Date of emergence (days)	Date of first flowering (days)	Date of 50% flowering (days)
S <sub>1</sub> T <sub>1</sub>	4.00 c	48.33 f	68.33 f
S <sub>1</sub> T <sub>2</sub>	4.00 c	54.00 e	74.00 e
S <sub>1</sub> T <sub>3</sub>	4.00 c	57.00 de	77.00 de
S <sub>1</sub> T <sub>4</sub>	5.00 b	54.00 e	74.00 e
S <sub>1</sub> T <sub>5</sub>	6.00 a	64.00 a	84.00 a
S <sub>2</sub> T <sub>1</sub>	4.00 c	63.00 ab	83.00 ab
S <sub>2</sub> T <sub>2</sub>	5.00 b	62.00 ab	82.00 ab
S <sub>2</sub> T <sub>3</sub>	3.00 d	48.00 f	68.00 f
S <sub>2</sub> T <sub>4</sub>	5.00 b	63.00 ab	83.00 ab
S <sub>2</sub> T <sub>5</sub>	4.00 c	58.00 cd	78.00 cd
S <sub>3</sub> T <sub>1</sub>	4.00 c	60.00 bcd	80.00 bcd
S <sub>3</sub> T <sub>2</sub>	4.00 c	60.00 bcd	80.00 bcd
S <sub>3</sub> T <sub>3</sub>	5.00 b	63.00 ab	83.00 ab
S <sub>3</sub> T <sub>4</sub>	4.00 c	61.00 abc	81.00 abc
S <sub>3</sub> T <sub>5</sub>	5.00 b	48.00 f	68.00 f
SE	0.2620	1.154	1.323
CV(%)	10.31	3.47	3.99

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Table 2. Interaction effect of sowing time and seed treatment with GA<sub>3</sub> on plant height (cm) of chickpea**

Treatment	Plant height (cm) at			
	20 DAS	40 DAS	60 DAS	Harvest
S <sub>1</sub> T <sub>1</sub>	9.31 ef	32.35 cd	38.57 c-f	37.82 cd
S <sub>1</sub> T <sub>2</sub>	8.27 fg	25.48 gh	36.39 ef	33.60 e
S <sub>1</sub> T <sub>3</sub>	9.91 d-f	33.33 cd	39.24 c-f	38.04 b-d
S <sub>1</sub> T <sub>4</sub>	8.13 fg	28.96 ef	36.07 fg	37.49 cd
S <sub>1</sub> T <sub>5</sub>	6.76 g	23.38 h	33.13 g	33.38 e
S <sub>2</sub> T <sub>1</sub>	11.41 b-d	34.42 bc	43.70 ab	39.71 a-d
S <sub>2</sub> T <sub>2</sub>	11.83 a-c	34.10 bc	43.39 b	40.27 a-d
S <sub>2</sub> T <sub>3</sub>	13.32 a	38.71 a	46.80 a	42.60 a
S <sub>2</sub> T <sub>4</sub>	12.36 ab	37.00 ab	43.89 ab	41.38 ab
S <sub>2</sub> T <sub>5</sub>	10.27 c-e	34.00 bc	40.56 b-d	38.60 b-d
S <sub>3</sub> T <sub>1</sub>	9.70 d-f	26.61 fg	39.48 c-e	36.82 d
S <sub>3</sub> T <sub>2</sub>	10.49 b-f	33.96 bc	41.41 b-d	38.82 b-d
S <sub>3</sub> T <sub>3</sub>	11.01 b-e	34.97 bc	41.91 bc	39.38 a-d
S <sub>3</sub> T <sub>4</sub>	10.91 b-e	34.89 bc	41.47 b-d	40.60 a-c
S <sub>3</sub> T <sub>5</sub>	9.30 ef	30.63 de	38.17 d-f	38.12 b-d
SE	1.245	2.965	2.862	3.156
CV(%)	9.86	5.35	6.50	9.71

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Plant Height:** Significant differences were also recorded for the interaction effect of sowing time and seed treatment with GA<sub>3</sub> on plant height of chickpea at 20, 40, 60 DAS and at harvest. The tallest plants (13.32, 38.71, 46.80 and 42.60 cm) were observed from S<sub>2</sub>T<sub>3</sub>, which was statistically similar (12.36, 37.00, 43.89 and 41.60 cm) with S<sub>2</sub>T<sub>4</sub> and the shortest plants (6.76, 23.38, 33.13 and 33.38 cm) were found in S<sub>1</sub>T<sub>5</sub> at same days after sowing (Table 2).

**Table 3. Interaction effect of sowing time and seed treatment with GA<sub>3</sub> on number of branches per plant of chickpea**

Treatment	Number of branches per plant			
	20 DAS	40 DAS	60 DAS	Harvest
S <sub>1</sub> T <sub>1</sub>	1.17 e	7.57 f	14.53 e	15.70 gh
S <sub>1</sub> T <sub>2</sub>	1.40 bc	8.43 de	18.27 c	20.40 a-e
S <sub>1</sub> T <sub>3</sub>	1.40 bc	7.97 ef	16.90 d	18.20 ef
S <sub>1</sub> T <sub>4</sub>	1.27 d	8.27 d-f	15.10 e	16.07 gh
S <sub>1</sub> T <sub>5</sub>	1.17 e	6.73 g	13.03 f	14.90 h
S <sub>2</sub> T <sub>1</sub>	1.47 ab	9.40 b	18.90 bc	21.60 a-c
S <sub>2</sub> T <sub>2</sub>	1.50 ab	8.83 b-e	19.00 bc	20.53 a-d
S <sub>2</sub> T <sub>3</sub>	1.53 a	10.20 a	20.50 a	22.57 a
S <sub>2</sub> T <sub>4</sub>	1.50 ab	9.47 ab	19.83 ab	21.93 ab
S <sub>2</sub> T <sub>5</sub>	1.40 bc	8.17 d-f	17.90 cd	18.90 d-f
S <sub>3</sub> T <sub>1</sub>	1.40 bc	8.30 d-f	18.03 c	18.57 d-f
S <sub>3</sub> T <sub>2</sub>	1.43 a-c	8.80 b-e	18.57 c	21.20 a-c
S <sub>3</sub> T <sub>3</sub>	1.43 a-c	8.53 c-e	18.47 c	21.60 a-c
S <sub>3</sub> T <sub>4</sub>	1.43 a-c	9.30 bc	18.47 c	20.07 b-e
S <sub>3</sub> T <sub>5</sub>	1.33 cd	7.50 f	16.80 d	17.73 fg
SE	0.086	0.845	1.205	1.864
CV(%)	6.87	5.34	9.75	6.13

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Number of Branches Plant<sup>-1</sup>:** Sowing time and seed treatment with GA<sub>3</sub> interact significant differences on number of branches plant<sup>-1</sup> of chickpea at 20, 40, 60 DAS and at harvest. The maximum number of branches plant<sup>-1</sup> (1.53, 10.20, 20.50 and 22.57) were observed from S<sub>2</sub>T<sub>3</sub>, which the lowest number of branches plant<sup>-1</sup> (1.17, 6.73, 13.03 and 14.90) were found in S<sub>1</sub>T<sub>5</sub> at same days after sowing (Table 3).

**Total Dry Matter:** Sowing time and seed treatment with GA<sub>3</sub> interact significant differences on total dry matter of chickpea at 20, 40 and 60 DAS. The highest dry matter (6.46, 9.61 and 12.19 g) were observed from S<sub>2</sub>T<sub>3</sub>, whereas the lowest dry matter (3.85,

6.02 and 9.40 g) were found in S<sub>1</sub>T<sub>5</sub> at same days after sowing (Table 4).

**Table 4. Interaction effect of sowing time and seed treatment with GA<sub>3</sub> on dry mater of chickpea**

Treatment	Dry matter content per plant (g)		
	20 DAS	40 DAS	60 DAS
S <sub>1</sub> T <sub>1</sub>	4.08 fg	6.81 fg	11.42 a-c
S <sub>1</sub> T <sub>2</sub>	4.31 e-g	6.85 e-g	9.30 e
S <sub>1</sub> T <sub>3</sub>	4.26 d-g	7.03 d-g	9.49 e
S <sub>1</sub> T <sub>4</sub>	4.26 e-g	7.12 d-f	9.79 e
S <sub>1</sub> T <sub>5</sub>	3.85 g	6.02 g	9.40 e
S <sub>2</sub> T <sub>1</sub>	5.45 bc	7.91 b-f	11.60 ab
S <sub>2</sub> T <sub>2</sub>	6.22 a	8.37 bc	11.33 a-d
S <sub>2</sub> T <sub>3</sub>	6.46 a	9.61 a	12.19 a
S <sub>2</sub> T <sub>4</sub>	6.07 ab	8.43 b	11.80 ab
S <sub>2</sub> T <sub>5</sub>	4.84 c-f	7.34 b-f	10.50 b-e
S <sub>3</sub> T <sub>1</sub>	4.82 c-f	7.27 c-f	10.50 b-e
S <sub>3</sub> T <sub>2</sub>	5.00 c-e	8.03 b-d	9.90 de
S <sub>3</sub> T <sub>3</sub>	5.18 cd	7.95 b-e	12.08 a
S <sub>3</sub> T <sub>4</sub>	4.87 c-f	7.44 b-f	10.53 b-e
S <sub>3</sub> T <sub>5</sub>	4.40 d-g	6.91 e-g	11.50 ab
SE	0.695	0.895	1.354
CV (%)	8.79	7.65	7.23

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Table 5. Effect of interaction of sowing time and seed treatment with GA<sub>3</sub> on yield and yield components of chickpea**

Treatment	Number of pod plant <sup>-1</sup>	Days to pod maturity	Pod length (cm)	Number of seeds pod <sup>-1</sup>
S <sub>1</sub> T <sub>1</sub>	35.76 fg	115 ab	2.31 ef	1.64 bc
S <sub>1</sub> T <sub>2</sub>	34.09 fg	114 a-c	2.26 ef	1.58 cd
S <sub>1</sub> T <sub>3</sub>	42.86 c-e	112 a-e	2.70 c-e	1.56 cd
S <sub>1</sub> T <sub>4</sub>	38.42 ef	113 a-d	2.55 d-f	1.52 cd
S <sub>1</sub> T <sub>5</sub>	32.66 g	118 a	2.01 f	1.45 d
S <sub>2</sub> T <sub>1</sub>	46.92 bc	107 d-f	3.21 bc	1.87 ab
S <sub>2</sub> T <sub>2</sub>	49.81 ab	106 ef	3.24 a-c	1.89 ab
S <sub>2</sub> T <sub>3</sub>	53.98 a	103 f	3.76 a	1.96 a
S <sub>2</sub> T <sub>4</sub>	50.10 ab	106 ef	3.38 ab	1.91 a
S <sub>2</sub> T <sub>5</sub>	44.98 b-d	107 d-f	2.83 b-e	1.76 bc
S <sub>3</sub> T <sub>1</sub>	44.01 cd	112 a-e	2.74 c-e	1.71 bc
S <sub>3</sub> T <sub>2</sub>	46.69 b-d	109 b-e	2.95 b-d	1.85 ab
S <sub>3</sub> T <sub>3</sub>	47.30 bc	107 d-f	3.09 b-d	1.89 ab
S <sub>3</sub> T <sub>4</sub>	44.96 b-d	109 b-e	3.04 b-d	1.84 ab
S <sub>3</sub> T <sub>5</sub>	41.37 de	113 a-d	2.57 de	1.73 bc
SE	0.465	4.985	0.465	0.114
CV (%)	10.52	12.98	10.52	9.65

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Number of pods plant<sup>-1</sup>:** Sowing time and seed treatment with GA<sub>3</sub> interact significant differences on number of pods plant<sup>-1</sup> of chickpea. The height number of pods plant<sup>-1</sup> (53.98) was observed from S<sub>2</sub>T<sub>3</sub>, which was similar to S<sub>2</sub>T<sub>4</sub> and S<sub>2</sub>T<sub>2</sub>, whereas the lowest

number of pods plant<sup>-1</sup> of chickpea (32.66) was found in S<sub>1</sub>T<sub>5</sub> (Table 5).

**Days to pod maturity:** Interaction between sowing time and seed treatment with GA<sub>3</sub> showed significant variation in days to pod maturity. The maximum days to pod maturity (118 days) was recorded from S<sub>1</sub>T<sub>5</sub>, which the statistically similar (115 days) to S<sub>1</sub>T<sub>1</sub>, whereas the minimum days to pod maturity (103 days) was observed from S<sub>2</sub>T<sub>3</sub> (Table 5). The minimum days to pod maturity was observed on 29<sup>th</sup> November with 225 ppm GA<sub>3</sub> treatment sowing.

**Pod length plant<sup>-1</sup>:** Interaction between sowing time and seed treatment with GA<sub>3</sub> showed significant variation in pod length plant<sup>-1</sup>. The highest pod length plant<sup>-1</sup> (3.76 cm) was recorded from S<sub>2</sub>T<sub>3</sub>, which the statistically similar (3.38 cm) to S<sub>2</sub>T<sub>4</sub>. The lowest pod length plant<sup>-1</sup> (2.01 cm) was observed from S<sub>1</sub>T<sub>5</sub> (Table 5).

**Number of seeds pod<sup>-1</sup>:** Interaction between sowing time and seed treatment with GA<sub>3</sub> showed significant variation in number of seeds pod<sup>-1</sup>. The highest number of seeds pod<sup>-1</sup> (1.96) was recorded from S<sub>2</sub>T<sub>3</sub>, which the statistically similar (1.91) to S<sub>2</sub>T<sub>4</sub>. The lowest number of seeds pod<sup>-1</sup> (1.45) was observed from S<sub>1</sub>T<sub>5</sub> (Table 5).

**Weight of 1000 seeds (g):** Interaction between sowing time and seed treatment with GA<sub>3</sub> showed significant variation in weight of 1000 seeds. The highest weight of 1000 seeds (123.47 g) was recorded from S<sub>2</sub>T<sub>3</sub>, which the statistically similar to S<sub>2</sub>T<sub>4</sub> and S<sub>2</sub>T<sub>2</sub> (120.35 g and 116.72 g). The lowest weight of 1000 seeds (89.45 g) was observed from S<sub>1</sub>T<sub>5</sub>, which the statistically similar to S<sub>1</sub>T<sub>1</sub>, S<sub>1</sub>T<sub>2</sub>, S<sub>1</sub>T<sub>4</sub> and S<sub>3</sub>T<sub>5</sub> (Table 6).

**Grain yield (Kg ha<sup>-1</sup>):** Statistically significant differences were recorded for the interaction effect of sowing time and seed treatment with GA<sub>3</sub> on grain yield of chickpea. The maximum grain yield (1705.30 Kg ha<sup>-1</sup>) was observed from S<sub>2</sub>T<sub>3</sub>,

which was statistically similar (1688.28 Kg ha<sup>-1</sup>) to S<sub>2</sub>T<sub>4</sub>. The minimum grain yield

(859.30 Kg ha<sup>-1</sup>) was found in S<sub>1</sub>T<sub>5</sub>, which was statistically similar to S<sub>1</sub>T<sub>1</sub> (Table 6)

**Table 6. Effect of interaction of sowing time and seed treatment with GA<sub>3</sub> on yield and yield components of chickpea**

Treatment	Weight of 1000 seeds (g)	Grain yield (Kg ha <sup>-1</sup> )	Straw yield (Kg ha <sup>-1</sup> )	Biological yield (Kg ha <sup>-1</sup> )	Harvest Index (%)
S <sub>1</sub> T <sub>1</sub>	91.27 e	925.28 g	1464.13 g	2333.91 d	38.06 g
S <sub>1</sub> T <sub>2</sub>	91.27 e	1160.19 f	1652.19 f	2854.19 cd	38.06 g
S <sub>1</sub> T <sub>3</sub>	95.18 de	1041.97 ef	1789.37 f	3659.06 b	38.57 efg
S <sub>1</sub> T <sub>4</sub>	92.86 e	1589.61 a-d	1652.17 f	2694.16 cd	38.59 e-g
S <sub>1</sub> T <sub>5</sub>	89.45 e	859.30 g	1408.63g	2323.43 d	36.98 h
S <sub>2</sub> T <sub>1</sub>	104.94 b	1605.33 a-d	2612.00 a-c	4217.33 ab	39.80 b-d
S <sub>2</sub> T <sub>2</sub>	116.72 a	1659.87 a-c	2643.83 ab	4303.70 a	48.44 a-c
S <sub>2</sub> T <sub>3</sub>	123.47 a	1705.30 a	2747.17 a	4435.45 a	40.64 a
S <sub>2</sub> T <sub>4</sub>	120.35 a	1688.28 ab	2713.30 ab	4418.6 a	40.47 ab
S <sub>2</sub> T <sub>5</sub>	104.94 b	1520.67 de	2316.40 de	3204.37 ab	39.39 c-e
S <sub>3</sub> T <sub>1</sub>	95.04 de	1552.20 c-e	2202.60 e	3891.34 ab	38.76 e-g
S <sub>3</sub> T <sub>2</sub>	96.83 cde	1563.78 b-e	2467.40 cd	4031.18 ab	38.67 e-g
S <sub>3</sub> T <sub>3</sub>	102.83 bc	1589.61 a-d	2559.27 bc	4148.88 ab	39.64 b-d
S <sub>3</sub> T <sub>4</sub>	101.37 b-d	1574.94 b-e	2378.33 d	3899.00 ab	38.00 d-f
S <sub>3</sub> T <sub>5</sub>	92.83 e	1456.46 e	1694.00 f	2952.60 c	38.31 fg
SE	0.05	39.13	51.49	169.5	0.2646
CV (%)	4.15	4.82	4.14	8.15	4.17

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Straw yield (Kg ha<sup>-1</sup>):** Sowing time and seed treatment with GA<sub>3</sub> interact significant differences on straw yield of chickpea. The height straw yield (2747.17 Kg ha<sup>-1</sup>) was observed from S<sub>2</sub>T<sub>3</sub>, which statistically similar (2713.30 Kg ha<sup>-1</sup> and 2643 Kg ha<sup>-1</sup>) to S<sub>2</sub>T<sub>4</sub> and S<sub>2</sub>T<sub>2</sub>. The lowest straw yield (1408.63 Kg ha<sup>-1</sup>) was found in S<sub>1</sub>T<sub>5</sub>, which statistically similar (1464.13 Kg ha<sup>-1</sup>) to S<sub>1</sub>T<sub>1</sub> (Table 6).

**Biological yield (kg ha<sup>-1</sup>):** Interaction between sowing time and seed treatment with GA<sub>3</sub> showed significant variation in biological yield. The highest biological yield (4435.45 Kg ha<sup>-1</sup>) was recorded from S<sub>2</sub>T<sub>3</sub>, which the statistically similar (4418.60 Kg ha<sup>-1</sup> and 4303.70 Kg ha<sup>-1</sup>) to S<sub>2</sub>T<sub>4</sub> and S<sub>2</sub>T<sub>2</sub>. The lowest biological yield (2323.43 Kg ha<sup>-1</sup>) was observed from S<sub>1</sub>T<sub>5</sub>, which the statistically similar to S<sub>1</sub>T<sub>1</sub> (Table 6).

**Harvest Index (%):** Sowing time and seed treatment with GA<sub>3</sub> interact significant differences on harvest index of chickpea. The height harvest index (40.64 %) was observed from S<sub>2</sub>T<sub>3</sub>, which statistically similar (40.47 %) to S<sub>2</sub>T<sub>4</sub>. The lowest

harvest index (36.98 %) was found in S<sub>1</sub>T<sub>5</sub> (Table 6).

**Table 7. Effect of interaction of sowing time and seed treatment with GA<sub>3</sub> on germination and vigor index of chickpea**

Treatment	Germination (%)	Vigor index
S <sub>1</sub> T <sub>1</sub>	82.00 l	672.00 l
S <sub>1</sub> T <sub>2</sub>	84.00 k	1010.00 h
S <sub>1</sub> T <sub>3</sub>	86.00 i	1169.00 g
S <sub>1</sub> T <sub>4</sub>	87.00 h	666.00 m
S <sub>1</sub> T <sub>5</sub>	78.00 m	624.00 n
S <sub>2</sub> T <sub>1</sub>	92.00 d	624.00 n
S <sub>2</sub> T <sub>2</sub>	88.00 g	1786.00 e
S <sub>2</sub> T <sub>3</sub>	97.00 a	2441.00 a
S <sub>2</sub> T <sub>4</sub>	95.00 b	1904.00 d
S <sub>2</sub> T <sub>5</sub>	93.00 c	2050.00 b
S <sub>3</sub> T <sub>1</sub>	90.00 f	1984.00 c
S <sub>3</sub> T <sub>2</sub>	85.00 j	1634.00 f
S <sub>3</sub> T <sub>3</sub>	87.00 h	771.00 k
S <sub>3</sub> T <sub>4</sub>	93.00 c	797.00 j
S <sub>3</sub> T <sub>5</sub>	91.00 e	941.00 i
SE	0.05289	0.05289
CV (%)	0.01	0.01

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Germination (%):** Interaction between sowing time and seed treatment with GA<sub>3</sub> showed significant variation in germination percentage. The highest germination percentage (97.00) was recorded from S<sub>2</sub>T<sub>3</sub>.

The lowest germination percentage (78.00) was observed from S<sub>1</sub>T<sub>5</sub> (Table 7).

**Vigor Index:** Interaction between sowing time and seed treatment with GA<sub>3</sub> showed significant variation in vigor index. The highest vigor index (2441.00) was recorded from S<sub>2</sub>T<sub>3</sub>. The lowest vigor index (624.00) was observed from S<sub>1</sub>T<sub>5</sub>, which the statistically similar to S<sub>2</sub>T<sub>1</sub> (Table 7).

## CONCLUSION

In this experiment, the maximum number of pods plant<sup>-1</sup>, number of seeds pod<sup>-1</sup>, weight of 1000 seeds, grain yield, harvest index, germination percentage and vigor index was recorded from S<sub>2</sub>T<sub>3</sub>. So, the chickpea cultivation was suitable on 29<sup>th</sup> November and seed was treated on 225 ppm GA<sub>3</sub>.

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