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EFFECT OF FOLIAR APPLIED SALICYLIC ACID ON GROWTH AND FLOWERING OF *GAZANIA RIGENS* L. PLANT UNDER SALT STRESS

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ABSTRACT: This investigation was carried out at the nursery, Department of Floriculture, Ornamental Horticulture and Landscape Gardening, Faculty of Agriculture, Alexandria University, during 2019 and 2020 seasons. The study was a trial to investigate the effect of different levels of salinity (0, 1000, 2000 and 3000 mg/l) and different concentrations of salicylic acid sprayed on the leaves (0, 100 and 200 mg/l) and their combinations on the vegetative growth and some chemical constituents of *Gazania rigens* plants grown in plastic pots of 30 cm filled with a sandy clay soil (1:1 v/v). The results revealed that the salinity level of irrigation water was more effective than salicylic acid concentrations on the all studied characteristics of *Gazania rigens* plant. Additionally, using the tap water (control) combined with salicylic acid at 200 mg/l gave the significantly highest values of leaves number, leaves dry weight, leaves area, number of flowers per plant, flower dry weight, root length, root dry weight, chlorophyll, proline, sodium and carbohydrates (%) of the leaves. Generally, it is recommended to irrigate the plants cultivated in the sandy clay soil (1:1 v/v) three times per week with using level of saline irrigation water no more than 3000 mg/l combined with salicylic acid at the rate of 200 mg/l to induce improvements in the vegetative, floral growth and some chemical constituents of *Gazania rigens* plants.

Key words: *Gazania rigens*, salinity, irrigation water, salicylic acid.

INTRODUCTION

Gazania rigens L. is a species of flowering plants in the Asteraceae family. It is native to South Africa and consists of 16 species that are all herbal plants. It can be cultivated in temperate regions as a perennial plant and also sown in cold regions annually. This plant has become very attractive to domestic producers in the last few years because of its ornamental and medicinal properties. It is the source of relatively few products but has great economic and medical importance (Vujosevic *et al*., 2007; Moustafa *et al*., 2007). Capitula are bright with orange, yellow and red colors. The bases of the petals have a halo of dark or bright colors such as white, blue, brown and black. The flowers bloom on sunny days and stay dormant in foggy weather and nights (Moustafa *et al*., 2007).

Salinity is the one of the major environmental factors determining plant productivity and plant distribution. Salinity affects more than 10% of Arab lands. In general, desertification and salinization are rapidly increasing on a global scale, leading to declining the average yields of most major crop plants. Several researchers have reported that water salinity also has considerable effects on the growth of different ornamental tree species (Sapeta *et al*., 2013).

Salicylic acid (SA) or ortho-hydroxy benzoic acid and other salicylates are known to affect various physiological and biochemical activities of plants and may play a key role in regulating their growth and productivity and in the responses to environmental stresses (Hayat *et al*., 2010). Further, its role is evident in seed germination, fruit yield, glycolysis, flowering in thermogenic plants (Klessig and Malamy, 1994), ion uptake and transport (Harper and Balke, 1981), photosynthetic rate, stomatal conductance and transpiration (Khan *et al*., 2003). SA has been reported to induce flowering in a number of plants. Different plant species including ornamental plant *Sinningia speciosa* flowered much earlier as compared to the untreated control, when they received an exogenous foliar spray of salicylic acid (Martin-Mex *et al*., 2005). The main objective was to investigate the effect of foliar spray with salicylic acid (SA) on early flowering and to extend the flowering duration of *Gazania rigens* L. cv. Frosty Kiss Mixed.

MATERIALS AND METHODS

The present study was carried-out at the nursery, Department of Floriculture, Ornamental Horticulture and Landscape Gardening, Faculty of Agriculture, Alexandria University, Egypt during the two successive seasons of 2019 and 2020. The aim of this study was to evaluate the adverse effects of irrigation water salinity on *Gazania rigens* L. plants, and to investigate the possibility of using salicylic acid treatments to overcome these effects.

On March 15th, 2019 and 2020 (in the first and second seasons, respectively) homogenous seedlings of *Gazania rigens* L. (6-10 leaves) were individually planted in plastic pots of 30 cm diameter filled with (7 kg) mixture of sand and clay at the ratio of (1:1) by volume. The chemical constituents of the soil were determined as described by Jackson (1973) and presented in Table (1).

On April 1st (in both seasons), the saline irrigation water treatments were prepared, using sodium chloride (NaCl). The plants were irrigated three times per week using saline water concentrations of tap water (control), 1000, 2000 and 3000 mg/l. In both seasons, the plants received salicylic acid by monthly spraying from May 1st till August 1st in both seasons. The plants also were sprayed with salicylic acid at concentrations of 0, 100 and 200 mg/l. Control plants were sprayed with tap water. On August 15th (in both season), the plants were harvested.

The plants were irrigated three times per week, to keep the soil moisture at the field capacity level of the sandy clay soil (100% F.C.). The reduction in the moisture level was determined by using Moisture Tester Model KS-DI (Gypsum Block) during growing season. At the end of the experiment the total amount of irrigation water for each pot was calculated and presented in Tables (2), every plant received about 65.4 liters per pot of saline water. The field capacity of the sandy clay soil was determined by the pressure Cooker method at 1/3 atm., as described by Israelsen and Hansen (1962).

In both seasons, all plants received NPK chemical fertilization using soluble fertilizer (Milagro Aminoleaf 20-20-20) at the rate of 2 g/pot. Fertilization was repeated every 30 days throughout the growing season (from the April 15th till August 15th). In addition, weeds were removed manually upon emergence.

Data recorded :

Vegetative growth parameters:

Leaves number per plant, leaves dry weight per plant (g), leaves area (cm^2) according to Koller (1972), tillers number per plant, root length (cm), root dry weight (g), number of flower per plant and flower dry weight (g).

Chemical analysis determination:

- Chlorophylls content was determined as SPAD units of the fresh leaves of plants for the different treatments under the experiment at the end of the season using

Table 1. Chemical analysis of the used mixture soil for the two successive seasons of 2019 and 2020.

Season	pH	EC (dSm^{-1})	Soluble cations (mg/l)				Soluble anions (mg/l)		
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{--}
2019	8.11	1.40	1.7	0.9	1.6	0.65	1.3	1.38	1.10
2020	8.05	1.21	1.3	0.6	1.4	0.53	1.0	1.13	0.98

Table 2. Total amount of the water used for each plant (l/pot) in each treatment during the growing two seasons of 2019 and 2020.

Field capacity (%)	Irrigation water (l) at months of the first and second seasons						
	January	February	March	April	May	June	Total
100	4.80	9.75	11.25	12.00	13.20	14.40	65.4

Minolta (chlorophyll meter) SPAD 502 according to Yadava (1986).

- Total carbohydrates (%) of the leaves were determined according to Dubios *et al.* (1956).
- Sodium (mg/g) in the leaves was determined according to Piper (1947).
- Proline content (% of dry matter) in the leaves was determined according to Bates *et al.* (1973).

The layout of the experimental design was split plot design with three replicates. Each replicate contained three plants. The main plots were the salinity levels, while the sub plots were the concentrations of salicylic acid. Data were subjected to analysis of variance (ANOVA) using the SAS program, SAS Institute (SAS Institute, 2002). The means of the individual factors and their interactions were compared by L.S.D test at 5% level of probability according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Leaves characteristics:

Data presented in Table (3) showed that plants irrigated with tap water had the highest number of leaves (69.60 and 98.16 leaves per plant), heaviest leaves dry weights (8.71 and 12.50 g per plant) and leaves area (840.65 and 932.06 cm^2) in the first and second seasons, respectively. On the other hand, the lowest number of leaves (62.33 and 92.83 leaves per plant), lightest leaves dry weight (8.18 and 11.47 g per plant) and leaves area (696.47 and 818.70 cm^2) were obtained from plants irrigated with saline water at 3000 mg/l, in the first and second seasons, respectively. Similar results were reported by El-Shanhorey *et al.* (2015) on *Chorisia speciosa,* El-Shanhorey *et al.* (2014) on *Jatropha curcas*, Abd El-Aziz *et al.* (2006) on *Khaya senegalensis,* El- Juhany *et al.* (2008) on *Eucalyptus camaldulensis, Eucalyptus intertexta* and *Eucalyptus microtheca,* and Sharif and Khan (2009) on *Salvadora oleoides, Prosopis cineraria, Capparis decidue* and *Tamarix aphylla.* They mentioned that the decrease in vegetative growth under saline conditions was probably due to the insufficient uptake of water and nutrients.

Also, data presented in Table (3) showed that, the different salicylic acid treatments had a significant effect on *Gazania rigens* L. plants. Foliar application with salicylic acid at 200 mg/l caused a significant increase in number of leaves (70.66 and 100.62 leaves per plant), leaves dry weight (9.28 and 12.86 g per plant) and leaves area (936.35 and 1041.32 cm^2) in the first and second seasons, respectively, compared with control plants that recorded lowest number of leaves (59.41 and 90.87 leaves per plant), leaves dry weight (7.51 and 11.02 g per plant) and leaves area (593.27 and 729.34 m^2) in the two seasons, respectively.

Table 3. Means of number of leaves per plant, leaves dry weight (g) and leaves area (cm^2) of *Gazania rigens* plants as influenced by salinity (S), salicylic acid (SA) and their combinations (S×SA) in the two seasons of 2019 and 2020.

Treatments		Number of leaves per plant		Leaves dry weight (g) per plant		Leaves area (cm^2)	
Salinity (S) (mg/l)	Salicylic acid (SA) (mg/l)	2019	2020	2019	2020	2019	2020
	0	67.66	94.00	7.69	11.20	687.26	783.67
000	100	69.00	98.66	8.68	12.27	805.48	922.41
	200	72.16	101.83	9.77	14.03	1029.21	1090.10
Mean (S)		69.60	98.16	8.71	12.50	840.65	932.06
	0	55.83	90.33	7.59	11.18	564.65	762.39
1000	100	64.83	96.00	8.46	11.74	821.31	909.48
	200	71.33	101.33	9.27	12.64	969.31	1089.38
Mean (S)		63.99	95.88	8.44	11.85	785.09	920.41
	0	59.50	90.66	7.50	11.06	561.45	706.46
2000	100	63.00	95.16	8.44	11.46	628.24	905.16
	200	67.66	101.50	9.15	12.47	907.02	993.67
Mean (S)		63.38	95.77	8.36	11.66	698.90	868.43
	0	54.66	88.50	7.29	10.66	559.74	664.86
3000	100	60.83	92.16	8.31	11.46	689.80	799.12
	200	71.50	97.83	8.95	12.31	839.88	992.14
Mean (S)		62.33	92.83	8.18	11.47	696.47	818.70
	0	59.41	90.87	7.51	11.02	593.27	729.34
Mean (SA)	100	64.41	95.49	8.47	11.73	736.20	884.04
	200	70.66	100.62	9.28	12.86	936.35	1041.32
	S	3.53	7.22	0.67	0.34	109.26	48.19
L.S.D. at 0.05	SA	3.14	4.53	0.39	0.35	65.35	36.67
	S × SA	3.61	4.81	0.45	0.41	75.11	42.15

Regarding the interaction between the effect of irrigation with saline water and salicylic acid concentrations on the leaves characteristics, the data in Table (3) showed that the lowest mean values in the leaves number (54.66 and 88.50 leaves per plant), leaves dry weight (7.29 and 10.66g per plant) and leaves area (559.74 and 664.86m^2) in the first and second seasons, respectively, were obtained in plants irrigated with 3000 mg/l saline water and sprayed with tap water, while the highest mean values in the leaves number (72.16 and 101.83 leaves per plant), leaves dry weight (9.77 and 14.03g per plant) and leaves area (1029.21 and 1090.10m^2) were recorded in plants irrigated with saline water at 0 mg/l and sprayed with salicylic acid at 200 mg/l, in the first and second seasons, respectively. Similar results were reported by El-Juhany and Aref (2005) on *Conocarpus erectus*, Abd El-Aziz *et al.* (2006) on *Khaya senegalensis*, Sayed (2006) on *Ficus alii*, El-Juhany *et al.* (2008) on *Eucalyptus camaldulensis*, *Eucalyptus intertexta* and *Eucalyptus microtheca* and Sharif and Khan (2009) on *Salvadora oleoides*, *Prosopis cineria*, *Capparis decidue* and *Tamarix aphylla*. Data showed that foliar spray with salicylic acid positively affected some vegetative growth traits of gazania plant. The improvement of vegetative qualities as a result of spraying with salicylic acid may be due to its role in different functions. It is a cofactor for the enzymes involved in a variety of processes including flavonoids, plant hormones synthesis, and xanthophyll cycle (Tullio and Arrigoni, 2004). In addition, higher nutrients uptake and their bioavailability to different cell metabolism is generally enhanced under higher salicylic acid content (Souri and Bakhtiarizade, 2019).

Rooting characteristics:

Data presented in Table (4) showed that the tested saline irrigation water significantly decreased the root characteristics of *Gazania rigens* L., compared with plants irrigated with tap water (control). Plants irrigated with tap water had the highest mean number of tillers of (6.82 and 10.11 per plant), longest root (25.16 and 36.49 cm) and heaviest root dry weight of (2.13 and 3.31 g) in the first and second seasons, respectively, while the lowest number of tillers of (6.21 and 9.71 per plant), shortest root (23.71and 34.16 cm) and lightest root dry weight (1.99 and 2.96 g) were obtained from plants treated with saline water at the concentration of 3000 mg/l in the first and second seasons, respectively.

Data presented in Table (4) indicated that salicylic acid treatments had significant effects on the root characteristics. Plants sprayed with salicylic acid at 200 mg/l gave the highest number of tillers of (7.32 and 10.49 per plant), longest root (26.74 and 39.12 cm) and heaviest root dry weight (2.28 and 3.51 g per plant) in the first and second seasons, respectively, compared with the control plants giving the lowest number of tillers (5.95 and 8.99 per plant), shortest root (21.87 and 31.91 cm) and lightest root dry weight (1.78 and 2.78 g per plant) in the first and second seasons, respectively.

Regarding the interaction between irrigation using saline water and salicylic acid concentrations on the root characteristics, data presented in Table (4) showed that the lowest mean values in the number of tillers (5.66 and 9.16 per plant), shortest root (21.66 and 30.50 cm), and lightest root dry weight (1.73 and 2.52 g per plant) in the first and second seasons, respectively, were obtained for plants irrigated with 3000 mg/l saline water and sprayed with tap water, while the highest means values in the number of tillers of (7.66 and 11.50 per plant), root length of

Table 4. Means o of number of tillers per plant, root length (cm) and root dry weight (g) of *Gazania rigens* plants as influenced by salinity (S), salicylic acid (SA) and their combinations (S×HA) in the two seasons of 2019 and 2020.

Treatments		Number of tillers per plant		Root length (cm)		Root dry weight (g)	
Salinity (S) (mg/l)	Salicylic acid (SA) (mg/l)	2019	2020	2019	2020	2019	2020
	0	6.16	8.83	22.16	32.83	1.90	3.05
000	**100**	6.66	10.00	25.66	36.66	2.19	3.25
	200	7.66	11.50	27.66	40.00	2.30	3.65
Mean (S)		6.82	10.11	25.16	36.49	2.13	3.31
	0	6.00	8.83	22.00	32.33	1.79	2.90
1000	**100**	6.50	10.00	25.33	35.33	2.11	3.18
	200	7.66	10.16	27.33	39.66	2.31	3.59
Mean (S)		6.72	9.66	24.88	35.77	2.07	3.22
	0	6.00	9.16	21.66	32.00	1.73	2.66
2000	**100**	6.16	9.83	23.00	34.66	2.02	3.18
	200	7.33	10.16	25.66	39.50	2.27	3.49
Mean (S)		6.49	9.71	23.44	35.38	2.00	3.11
	0	5.66	9.16	21.66	30.50	1.73	2.52
3000	**100**	6.33	9.83	23.16	34.66	1.99	3.06
	200	6.66	10.16	26.33	37.33	2.26	3.32
Mean (S)		6.21	9.71	23.71	34.16	1.99	2.96
	0	5.95	8.99	21.87	31.91	1.78	2.78
Mean (SA)	**100**	6.41	9.91	24.28	35.32	2.07	3.16
	200	7.32	10.49	26.74	39.12	2.28	3.51
	S	0.38	0.26	1.00	3.17	0.09	0.17
L.S.D. at 0.05	**SA**	0.39	0.27	1.20	2.60	0.11	0.08
	S × SA	0.45	0.32	1.37	2.99	0.13	0.09

(27.66 and 40.00 cm) and root dry weight (2.30 and 3.65 g per plant) in the first and second season, respectively, were recorded in plants irrigated with saline water at 0 mg/l and sprayed with salicylic acid at 200 mg/l. Similar results were reported by El-Shanhorey *et al.* (2015) on *Chorisia speciosa,* El-Shanhorey *et al.* (2014) on *Jatropha curcas*, El-Feky (2004) on *Erythrina indica* and *Tecoma stans*, Abd El-Aziz *et al.* (2006) on *Khaya senegalensis* and Sayed (2006) on *Ficus alii*.

Flowering parameters:

Data presented in Table (5) show the effect of saline water on flowers of *Gazania rigens* L. plants. In both seasons, plants irrigated with tap water had the highest number of flowers per plant (17.05 and 24.16) and heaviest flower dry weight (6.05 and 8.57 g) in the first and second seasons, respectively. Accordingly, the lowest number of flowers per plant (15.10 and 22.88) and lightest flower dry weight (5.36 and 8.11 g) in the first and second seasons, respectively, were obtained from the plants irrigated with the highest saline water concentration (3000 mg/l).

Concerning the effect of salicylic acid treatments on the flowering, data recorded in Table (5) show that the treatment of salicylic acid at 200 mg/l caused significant increases in number of flower per plant (17.24 and 24.79) and flower dry weight (6.11 and 8.79 g) in the first and second seasons, respectively, compared to that of the control plants in number of flower per plant (14.49 and 22.29) and flower dry weight (5.14 and 7.90 g) in the first and second seasons, respectively.

Data presented in Table (5) showed significant interaction in both seasons between irrigation with saline water and salicylic acid treatments on flowering parameters. Combination between irrigation

Table 5. Means of number of flowers per plant and flower dry weight (g) of *Gazania rigens* plants as influenced by salinity (S), salicylic acid (SA) and their combinations (S×SA) in the two seasons of 2019 and 2020.

Treatments		Number of flowers per plant		Flower dry weight (g)	
Salinity (S) (mg/l)	Salicylic acid (SA) (mg/l)	2019	2020	2019	2020
	0	16.66	23.00	5.91	8.16
000	**100**	16.83	24.33	5.97	8.63
	200	17.66	25.16	6.27	8.93
Mean (S)		17.05	24.16	6.05	8.57
	0	13.66	22.00	4.84	7.80
1000	**100**	15.66	23.66	5.56	8.39
	200	17.33	25.00	6.14	8.87
Mean (S)		15.55	23.55	5.51	8.35
	0	14.50	22.33	5.14	7.91
2000	**100**	15.33	23.50	5.44	8.34
	200	16.50	25.00	5.85	8.87
Mean (S)		15.44	23.61	5.47	8.37
	0	13.16	21.83	4.67	7.74
3000	**100**	14.66	22.83	5.20	8.10
	200	17.50	24.00	6.21	8.51
Mean (S)		15.10	22.88	5.36	8.11
	0	14.49	22.29	5.14	7.90
Mean (SA)	**100**	15.62	23.58	5.54	8.36
	200	17.24	24.79	6.11	8.79
	S	0.94	1.84	0.33	0.65
L.S.D. at 0.05	**SA**	0.77	1.09	0.27	0.38
	S × SA	0.89	1.25	0.31	0.44

using tap water and spraying the plants with salicylic acid at 200 mg/l gave the highest number of flowers per plant (17.66 and 25.16) and heaviest flower dry weight (6.27 and 8.93 g) in the first and second seasons, respectively. On the other hand, the lowest number of flower per plant (13.16 and 21.83) and lightest flower dry weight (4.67 and 7.74 g) in the first and second seasons, respectively, were obtained from plants irrigated with the highest saline water concentration of 3000 mg/l and sprayed with salicylic acid at 0 mg/l. Data showed that foliar spray with salicylic acid had a positive effect on most floral qualities of gazania. The improvement of floral qualities as a result of spraying with salicylic acid may be due to the fact that salicylic acid is a phenolic compound that enables plants to survive under challenging soil and environmental situations. Salicylic acid plays key roles in regulation of various physiological and developmental processes of plants (Souri and Tohidloo, 2019). These positive effects may be due to the role of salicylic acid in increasing the plant content of internal hormones such as gibberellins, auxins and cytokinines, thus increasing cell division and elongation and ultimately promoting plant growth and development (Hayat and Ahmed, 2007). Similarly, data of this study showed that treatment with salicylic acid caused increase in number and flower diameter and dry weight of flower. This result may be due to the role of salicylic acid in improving vegetative growth and that leads to an increase in the absorption of nutrients, also it promotes photosynthesis in plant that leads to higher carbohydrate biosynthesis (Souri and Tohidloo, 2019) toward higher flower differentiation and inductions. Application of salicylic acid can also increase auxin levels and therefore flower growth (Hayat and Ahmed, 2007; Zamani *et al.,* 2011). Improvement of floral growth qualities of gazania due to foliar spray with salicylic acid in this study is in agreement with those results obtained by Pacheco *et al.* (2013) on *Calendula officinalis* and Sardoei *et al.* (2014) on *Petunia hybrida*.

Chemical analysis:

The results presented in Table (6) showed that the highest content of chlorophyll was obtained in plants irrigated with tap water (57.33 and 55.83 SPAD) in the first and second seasons, respectively. Increasing saline water levels resulted in steady significant reductions in the chlorophyll content, which reached its lowest values after treatment with 3000 mg/l (49.83 and 48.97 SPAD) in the first and second seasons, respectively. The percentages of carbohydrates, proline and sodium in dried leaves of plants were decreased steadily with increasing the saline concentration in the irrigation water. The highest percentages of carbohydrates (5.82 and 5.82%), proline value (4.75 and 4.72 mg/g) and sodium (81.21 and 82.21%) in the first and second seasons, respectively, were found in plants irrigated with 3000 mg/l saline water, whereas the lowest mean values of carbohydrates (4.60 and 4.57%), proline (3.52 and 3.59 mg/g) and sodium (51.22 and 51.77%) in the first and second seasons, respectively, were found in control plants.

Moreover, Table (6) illustrated that salicylic acid treatments had a clear positive effect on the chlorophyll content. Mean values ranged from (54.03 and 54.21 SPAD) in the first and second seasons, respectively, in plants sprayed with 0 mg/l salicylic acid to (52.90 and 51.20 SPAD) in plants sprayed with 100 mg/l salicylic acid in the first and second seasons, respectively. Salicylic acid treatments had a clear positive effect on the percentage of carbohydrates, proline and sodium. Among the plants receiving the different salicylic acid treatments, plants sprayed with 200 mg/l salicylic acid had the highest carbohydrates percentage in their leaves (5.28 and 5.26 %), proline value (4.35 and 4.37 mg/g) and sodium (72.83 and 73.49 %) in the first and second seasons, respectively, compared with the control plants giving carbohydrates percentage in their leaves of (5.21 and 5.21 %), proline

Table 6. Means of chlorophyll content (SPAD), carbohydrates (%), proline (mg/g) and sodium t (%) of *Gazania rigens* plants as influenced by salinity (S), salicylic acid (SA) and their combinations (S×SA) in the two seasons of 2019 and 2020.

Treatments		Chlorophyll content (SPAD unites)		Carbohydrates (%)		Proline (mg/g)		Sodium (% d.w.)	
Salinity (S) (mg/l)	Salicylic acid (SA) (mg/l)	2019	2020	2019	2020	2019	2020	2019	2020
	0	58.26	58.78	4.68	4.67	3.71	3.74	52.33	54.00
000	100	53.31	48.45	4.51	4.48	3.47	3.58	52.33	52.33
	200	60.42	60.28	4.63	4.57	3.40	3.46	49.00	49.00
Mean (S)		57.33	55.83	4.60	4.57	3.52	3.59	51.22	51.77
	0	55.08	56.07	4.89	4.88	3.40	3.46	45.00	46.33
1000	100	59.80	51.57	5.01	5.00	4.45	4.56	77.66	81.00
	200	48.65	56.11	5.09	5.07	4.29	4.42	73.33	74.66
Mean (S)		54.51	54.58	4.99	4.98	4.04	4.14	65.33	67.33
	0	55.61	54.05	5.38	5.36	4.21	4.34	64.33	65.66
2000	100	47.21	55.12	5.46	5.45	4.24	4.36	65.66	67.00
	200	54.84	53.30	5.53	5.52	4.96	4.94	92.66	92.66
Mean (S)		52.55	54.15	5.45	5.44	4.47	4.54	74.21	75.10
	0	47.18	47.95	5.92	5.95	4.77	4.77	86.66	86.66
3000	100	51.28	49.69	5.65	5.63	4.74	4.70	80.66	82.33
	200	51.04	49.29	5.90	5.89	4.76	4.69	76.33	77.66
Mean (S)		49.83	48.97	5.82	5.82	4.75	4.72	81.21	82.21
	0	54.03	54.21	5.21	5.21	4.02	4.07	62.08	63.16
Mean (SA)	100	52.90	51.20	5.15	5.14	4.22	4.30	69.07	70.66
	200	53.73	54.74	5.28	5.26	4.35	4.37	72.83	73.49
	S	5.04	8.69	0.03	0.02	0.10	0.06	1.77	1.67
L.S.D. at 0.05	SA	4.64	4.86	0.01	0.02	0.05	0.05	2.44	1.81
	S × SA	5.33	5.59	0.01	0.03	0.06	0.05	2.80	2.07

value (4.02 and 4.07 mg/g) and sodium (62.08 and 63.16 %) in the first and second seasons, respectively.

Data presented in Table (6) clearly showed that a significant interaction was detected between the effects of plants irrigated with saline water and salicylic acid treatments. The highest chlorophyll content (60.42 and 60.28 SPAD) in the first and second seasons, respectively, was obtained from plants irrigated with tap water and sprayed with salicylic acid at 200 mg/l. On the other hand, the lowest chlorophylls content (47.18 and 47.95 SPAD) was recorded in the first and second seasons, respectively, for plants irrigated by 3000 mg/l saline water combined with 0 mg/l salicylic acid treatment. The lowest percentages of carbohydrates were (4.63 and 4.57%), proline value (3.40 and 3.46 mg/g) and sodium (49.00 and 49.00%) were obtained from plants irrigated with tap water and sprayed with salicylic acid at 200 mg/l. On the other hand, the highest percentages of carbohydrates (5.92 and 5.95%), proline value (4.77 and 4.77 mg/g) and sodium (86.66 and 86.66 %) in the first and second seasons, respectively, were obtained from plants irrigated by the highest saline water concentration at 3000 mg/l combined with salicylic acid at 0 mg/l. The results are in agreement with those reported by El-Shanhorey *et al.* (2015) on *Chorisia speciosa,* El-Shanhorey *et al.* (2014) on *Jatropha curcas*, Campos *et al.* (2012) on *Jatropha curcas*, El-Feky (2004) on *Erythrina indica* and *Tecoma stans*, Woodward and Bennett (2005) on *Eucalyptus camaldulensis*, Helmy (2004) on *Senna occidentalis* and Kumar *et al.* (2003) on *Morus alba,* as the highest carbohydrates in leaves of plants irrigated using saline

water may be attributed to the reduction in the chlorophyll as a result of the salinity treatments. This reduction in the chlorophyll content leads to a reduction in the rate of photosynthesis which occurs within the leaf tissues, leading in turn to a reduction in the synthesis and accumulation of carbohydrates. The considerable enhancement of proline accumulation in plants irrigated using high salt concentrations may lead to the conclusion that proline plays a role in plant tolerance to salinity. So, proline can be considered as a stabilizer of osmotic pressure within the cell. Increases in the Na contents with increasing the salinity level have been reported by Franklin *et al.* (2002) on *Pinus banksiana*, and Cassanitia *et al.* (2009) on a number of ornamental shrubs. Proline content in pea leaves rose with decreasing irrigation level up to the lowest one. Spraying plants with salicylic acid at 100 ppm had a positive significant influence in photothynthetic pigments (chlorophyll a+b and carotenoids) as well as proline content under drought stress (El-Saadony *et al.,* 2017).

CONCLUSION

The results of the vegetative growth and chemical constituents, showed that the best spraying treatments salicylic acid is 200 mg/l, while the results showed better irrigation with tap water (control). But in the audit results can find it with salt water irrigation 1000 mg/l as less loss in the growth rates of plants. From these results, the plants can be irrigated with water of lower quality (water drainage) up salinity faithful to 1000 mg/l as it can reduce the damage caused by the increasing salinity of the incident on the plants sprayed once a month, salicylic acid at a rate of 200 mg/l.

Generally, the obtained results showed that *Gazania rigens* L. plants irrigated three times per week with the level of saline irrigation water no more than 2000 mg/l along with salicylic acid at a rate of 200 mg/l gave improvements for good vegetative growth and some chemical components of plants *Gazania rigens* L. planted in sandy clay soil.

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تأثير الرش بحمض السلسليك على النمو وإزهار نبات الجازانيا تحت الأجهاد الملحي

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أجريت هذه الدراسة خلال موسمي ٢٠١٩ و ٢٠٢٠ على نباتات الجازانيا المزروعة في الأواني البلاستيكية ذات قطر ٣٠ سم في مشتل كلية الزراعة ، جامعة الإسكندرية ، مصر. ويهدف هذا البحث لدراسة تأثير مستويات مختلفة من الملوحة (٠، ١٠٠٠، ٢٠٠٠ و ٣٠٠٠ جزء في المليون) وكذلك تركيزات مختلفة من حمض السالسليك (رشا على الأوراق) بتركيزات (٠، ١٠٠، ٢٠٠ جزء في المليون) على النمو الخضري والزهرى وبعض المكونات الكيميائية لنباتات الجازانيا المزروعة في التربة الرملية الطميية (١:١). أوضحت النتائج أن مستوى ملوحة ماء الري كان أكثر فعالية من نسب حمض السالسليك على الخصائص التى تم دراستها على نباتات الجازانيا. أيضا استخدام ماء الصنبور (كنترول) مع حمض السالسيلك بتركيز ٢٠٠ مليجرام/لتر أعطى أعلى القيم لكل من عدد الأوراق للنبات، الوزن الجاف للأوراق، مساحة الأوراق، عدد الأزهار لكل نبات، الوزن الجاف للزهرة، طول الجذر، الوزن الجاف للجذر، محتوى الأوراق من

الكلوروفيل، محتوى الأوراق من البرولين ، النسبة المئوية للصوديوم، الكربوهيدرات فى الأوراق. عموما، ينصح بري نباتات الجازانيا المزروعة في التربة المخلطة (طمى+رمل) ثلاث مرات كل أسبوع مع استخدام مستويات ملوحة بماء الري لا يزيد عن ٣٠٠٠ مليجرام/لتر متداخلة مع حمض السالسليك بمعدل ٢٠٠ مليجرام/لتر أدى إلى تحسن جيد فى النمو الخضري والزهرى وبعض المكونات الكيميائية لنباتات الجازانيا.