

## Original Research Article

# **Ameliorating the Adverse Effects of Salinity on Chickpea (*Cicer arietinum* L.) by Applying Plant Growth Regulators**

### **ABSTRACT**

An experiment was conducted at the plant protective culture unit under semi-controlled environmental conditions of Bangladesh Agricultural Research Institute during 2020-21 to ameliorate the adverse effects of salinity stress on chickpea using plant growth regulators like different levels of salicylic acid (SA) and gibberellic acid (GA<sub>3</sub>). Plants were treated with four concentrations of saline water (5, 7.5, 10 and 12.5 dSm<sup>-1</sup>) from 14<sup>th</sup> days after sowing (DAS) to maturity (100 DAS) and control plants were irrigated with tap water. Two concentrations of SA (200 ppm and 400 ppm) and GA<sub>3</sub> (10 ppm and 20 ppm) were applied as a foliar spray once a week from 20 DAS to the flowering stage. The data of chlorophyll content in leaf and water relation traits such as relative water content (RWC) and water retention capacity (WRC) were measured 7 days after foliar spray of plant growth regulators at the flowering stage. Total dry weight, yield and yield contributing characters were measured at maturity. Results showed that salinity decreased chlorophyll content, relative water content, water retention capacity, total dry weight and yield of chickpea. Foliar application of SA and GA<sub>3</sub> at different doses under different salinity conditions had positive effects related to the mitigation of salinity stress effect but the low concentration of SA @ 200 ppm and GA<sub>3</sub> @ 10 ppm, respectively were found to ameliorate the adverse effects the salinity tolerance in chickpea under saline condition significantly at low salinity condition on the above parameters.

Key words: Salinity tolerance, Chickpea, gibberellic acid, salicylic acid ameliorating

### **INTRODUCTION**

Salinity is a significant problem affecting agriculture worldwide, including Bangladesh, resulting in substantial losses in crop yield. In Bangladesh, coastal areas about 2.86 million ha covered by 30% of the total crop land of the country. Of this, nearly 1.056 million ha are affected by varying degrees of salinity (Siddiky, *et al.*, 2012). The severity of salinity of this area increases with the desiccation of the soil. It affects crops depending on degree of salinity at the critical stages of growth and reduces yield and in severe cases, total yield is lost. It has become obligatory to inquire the possibilities of increasing potential of these (saline) lands for increasing crop production (Alam& Islam, 2018). Out of coastal cultivable saline area, about 328 (31%), 274 (26%) and 190 (18%) thousand hectares of land are affected by very slight (2.0 - 4.0 dSm<sup>-1</sup>), slight (4.1- 8.0 dSm<sup>-1</sup>) and moderate salinity (8.1-12.0 dSm<sup>-1</sup>), respectively are scope to successfully crop production (SRDI, 2013).

To mitigate the reduction in plant growth under saline conditions different strategies are being employed. One of them is to introduce salt tolerant varieties of different crops.

Attempts to improve salinity tolerant variety through conventional plant breeding methods are time consuming, laborious and availability of existing genetic variability (Kaya *et al.*, 2009). An alternative approach for coping with salinity could, therefore, be an exogenous application of growth regulators which diminish salinity effect in plant to a tolerable level. Plant growth regulators like salicylic acid (SA) and gibberellic acid (GA<sub>3</sub>) are recognized endogenous regulator of plant metabolism, which mainly involved in biotic and abiotic stress (Aydin and Nalbantoglu, 2011). Salicylic acid is involved in water relations of plant cells in abiotic stress conditions and diminishes the impairments arisen from water deficiency in plants (Hussain *et al.*, 2009). Gibberellic acid regulates growth and development to the plants and reduced stomatal resistance and enhanced plant water use at low salinity (Maggio *et al.*, 2010).

Chickpea (*Cicer arietinum* L.) is the primary source of food protein for about 20% of the world population and is the second largest pulse crop (FAO, 2018). Chickpea seeds contain 21% protein, 5.6% fat, 60% carbohydrate, and are rich in minerals and vitamins. Chickpea is a salt-sensitive crop, and yields are seriously reduced by salinity (Manchanda and Sharma, 1990). The information regarding the action of salicylic acid and gibberellic acid in enhancing salt tolerance and growth of chickpea is not enough for making any concrete recommendation to the end-users. There are insufficient research studies regarding the effects of plant growth regulators like SA and GA<sub>3</sub> on chickpea varieties in relation to salinity tolerance. Therefore, this experiment was aimed to study the effects of SA and GA<sub>3</sub> to enhance salinity tolerance of chickpea.

## MATERIALS AND METHODS

A pot experiment was conducted at plant protective culture unit, under semi-controlled environmental condition in the Regional Horticulture Research Station, Bangladesh Agricultural Research Institute (BARI), Patuakhali during 2021-22. Chickpea variety BARI Chola-5 was used as plant material in the experiment. The experimental soil was collected before the sowing of seeds. The physical and chemical properties of the soil was clay loam in texture with neutral in nature and medium fertility status. The soil of the pot was fertilized uniformly with compost (25% of the soil volume) 0.27-0.28-0.20 g of urea, triple super phosphate and muriate of potash per pot for supplying N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O, respectively. The compost was made mostly from cow dung which contained 0.8% N, 0.6% P<sub>2</sub>O<sub>5</sub> and 1.0% K<sub>2</sub>O on dry weight basis. Ten seeds were sown in each plastic pots filled with soil inside plastic house under natural light. After seedling establishment, five uniform and healthy plants were allowed to grow in each pot. Weeding and pest control measures were taken for proper growth of plants. Salt solution was prepared by adding tap water in sea water to make 5, 7.5, 10 and 12.5 dSm<sup>-1</sup> salinity levels. Plants were irrigated with these 5, 7.5, 10 and 12.5 dSm<sup>-1</sup> concentrates saline water from 14<sup>th</sup> days after sowing (DAS) to maturity (100 DAS) and control plants were irrigated with tap water. Different concentration of SA and GA<sub>3</sub> were applied as foliar spray once in a week from 20 DAS to flowering stage. The experiment will be laid out in Randomized Complete Block Design (RCBD) having three replications. A treatment detail is given below-

T<sub>1</sub> – Control (non saline condition)

T<sub>12</sub> – 10 dSm<sup>-1</sup> salinity + 400 ppm SA

T <sub>2</sub> – 5 dSm <sup>-1</sup> salinity	T <sub>13</sub> – 12.5 dSm <sup>-1</sup> salinity + 400 ppm SA
T <sub>3</sub> – 7.5 dSm <sup>-1</sup> salinity	T <sub>14</sub> – 5 dSm <sup>-1</sup> salinity + 10 ppm GA <sub>3</sub>
T <sub>4</sub> – 10 dSm <sup>-1</sup> salinity	T <sub>15</sub> – 7.5 dSm <sup>-1</sup> salinity + 10 ppm GA <sub>3</sub>
T <sub>5</sub> – 12.5 dSm <sup>-1</sup> salinity	T <sub>16</sub> – 10 dSm <sup>-1</sup> salinity + 10 ppm GA <sub>3</sub>
T <sub>6</sub> – 5 dSm <sup>-1</sup> salinity + 200 ppm SA	T <sub>17</sub> – 12.5 dSm <sup>-1</sup> salinity + 10 ppm GA <sub>3</sub>
T <sub>7</sub> – 7.5 dSm <sup>-1</sup> salinity + 200 ppm SA	T <sub>18</sub> – 5 dSm <sup>-1</sup> salinity + 20 ppm GA <sub>3</sub>
T <sub>8</sub> – 10 dSm <sup>-1</sup> salinity + 200 ppm SA	T <sub>19</sub> – 7.5 dSm <sup>-1</sup> salinity + 20 ppm GA <sub>3</sub>
T <sub>9</sub> – 12.5 dSm <sup>-1</sup> salinity + 200 ppm SA	T <sub>20</sub> – 10 dSm <sup>-1</sup> salinity + 20 ppm GA <sub>3</sub>
T <sub>10</sub> – 5 dSm <sup>-1</sup> salinity + 400 ppm SA	T <sub>21</sub> – 12.5 dSm <sup>-1</sup> salinity + 20 ppm GA <sub>3</sub>
T <sub>11</sub> – 7.5 dSm <sup>-1</sup> salinity + 400 ppm SA	

The data for chlorophyll content and water relation traits in leaf such as relative water content (RWC) and water retention capacity (WRC) were recorded 7 days after foliar spray of SA and GA<sub>3</sub> at flowering stage. Chlorophyll content was estimated from the fully expanded uppermost leaf samples using the method described by Witham *et al.*, (1986).

To measure the relative water content (RWC), fresh weight of the collected leaves sample was measured immediately. Thereafter, the leaves sample were then incubated in deionized water for 4 hours as described by Sairam *et al.* (2002) and turgid weight of the leaf sample was recorded. The leaf sample was then filled into a brown paper bag and oven dried at 70<sup>0</sup>C temperature for 48 hours and the dry weight of the sample was taken. The relative water content (RWC) was estimated as follows:

$$\text{RWC} = (\text{FW} - \text{DW}) / (\text{TW} - \text{DW}) \times 100$$

Where, FW = Fresh weight of the leaf,

DW = Dry weight of the leaf,

TW = Turgid weight of the leaf.

Water retention capacity is the ratio of the turgid weight and dry weight of a tissue. After the harvest both treated and controlled plants were segmented into different components (root, stem, leaf). The segmented parts were then oven dried for 72 hours and the dry weights were recorded. Total dry weight of both treated and control plant were estimated by summing up the dry weight of root, stem and leaf. Yield and yield contributing characters like number of pod plant<sup>-1</sup>, number of seed pod<sup>-1</sup>, 100 seed weight and seed yield plant<sup>-1</sup> etc. data were recorded on in case of both treated as well as control plants in each pot. The data recorded on different parameters were statistically analyzed with the help of R program. Means were compared to adjust the difference in plant performance under growth regulators treatments experiencing both salinity and control conditions by Least Significant Different Test (Gomez and Gomez, 1984).

## RESULTS AND DISCUSSION

### Yield and yield contributing characters

#### Pods number per plan

The results showed that salinity significantly affected the pods number per plant (Table 1). The maximum number of pods per plant was obtained by the non-saline condition (control). Pod number decreased with increasing salinity level. Lowest pod number (16.08) was found in plant irrigated with  $12.5\text{dSm}^{-1}$ , which was  $7.16\text{ pod plant}^{-1}$  and it was 20.26% of the control plant. However, when plant was sprayed with SA and  $\text{GA}_3$  under saline condition then pod number increased. When plant was sprayed with SA @ 200 ppm under 5, 7.5, 10 and  $12.5\text{ dSm}^{-1}$  saline water treated plant; number of pod was produced by chickpea 33.23, 23.07, 18.00 and 8.72 which were 94%, 65%, 51% and 25% respectively compared to control. But it was 82%, 69%, 55% and 23% respectively when plant was sprayed with SA @ 400 ppm. On the other hand, when plant was sprayed with  $\text{GA}_3$  @ 10 ppm under 5, 7.5, 10 and  $12.5\text{ dSm}^{-1}$  saline water treated plant; number of pods per plant was produced by chickpea on average 31.60, 24.06, 21.37 and 9.01 which were 89%, 68%, 60% and 26%, respectively of the control. But it was 82%, 66%, 52% and 21%, respectively when plant was sprayed with  $\text{GA}_3$  @ 20 ppm. It is revealed that high concentration of SA and  $\text{GA}_3$  did not show significant ameliorative effect of salinity stress in chickpea in respect of number of pod.

### **100-seed weight**

Effects of salinity on 100-seed weight were statistically significant. The highest seed weight per plant was found in non-saline condition (25.18 g). Seed weight decreased when plant was irrigated with sea water and decreasing rate was higher with increasing salinity level. Lowest weight obtained 3.56 g, which was only 14.13% of the control when plant was irrigated with  $12.5\text{dSm}^{-1}$  saline water (Table 1). However, seed weight increased when plant was sprayed with SA and  $\text{GA}_3$  under saline condition. When foliage was sprayed with SA @ 200 ppm under 5, 7.5, 10 and  $12.5\text{dSm}^{-1}$  saline water irrigated plant; 100 seed weight was produced by chickpea 19.06 g, 15.01 g, 12.82 g and 4.55g which were 76%, 60%, 51% and 18%, respectively compared to control. But it was 70%, 63%, 55% and 17%, respectively when plant was sprayed with SA @ 400 ppm. On the other hand, when plant was sprayed with  $\text{GA}_3$  @ 10 ppm under 5, 7.5, 10 and  $12.5\text{ dSm}^{-1}$  saline water irrigated plant; 100 seed weight was 17.39 g, 15.60 g, 12.72 g and 5.08 g which were 73%, 63%, 55% and 21% respectively of the control. But it was 69%, 61%, 52% and 20% respectively when plant was sprayed with  $\text{GA}_3$  @ 20 ppm. It is clear that high concentration of SA and  $\text{GA}_3$  did not show significant ameliorative effect of salinity stress in chickpea in relation to seed weight.

### **Seed yield**

Analysis of variance showed that the plant biomass was significantly affected by salinity stress. The highest amount of seed yield per plant was obtained from the control plants (6.77 g). The mean seed yield of under stress plants decreased when plant was irrigated with sea water and decreasing rate was higher with increasing salinity level. Lowest yield obtained 1.88 g, which was 28% of the control when plant was irrigated with  $12.5\text{dSm}^{-1}$  saline water (Table 1). However, seed yield was significantly increased when plant was sprayed with SA and  $\text{GA}_3$  under saline condition. When foliage was sprayed with SA @ 200 ppm under 5, 7.5, 10 and  $12.5\text{dSm}^{-1}$  saline water irrigated plant; seed yield was produced by chickpea 6.25 g, 4.66 g, 3.70 g and 2.62 g which were 92%, 69%, 55% and 39%, respectively compared to control. But it was 83%, 56%, 48% and 35%, respectively when plant was sprayed with SA

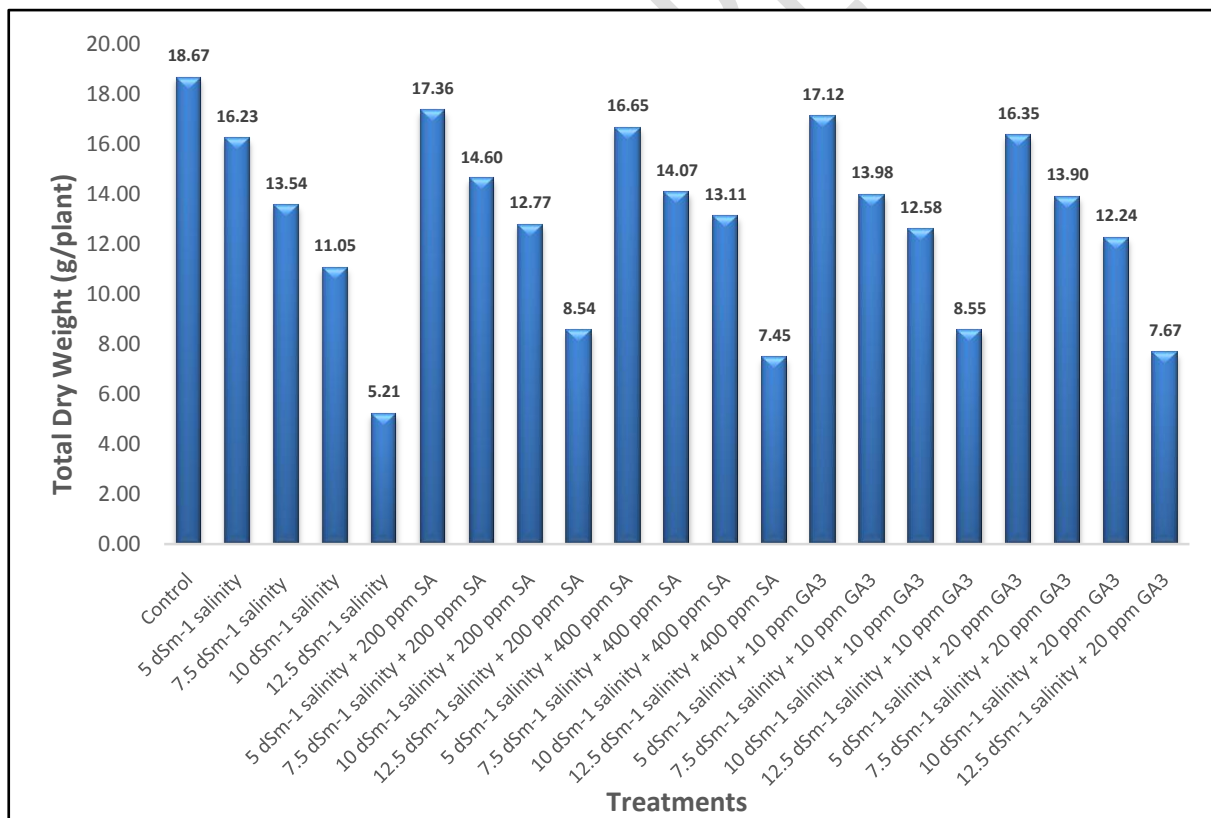
@ 400 ppm. On the other hand, when plant was sprayed with GA<sub>3</sub> @ 10 ppm under 5, 7.5, 10 and 12.5 dSm<sup>-1</sup> saline water irrigated plant; seed yield per plant was 6.08 g, 4.44 g, 2.71 g and 2.12 g which were 90%, 66%, 40% and 31%, respectively of the control. But it was 81%, 60%, 39% and 29%, respectively when plant was sprayed with GA<sub>3</sub> @ 20 ppm. It could be stated that the beneficial effect of SA on improving yield may be due to the translocation of more photo assimilates to the seeds. These results may be due to the role of salicylic acid in enhancing some physiological and biochemical aspects under stressful conditions (Maity and Bera, 2009). Reduction in chickpea seed yield by means of terminal salinity stress has been previously reported by Hossain *et al.* (2015).

**Table 1. Effects of plant growth regulators on seed yield and yield contributing characters of chickpea under different levels of salinity stress conditions.**

Sl. No.	Treatment	Number of pod/plant	100-seed weight (g)	Seed yield/plant (g)
1	Control	35.33	25.18	6.77
2	5 dSm <sup>-1</sup> salinity	28.59	17.23	5.18
3	7.5 dSm <sup>-1</sup> salinity	23.10	11.55	3.77
4	10 dSm <sup>-1</sup> salinity	17.68	9.77	2.80
5	12.5 dSm <sup>-1</sup> salinity	7.16	3.56	1.88
6	5 dSm <sup>-1</sup> salinity + 200 ppm SA	33.23	19.06	6.25
7	7.5 dSm <sup>-1</sup> salinity + 200 ppm SA	23.07	15.01	4.66
8	10 dSm <sup>-1</sup> salinity + 200 ppm SA	18.00	12.82	3.70
9	12.5 dSm <sup>-1</sup> salinity + 200 ppm SA	8.72	4.55	2.62
10	5 dSm <sup>-1</sup> salinity + 400 ppm SA	28.81	17.60	5.60
11	7.5 dSm <sup>-1</sup> salinity + 400 ppm SA	24.48	15.91	3.81
12	10 dSm <sup>-1</sup> salinity + 400 ppm SA	19.52	13.93	3.27
13	12.5 dSm <sup>-1</sup> salinity + 400 ppm SA	8.28	4.42	2.38
14	5 dSm <sup>-1</sup> salinity + 10 ppm GA <sub>3</sub>	31.60	18.43	6.08
15	7.5 dSm <sup>-1</sup> salinity + 10 ppm GA <sub>3</sub>	24.06	15.92	4.44
16	10 dSm <sup>-1</sup> salinity + 10 ppm GA <sub>3</sub>	21.37	13.90	2.71
17	12.5 dSm <sup>-1</sup> salinity + 10 ppm GA <sub>3</sub>	9.01	5.28	2.12
18	5 dSm <sup>-1</sup> salinity + 20 ppm GA <sub>3</sub>	29.06	17.39	5.46
19	7.5 dSm <sup>-1</sup> salinity + 20 ppm GA <sub>3</sub>	23.38	15.60	4.05
20	10 dSm <sup>-1</sup> salinity + 20 ppm GA <sub>3</sub>	18.50	12.72	2.63
21	12.5 dSm <sup>-1</sup> salinity + 20 ppm GA <sub>3</sub>	7.56	5.08	1.99
<b>STDEV</b>		<b>8.79</b>	<b>6.03</b>	<b>1.52</b>
<b>CV (%)</b>		<b>17.05</b>	<b>14.26</b>	<b>13.72</b>

### Dry matter production

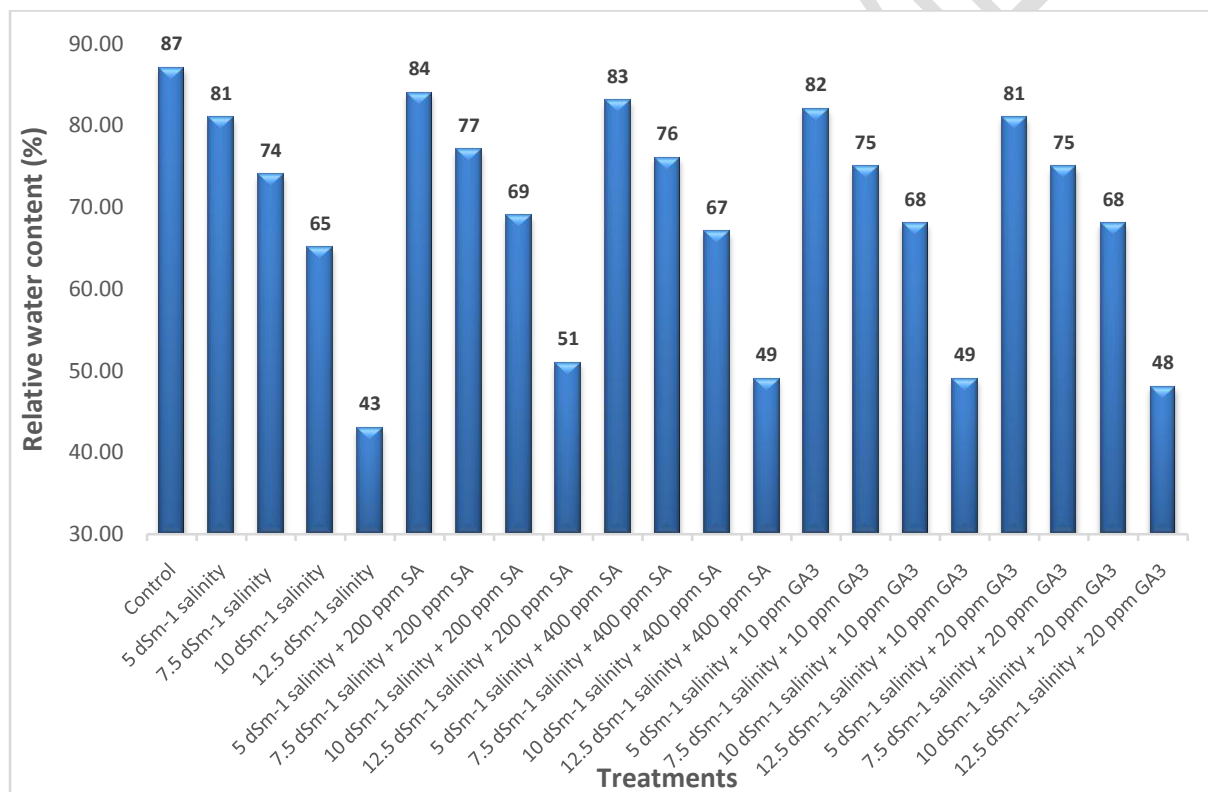
Dry matter accumulation was decreased significantly under the saline condition at vegetative stage and higher reduction found at 12.5 dSm<sup>-1</sup> saline condition (5.21 g plant<sup>-1</sup>), which was only 28% of the control (Fig. 1). It was found that, control plant produced highest total dry matter (18.67 g plant<sup>-1</sup>) and under 5 dSm<sup>-1</sup> saline condition it was (16.23 g plant<sup>-1</sup>). Plant growth regulators increased total dry weight under salinity stress. Among the plant growth regulators treated plant, the maximum dry matter was obtained 17.36 g plant<sup>-1</sup> when plant was sprayed with SA @ 200 ppm, followed by 17.12 g plant<sup>-1</sup> when plant was sprayed with GA<sub>3</sub> @ 10 ppm under 5 dSm<sup>-1</sup> salt treated plants. When plant was sprayed with SA @ 400 ppm and GA<sub>3</sub> @ 20 ppm total dry matter plant<sup>-1</sup> was found 16.65 g plant<sup>-1</sup> and 16.35 g plant<sup>-1</sup> respectively under the same (5 dSm<sup>-1</sup>) salinity condition. At 12.5 dSm<sup>-1</sup> saline condition when plant was sprayed with SA @ 200 ppm and GA<sub>3</sub> @ 10 ppm, dry matter production was 8.54 g and 8.51 g plant<sup>-1</sup> respectively. On the other hand, when plant was sprayed with SA @ 400 ppm and GA<sub>3</sub> @ 20 ppm dry matter production was 7.45 g and 7.67 g plant<sup>-1</sup>, respectively under the same (12.5 dSm<sup>-1</sup>) salinity stress. Lower doses of SA and GA<sub>3</sub> show remarkable effect on dry matter production under saline condition. Similar results also reported by Hossain *et al.* (2015) and Yildirim *et al.* (2008) who reported that exogenous application of SA and GA<sub>3</sub> ameliorated the negative effect of salt stress on dry weight of plants.



**Figure 1.** Effect of plant growth regulators on total dry weight of chickpea under different levels of salinity stress conditions.

**Relative water content (RWC)**

Relative water content was decreased significantly under the saline conditions compared to control (Fig. 2). Under saline condition, RWC% decreased and decreasing rate was higher with increasing salinity levels. At 5, 7.5, 10 and 12.5 dSm<sup>-1</sup> salinity conditions RWC were 81%, 74%, 65% and 43%, respectively. Control plant maintained highest RWC (87%). However, foliar application of SA and GA<sub>3</sub> increased the RWC under different salinity conditions. When plant was sprayed with SA @ 200 ppm and GA<sub>3</sub> @ 10 ppm RWC was 84% and 82%, respectively under 5 dSm<sup>-1</sup> salinity conditions. At 12.5 dSm<sup>-1</sup> saline condition when plant was sprayed with SA @ 200 ppm and GA<sub>3</sub> @ 10 ppm, RWC was 51% and 49%, respectively. On the other hand, when plant was sprayed with SA @ 400 ppm and GA<sub>3</sub> @ 20 ppm RWC was 83% and 82%, respectively under the same salinity (5dSm<sup>-1</sup>) stress. So RWC increasing rate was lower when plant was sprayed with higher doses of SA and GA<sub>3</sub>. The results are in close conformity of the fact that SA potentially generates a wide array of metabolic and physiological responses and also affects plant water relations (Hayat *et al.*, 2010).

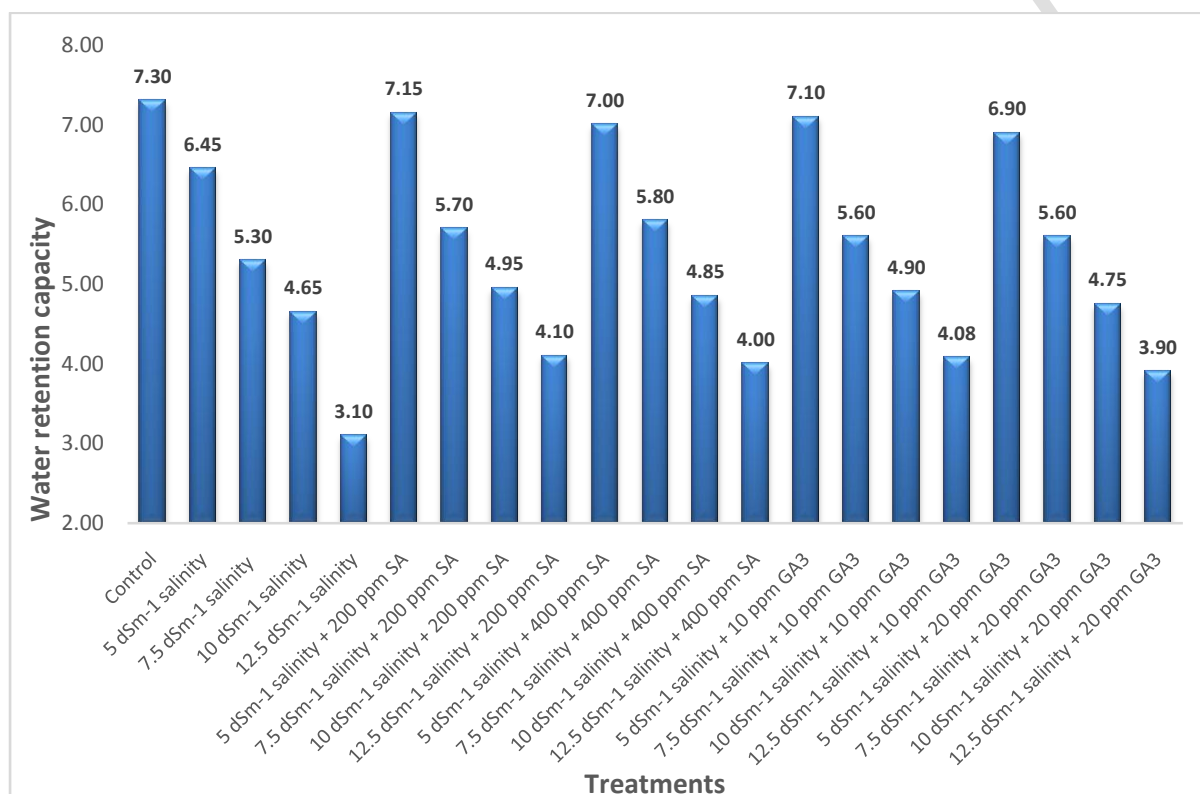


**Figure 2.**Effect of plant growth regulators on relative water content of chickpea under different levels of salinity stress conditions.

### Water retention capacity (WRC)

Water retention capacity (WRC) was affected by plant growth regulators. Control plants showed the maximum WRC (about 7.30) than the saline treated plants and it was gradually decreased with the increased salinity level. Under 12.5 dSm<sup>-1</sup> salinity level it was 3.10. SA and GA<sub>3</sub> enhance the salinity tolerance and increase the water retention capacity (Fig. 3) and increasing rate was higher when plant was sprayed with 200 ppm SA and 10 ppm GA<sub>3</sub> under 5 dSm<sup>-1</sup> saline conditions. Foliar application of SA and GA<sub>3</sub> increased the WRC under

different salinity conditions. When plant was sprayed with SA @ 200 ppm and GA<sub>3</sub> @ 10 ppm RWC was 7.15 and 7.10, respectively under 5 dSm<sup>-1</sup> salinity conditions. At 12.5 dSm<sup>-1</sup> saline condition when plant was sprayed with SA @ 200 ppm and GA<sub>3</sub> @ 10 ppm, RWC was 4.10 and 4.08, respectively. On the other hand, when plant was sprayed with SA @ 400 ppm and GA<sub>3</sub> @ 20 ppm WRC was 7.00 and 6.90, respectively under the same salinity (5 dSm<sup>-1</sup>) stress. So RWC increasing rate was lower when plant was sprayed with higher doses of SA and GA<sub>3</sub>. Ahmad *et al.*, (2009) reported in their study that application of GA<sub>3</sub> counteracted the adverse effects of NaCl salinity on relative water content.

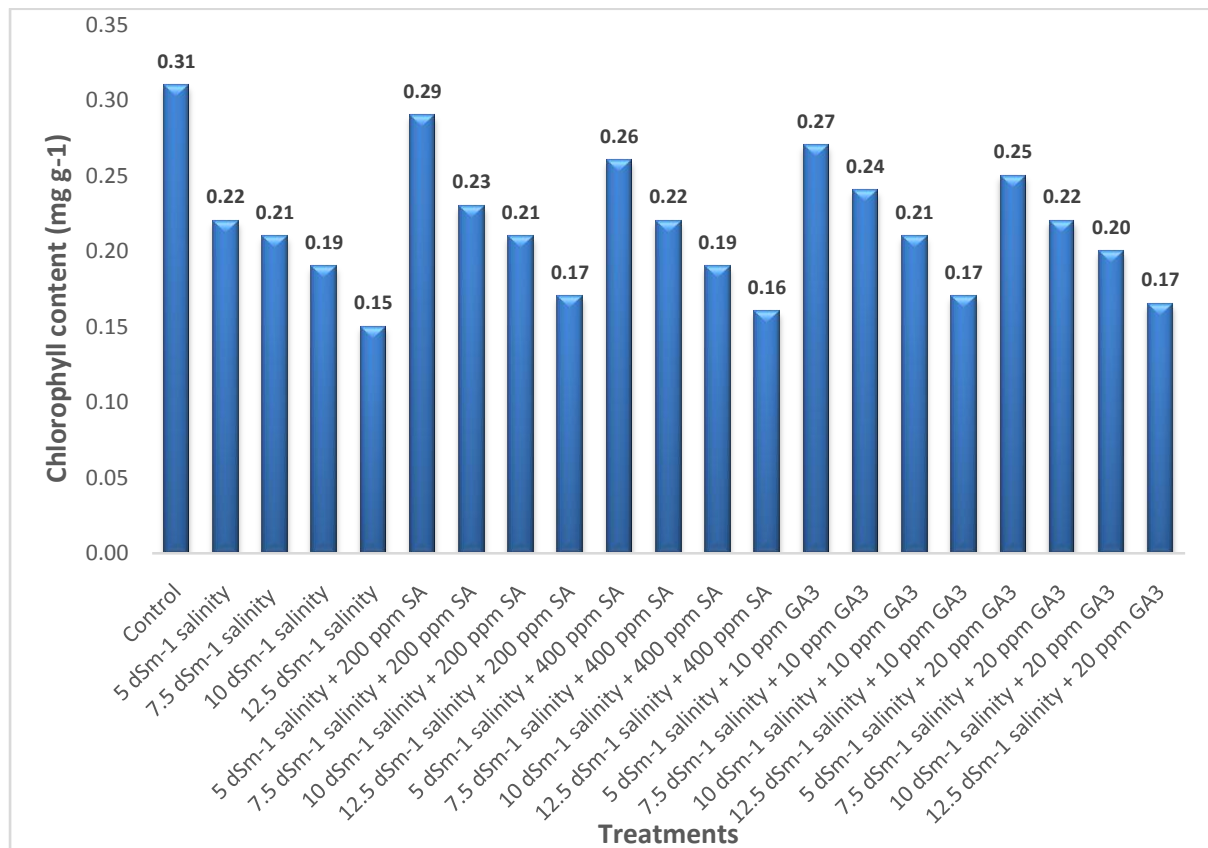


**Figure 3. Effect of plant growth regulators on water retention capacity of chickpea under different levels of salinity stress conditions.**

### Chlorophyll content

The chlorophyll content of chickpea leaf was reduced significantly at salinity stress conditions. The highest total chlorophyll (0.31 mg g<sup>-1</sup>) was found in the non-saline condition. Chlorophyll in chickpea leaf decreased as the salinity level increased and maximum reduction was observed at the highest salinity level (12.5 dSm<sup>-1</sup>) (Fig. 4). Total chlorophyll content increased when plant growth regulators were applied under saline conditions. The foliar application of SA and GA<sub>3</sub> increased the chlorophyll level in salt treated plant but increasing rate was higher when plant was sprayed with lower doses of SA and GA<sub>3</sub>. The superior effects on chlorophyll content were recorded under the treatments of SA and GA<sub>3</sub> at concentration of 200 ppm and 10 ppm, respectively under lower salinity level (5 dSm<sup>-1</sup>).

When plants are grown under saline conditions, photosynthetic activity decreases leading to reduced plant growth, leaf area, chlorophyll content and chlorophyll fluorescence reported by Muhammad et al. (2007). Szepesi *et al.*,(2005)reported that the positive effect of SA could be attributed to increased CO<sub>2</sub> assimilation and photosynthetic rate and increased mineral uptake by the stressed plant under SA treatment. Zeid (2011) reported an alleviation of adverse effect of salinity on chlorophyll content in barley with GA<sub>3</sub> treatment. Ali *et al.* (2012) recorded restoration of altered pigments by application of GA<sub>3</sub> under saline condition in Hibiscus sabdariffa.



**Figure 4.**Effect of plant growth regulators on chlorophyll content of chickpea under different levels of salinity stress conditions.

## CONCLUSION

From this study, it might be concluded that, salinity affects the yield, dry matter production, water relation traits and chlorophyll content of chickpea. Application of plant growth regulators likes salicylic acid and gibberellic acid @ 200 ppm and 10ppm, respectively increased number of pod/plant, 100-seed weight (g), seed yield/ plant (g), stem fresh weight as well as total dry weight, chlorophyll content, water relation traits in chickpea. Plant growth regulators also help to alleviate the adverse effects of salinity at low level (5 and 7.5 dSm<sup>-1</sup>) and show the best performance in improving the salinity tolerance in chickpea. Salicylic acid and gibberellic acid at high concentration did not show significant performance to ameliorate the adverse effect of salinity at high saline conditions. Therefore, reduction in the plant growth and yield of chickpea due to salinity stress could be ameliorate by exogenous foliar application of plant growth regulators at low concentration under low to moderate salinity stress condition.

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