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EFFECT OF GIBBERLLINE SPRAY ON GROWTH AND SOME CHEMICAL CONSTITUENTS OF *Calendula officinalis*, L. PLANTS GROWN UNDER DILUTED SEA WATER CONDITIONS.

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ABSTRACTS

This study was carried out during two successive seasons of 2003/04 and 2004/05 on pot marigold plant (*Calendula officinalis*, L.) at the Experimental Station of Ornamental plants, Fac. of Agric., Mansoura Univ., aiming to study the effect of different salinity levels of diluted sea water (2.5, 5 and 10 %), which were equivalent to the application of 825,1650 and 3300 ppm, respectively, and three gibberelline concentrations (25, 50 and 100 ppm), in addition to their interacting effect on growth and chemical constituents.

The results showed that salinity levels in most cases led to lower values of plant height (cm), stem diameter (cm), number of leaves and inflorescences, dry weights of herb (g), the contents of chlorophyll a, b in the leaves, flowers content of carotenoids as well as N, P and K percentages in the two seasons.

Gibberellic acid at all concentrations considerably improved the prementioned growth parameters and the three photosynthetic pigments content, however, the medium and high concentrations (50 and 100 ppm) were, in most cases, the most effective treatments. Moreover, application of GA_3 significantly increased concentration of N, P and K in the leaves which were increased parallel to the increase in the gibberellic acid concentrations in the two seasons.

It could be concluded that gibberellic acid at 50 and 100 ppm was effective in alleviating the harmful or the impaired effects caused by salinity on different vegetative traits and chemical composition which reflected, in turn, on growth and development of plants.

INTRODUCTION

Calendula officinalis, L. (pot marigold) which belongs to family *Asteraceae* is considered as one of the most popular winter annual flowering plants. This herbaceous plant is a native plant of the Mediterranean region (Earle *et al.*, 1964), and is grown widely across Europe and North America as an ornamental and medicinal plant. It is grown as an ornamental plant for planting in beds and borders and the plants carry bright yellow and orange colours of flowers which make them an attractive cut flowers. Besides the flowers are utilized as aromatic drug as an antiseptic and anti-inflammatory, activities (Boucaurd-Maitre *et al.*, 1988). Moreover, the flower petals are rich in carotenoids which are very important in the food industries as a natural colored materials.

Recently, a considerable attention has been directed to the expansion of ornamental and medicinal plants in the newly reclaimed areas which represents the great hope in increasing our cultivated land and consequently the economic agricultural production. On the other hand, and due to the restricted resources of the fresh water from the River Nile, the use of saline water or even diluted sea water becomes one of the sources of irrigation water in such newly cultivated areas and new resorts in Egypt where the water resources for agriculture are very limited. Thus, it is requisite to improve the salinity tolerance of calendula plants and consequently enhancing their ability to tolerate salinity which, in turn, increasing the possibility of their successful cultivation in such newly reclaimed areas.

Salinity remains one of the most serious problems influencing the productivity of agricultural system around the world. Under Egyptian conditions, salinity of water and soil became the most serious factor contributes to the considerable reductions in productivity of many crops. Salinity induces reduction in growth and yield which, generally, caused by salt ion direct specific toxic effects (Nou *et al*., 1995), ion and nutritional imbalances (Liu and Zhu, 1998) paralleled with membrane destabilization (Hasegawa *et al*., 2000), hyperosmotic stress (Greenway and Munns, 1980) followed by turger declines lead to suppression of cell division, elongation and less expansion growth and reduced photosynthesis (Pasternak, 1987). As a result, the stressed plants became severely susceptible to osmotic/turger effects, specific salt ions toxic effects, nutritional imbalances and disorders and energy lack. Thereby impaired chlorophyll, carbohydrate and protein metabolism, in turn, serious growth and yield decline with salinity (Abdalla *et al*., 1980; EL-Labban *et al*., 1988; Chakraborty and Sadhu, 1990; Abbas, 1992; EL-Khateeb and Salim, 1994; Dawh *et al*., 1998; Hasegawa, 2000; Habib, 2002; Mostafa, 2002; Mansour, 2003 as well as EL-Hindi and EL-Ghamry, 2005).

Increasing salty soil areas in the recent years in different regions in Egypt has suggested the competency of such important plant to grow under different levels of salinity. One of the main striking advantages of gibberellic acid is its ability to alleviate, modify or counteract the adverse effects of soil salinity on plant growth and development.

Gibberellic acid is known to have desirable and including effects on vegetative growth characters and decrease the photosynthetic pigments content of many ornamental plants. Ahmed and Aly (1998) on *Acacia saligna* seedlings found that GA_3 at concentrations of 50, 100 and 200 ppm was effective in increasing seedling height, number of leaves per seedling, fresh and dry weights of seedlings and decreasing stem diameter and number of branches per seedling. They concluded that GA_3 at all concentrations significantly reduced chlorophyll a, b and carotenoids contents in the leaves. Similar results were observed by Aly *et al*., (1989) on *Achilla millefolium*, Dawh *et al*., (1989) on *Ocimum basilicum*, EL-Sayed (1991) on *Calendula officinalis*, Shehata and EL-Tantawy (1994) on *Melia azedarach*, Ahmed (1999) on *Robinia pseudoacacia*, Balbaa (2002) on *Lavendula officinalis* and Eid *et al*., (2004) on *Casurina glauca*.

The objective of this study was to examine the effectiveness of the treatment with foliar application of GA_3 on improving salinity tolerance of the calendula plants grown under different levels of salinity (% sea water).

MATERIALS AND METHODS

This trial was conducted during the two successive seasons of 2003/2004 and 2004/2005 at the Experimental Station of the Fac. of Agric., Mansoura Univ. Before planting, both physical and chemical analysis of the soil under investigation were undertaken according to Jackson (1973) and the data are presented in (Table 1).

Table (1): Some physical and chemical characteristics of the experimental soil during 2002/03 and 2003/04 season.

Physical analysis	Values		Chemical analysis	Values	
	2002/03	2003/04		2002/03	2003/04
Sand (%)	27.9	27.2	Total N (%)	0.12	0.10
Silt (%)	31.5	31.9	Available P (ppm)	11.2	11.0
Clay (%)	40.6	40.9	Exchangeable K (ppm)	304	293
Texture class	Clay-Loam				
$CaCO_3$ (%)	3.6	3.4	pH	7.9	7.7
OM (%)	2.3	2.4	EC	0.9	0.7

Seeds were provided by Hort. Res. Station, Seeds, Dokky, Cairo, Egypt and were sown in the nursery beds on Sept. 25th of both seasons, then transplanted 45 days later in 30 cm diameter earthenware pots filled with ten kg clay loam soil as in Table (1). After three weeks, the plants were treated by the different saline water concentrations. Four levels of Salinity at the rate of 0.0, 2.5, 5 and 10 % sea water, obtained from Mediterranean sea, Gamasa region, Dakahlia Governorate (EC = 51.56, dSm^{-1} = 32998.4 ppm about 33000 ppm) were applied with each treatment of foliar application of gibberlline which were foliar sprayed as 4 treatments with 3 replicates each of which included 36 plants as follows :

a- Water Salinity :

1- The control treatment (irrigation with tap water).
2- Irrigation with tap water salinized with 25 ml sea water/1L (825 ppm).
3- Irrigation with tap water salinized with 50 ml sea water/1L (1650 ppm).
4- Irrigation with tap water salinized with 100 ml sea water/1L (3300 ppm).

After planting seedlings were irrigated with using tap water for 11 days, then they were irrigated with the dilluted see water at concentrations of 825, 1650 and 3300 ppm. The untreated plants (control) were irrigated with tap water (250 ppm). At each irrigation, the plants were watered till 65 – 70% of soil field capacity (F.C.). The soil moisture tension was measured before each irrigation using microtensiometers, and the quantity of water needed to reach 65 – 70% F.C. was calculated, as described by Richards (1949). The treatments were applied regularly until the termination of each season. The chemical analysis of sea water is presented in (Table 2).

Table (2) : Sea water analysis (ppm).

Na	Mg	K	Ca	S	Cl	Br
10770	1290	380	412	905	19400	65

b- Gibberellic acid (GA_3) :

Plant foliage sprayed with GA_3 till run off 3 times starting one month from transplanting with 2-week intervals by three concentrations of gibberellic acid (GA_3) namely 25, 50 and 100 ppm. All seedlings treatment, including control ones, were fertilized by 2 g ammonium nitrate (33.5 % N), 2.5 g calcium superphosphate (15.5 % P_2O_5) and 1.25 g potassium sulfate (48 % K_2O) per pot after 3-weeks from transplanting date. All other agricultural practices were performed as usual. The statistical layout of the experiment was a completely randomized design (CRD) of 2 factors factorial (3 GA_3 concentrations x 3 salinity concentrations) with three replicates, each replicate contained fifteen pots.

The data were recorded at the end of the experiment which included; plant height (cm), branch number/plant, herb dry weight/plant (g), flowering date (number of days from transplanting till first flower appearance), flower diameter and total flowers number, fresh weight and dry weight/plant (flowers were collected four times at two week intervals during the flowering period). Also, chlorophyll a and b in the leaves and carotenoids in the flowers were determined according to Holzl (1987) while, N, P and K % in the leaves were determined following the method described by Page *et al.*, (1982). The obtained data were statistically analyzed and means of treatments were compared by L.S.D method according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1. Effect of different salinity levels of diluted sea water and GA_3 on some growth characters :

Data presented in Table (3) show that there was significant reduction in all vegetative growth parameters, i.e. plant height (cm), dry weight (g/plant), number of branches/plant and herb dry weight (g/plant) due to using all saline water treatments compared to unsalinized plants. In both seasons, the mean values recorded for the different growth parameters were decreased steadily as the salt concentration was increased especially with the high level (10 %). In agreement with these results were those obtained by Abd EL-Kafie (1995) on *Salvia officinalis*, Dawh *et al.*, (1998) on *Tagetes erecta*, Habib (2002) on *Bougainvillea* Ms. Butte and EL-Hindi and EL-Ghamry (2005) on cherrygold.

The inhibitory effect of salinity on plant height may be due to the decrease in cell size and number of cells per unit area (Strogonov, 1964) as well as suppression of meristimatic activity (Nieman and Leon, 1959). Nieman (1965) and Kurth *et al.*, (1986) attributed the inhibition effects of salinity to its effects on cell division, cell elongation and/or inhibition of apical growth as well as hormone unbalance. Moreover, (Strogonov *et al.*, 1970) concluded that absorption of chloride salts from saline media and their accumulation up to a toxic level may affect the metabolic activity of plant tissues and causes the appearance of some intermediate toxic compounds consequently a decrease in plant growth seems to be due to the high respiration rate (Burchetts *et al.*, 1989), disturbance in various metabolic processes such as net photosynthesis (Robinson *et al.*, 1983 and Yeo *et al.*, 1985), ionic balance (Torres-Schumann *et al.*, 1989), hormone balance (Kavikishor, 1989) and water absorption (Passarakli *et al.*, 1989).

Table (3) : Effect of different salinity levels of diluted sea water and GA_3 concentrations on plant height (cm), branch number/plant and herb dry weight/plant (g) of *Calendula officinalis* during 2003/04 and 2004/05 seasons.

Salinity level% (A)	First season					Second season				
	GA_3 concentration (ppm) (B)					GA_3 concentration (ppm) (B)				
	0	25	50	100	Mean A	0	25	50	100	Mean A
					Plant height (cm)					
0.0	58.8	64.1	65.5	68.85	64.31	71.75	72.45	69.75	72.25	71.55
2.5	53.35	58.8	57.8	61.35	57.83	66.85	64.35	64.85	64.45	65.13
5.0	51.55	57.15	58.25	59.75	56.68	65.05	62.45	62.9	62.4	63.20
10.0	50.55	56.15	57.25	58.75	55.68	61.55	58.95	59.4	59.35	59.81
Mean B	53.56	59.05	59.70	62.18	---	66.30	64.55	64.23	64.61	---
L.S.D at 5%	A: 1.15		B: 1.15		AB: N.S	A: 1.55		B: 1.55		AB: N.S
					Number of branches / plant					
0.0	10.50	11.00	10.95	12.05	11.13	10.20	10.80	11.15	11.70	10.96
2.5	10.00	10.35	10.15	10.75	10.31	9.40	10.10	10.60	10.40	10.13
5.0	9.00	9.35	9.35	9.70	9.35	8.40	9.10	9.40	9.40	9.08
10.0	8.50	8.85	8.85	9.20	8.85	7.90	8.60	8.90	8.90	8.58
Mean B	9.50	9.89	9.83	10.43	---	8.98	9.65	10.01	10.10	---
L.S.D at 5%	A: 0.22		B: 0.22		AB: N.S	A: 0.22		B: 0.22		AB: N.S
					Herb dry weight / plant (g)					
0.0	380.5	388.5	394.5	425.0	397.1	404.5	430.0	434.5	445.0	428.5
2.5	353.5	361.5	367.5	372.0	363.6	396.0	403.0	407.5	418.0	406.1
5.0	338.5	346.5	352.5	357.0	348.6	372.0	388.0	392.5	400.5	388.3
10.0	328.5	336.5	341.0	347.0	338.3	370.0	378.0	383.0	390.5	380.4
Mean B	350.3	358.3	363.9	375.3	---	385.6	399.8	404.4	413.5	---
L.S.D at 5%	A: 6.0		B: 6.0		AB: 12.0	A: 8.8		B: 8.8		AB: N.S

Data concerning the effect of GA_3 on such criteria show that there was a gradual stimulation on plant height and number of branches and herb dry weight per plant with increasing GA_3 concentration from 0.0 to 100 ppm. Neglected and insignificant increase in such aspects were observed between spraying 50 and 100 ppm.

These results are in harmony with those reported by EL-Khateeb (1989) on *Rosmarinus officinalis*, Saker (1995) on *Chrysanthemum* cultivars, Naglaa (2001) on *Iris tingitana* and Balbaa (2002) on *Lavendula officinalis*.

The stimulatory effect of gibberellic acid (GA_3) on plant growth of pot marigold plants might be due to an increase in internode elongation which, in turn, was oftenly a consequence of increased cell wall extension. This might be explained on basis of striking increase in cell membrane permeability according to Wood and Paleg (1972), Vlitose and Most (1973) and Zee (1976). It may, also, be due to the stimulatory effect of GA_3 on auxin action as previously described by Kuraishi and Muir (1963).

The effect of interactions between saline irrigation water and GA_3 was, also, indicated in Table (3), it was clear that a significant increasing effect for these interactions was observed on plant growth except plant height which did not reach the level of significance at 5 % comparing with untreated plants with GA_3 under different salinity levels in all cases in the two seasons. Otherwise, increasing salinity level up to 10% under each level of GA_3 decreased plant growth compared to GA_3, treatments alone. Also, it was cleared that using GA_3, especially at the highest concentrations reduced the harmful effect of saline water treatments. The superior interaction in this respect was 100 ppm interacted with 2.5 % salinity level during both seasons. While, that of 25 ppm GA_3 and 10 % salinity gave the lowest plant growth. Similar results were found by Eid and Azza (2004) on *Casuarina glauca*, who reported that under high salinity levels in irrigation water spraying plants with GA_3 solely or in combinations at certain levels greatly overcome the harmful effect of salinity on plant growth.

As for the effect of irrigation with saline water at all concentrations significantly decreased marigold flower characters compared to unsalinized control plants (Tables 4,5). In both seasons, plants irrigated with tap water (control) gave the highest values of flowering characters. While, raising the salt concentration resulted in a gradual reduction in these parameters, since the highest salt concentration (10 % sea water) gave the lowest values for flowering date, total flower number per plant, average flower diameter (cm), total fresh weight of flowers/plant (g) and total dry weight of flowers/plant (g) in the two seasons. In general, a gradual decrease in the flowering characters was observed as salinity level increased.

This result may be due to the presence of chloride ions in the cell sap which greatly induced plant respiration (salt respiration) leading to depression of carbohydrates synthesis within plant tissues, consequently reflected on low production per plant as salinity level increased in the medium (Abbas, 1992). In harmony with these findings were those reported by EL-Sayed (1991); Abd EL-Kafie (1995); Mostafa, (2002) and EL-Hindi and EL-Ghamry (2005).

Table (4) : Effect of different salinity levels of diluted sea water and GA_3 concentrations on flowering age (days), total flower number/plant and average flower diameter (cm) of *Calendula officinalis* during 2003/04 and 2004/05 seasons.

Salinity level% (A)	First season					Second season				
	GA_3 concentration (ppm) (B)					GA_3 concentration (ppm) (B)				
	0	25	50	100	Mean A	0	25	50	100	Mean A
					Flowering date (days)					
0.0	123.0	130.0	131.5	133.5	129.5	121.0	123.0	120.0	115.0	119.8
2.5	119.0	124.0	125.5	127.5	124.0	134.0	128.0	125.0	120.0	126.8
5.0	116.0	121.0	122.5	124.5	121.0	139.0	133.0	130.0	124.0	131.5
10.0	111.0	116.0	118.5	120.0	116.4	141.0	135.0	132.0	127.0	133.8
Mean B	117.3	122.8	124.5	126.4	---	133.8	129.8	126.8	121.5	---
L.S.D at 5%	A: 2.5		B: 2.5		AB: N.S	A: 3.9		B: 3.9		AB: N.S
					Total flower number / plant					
0.0	104.85	109.35	111.9	112.65	109.68	108.05	112.85	114.05	115.30	112.56
2.5	95.85	100.35	102.9	103.65	100.68	99.05	103.85	105.05	106.30	103.56
5.0	89.85	94.35	96.9	97.65	94.68	93.05	97.85	99.05	100.30	97.56
10.0	85.85	90.35	92.9	93.65	90.68	89.05	93.85	95.05	96.30	93.56
Mean B	94.10	98.60	101.15	101.90	---	97.30	102.1	103.3	104.6	---
L.S.D at 5%	A: 0.92		B: 0.92		AB: N.S	A: 1.90		B: 1.90		AB: N.S
					Average flower diameter (cm)					
0.0	5.14	5.47	5.24	5.14	5.25	4.50	4.71	5.08	5.36	4.91
2.5	4.79	4.82	4.89	4.79	4.82	4.65	4.36	4.45	4.61	4.53
5.0	4.59	4.62	4.69	4.59	4.62	4.45	4.16	4.25	4.40	4.32
10.0	4.39	4.42	4.49	4.39	4.42	3.89	3.96	4.05	4.21	4.03
Mean B	4.73	4.83	4.83	4.73	---	4.37	4.29	4.46	4.65	---
L.S.D at 5%	A: 0.11		B: 0.11		AB: N.S	A: 0.14		B: 0.11		AB: 0.25

Table (5) : Effect of different salinity levels of diluted sea water and GA_3 concentrations on total flower fresh weight and total flower dry weight/plant (g) of *Calendula officinalis* during 2003/04 and 2004/05 seasons .

Salinity level% (A)	First season					Second season				
	GA_3 concentration (ppm) (B)					GA_3 concentration (ppm) (B)				
	0	25	50	100	Mean A	0	25	50	100	Mean A
Total flower fresh weight (g)										
0.0	513.5	544.0	551.0	553.5	540.5	544.5	590.0	603.0	617.5	588.8
2.5	478.5	494.0	501.0	503.5	494.3	529.5	540.0	553.5	567.5	547.6
5.0	448.5	464.0	471.0	473.5	464.3	499.5	510.0	523.5	537.5	517.6
10.0	433.5	449.0	456.0	458.5	449.3	484.5	495.0	508.5	522.5	502.6
Mean B	468.5	487.8	494.8	497.3	---	514.5	533.8	547.1	561.3	---
L.S.D at 5%	A: 21.2		B: 21.2		AB: N.S	A: 5.5		B: 5.5		AB: 11.0
Total flower dry weight (g)										
0.0	128.5	140.0	142.5	144.5	138.9	141.5	146.0	148.5	152.0	147.0
2.5	114.0	118.5	122.5	124.5	119.9	121.5	126.0	128.5	132.0	127.0
5.0	96.0	100.5	104.5	106.5	101.9	103.0	108.0	110.5	114.0	108.9
10.0	83.0	87.5	91.5	93.5	88.9	90.5	95.0	97.5	101.0	96.0
Mean B	105.4	111.6	115.3	117.3	---	114.1	118.8	121.3	124.8	---
L.S.D at 5%	A: 2.2		B: 2.2		AB: N.S	A: 1.8		B: 1.8		AB: N.S

Concerning the effect of GA_3 spray on flowering characters, it could be noticed that spraying the plants with GA_3 at levels 50 and 100 ppm gave uneven trend for the beginning of flowering age during the two seasons, while there was enhancement for other flowering characters. This increment may be due to the role of GA_3 which originally regulate growth and development processes by altering the endogenous hormones level. It is responsible for the most metabolic processes of cell division, elongation and differentiation and it could be excepted to influence the biosynthesis of plant growth phenomena such as germination, vegetative growth and the well known promotive effect of GA_3 on flowering. The response of floricultural crops to GA_3 application was reported by many investigators including EL-Keltawi (1981) on spearmint plants, Harridy (1981) on *Calamintha officinalis*, Dessouky (1986) on *Vinca sp.*, Badawy (1992) on *Calendula officinalis*, Schuch and Biernacka (1995) on azalea cultivars, Das *et al.*, (1999) on *Salvia splendens*, Azza (2001) on *Anethum graveolens*, Balbaa (2002) on *Lavendula officinalis* and Porwal *et al.*, (2002) on roses.

The interaction between the treatments of salinity and GA_3 spray on flowering characters, i.e. flowering age (days), total flower number/plant, flower diameter (cm) and fresh weight and dry weight of flowers/plant in both seasons. Otherwise, GA_3 at all concentrations was effective in overcoming the depressing effects of salinity on these parameters, especially, the medium and the high concentration (50 and 100 ppm). An explanation to such role of GA_3 was stated by Meawad *et al.*, (1991), who suggested that the use of GA_3 might enhance the anabolic pathway in *Casuarina* seedlings rather than the katabolic processes. Overcoming the harmful effect of salinity on plant growth of some plant species by the use of GA_3 was indicated by Ahmed (1995) on *Leucaena leucocephala*, Ahmed (1999) on *Robinia pseudoacacia* and Eid and Azza (2004) on *Casuarina glauca*.

II. Effect of salinity levels and GA_3 spray on some chemical composition :

Data presented in Table (6) show that photosynthetic pigments, i.e. chlorophyll a and b in the leaves and carotenoids in the flowers were reduced in respond of increasing the salinity levels in irrigation water. In both seasons, plants irrigated with tap water (control) gave the highest values of these parameters. While, raising the salt concentration resulted in a gradual reduction, since the highest salt concentration (10 % sea water) gave the lowest values for three photosynthetic pigments. The decrease in leaf and flower pigments under saline conditions might be, apparently, due to absorption of ions such as iron as involved in the chloroplast formation protein synthesis (Jacobson and Ortli, 1956), accumulation of ammonia in plant leaves was one of the main factors causing depression in chlorophyll content through, plastide breakdown as a result of salinity treatments (Puritch and Barker, 1967). The former results are in harmony with those found by Shaybany and Kashirad (1978) on *Acacia saligna*, Shehata and EL-Tantawy (1994) on *Melia azedarach*, Ahmed (1995) on *Leucaena leucocephala*, Bondok *et al.*, (1995) on the three peach root stocks, Ahmed (1999) on *Robinia pseuoacacia* as well as Eid and Azza (2004) on *Casuarina glauca*.

Table (6) : Effect of different salinity levels of diluted sea water and GA_3 concentrations on photosynthetic pigments contents of *Calendula officinalis* during 2003/04 and 2004/05 seasons .

Salinity level% (A)	First season					Second season				
	GA_3 concentration (ppm) (B)					GA_3 concentration (ppm) (B)				
	0	25	50	100	Mean A	0	25	50	100	Mean A
Chlorophyll A content (mg/g F.W.)										
0.0	0.388	0.394	0.417	0.435	0.409	0.400	0.406	0.422	0.446	0.419
2.5	0.338	0.344	0.367	0.385	0.359	0.350	0.356	0.372	0.396	0.369
5.0	0.308	0.314	0.337	0.355	0.329	0.320	0.326	0.342	0.366	0.339
10.0	0.288	0.294	0.317	0.335	0.309	0.300	0.306	0.322	0.346	0.319
Mean B	0.331	0.337	0.360	0.378	---	0.343	0.349	0.365	0.389	---
L.S.D at 5%	A: 0.008		B: 0.008		AB: N.S	A: 0.008		B: 0.008		AB: N.S
Chlorophyll B content (mg/g F.W.)										
0.0	0.140	0.142	0.149	0.152	0.146	0.125	0.134	0.147	0.153	0.140
2.5	0.125	0.127	0.134	0.137	0.131	0.151	0.119	0.132	0.138	0.135
5.0	0.114	0.116	0.124	0.127	0.120	0.190	0.107	0.121	0.126	0.136
10.0	0.109	0.111	0.119	0.122	0.115	0.162	0.102	0.116	0.121	0.125
Mean B	0.122	0.124	0.132	0.135	---	0.157	0.116	0.129	0.135	---
L.S.D at 5%	A: 0.001		B: 0.001		AB: N.S	A: 0.141		B: 0.141		AB: N.S
Carotenoids content (mg/g F.W.)										
0.0	427.5	437.0	461.0	523.0	462.1	429.0	445.0	467.0	477.5	454.6
2.5	387.5	395.0	420.0	427.0	407.4	389.0	405.0	423.0	437.0	413.5
5.0	366.0	373.0	401.0	407.5	386.9	371.0	383.0	401.0	415.0	392.5
10.0	351.0	359.0	386.0	392.5	372.1	356.0	368.0	386.0	400.0	377.5
Mean B	383.0	391.0	417.0	437.5	---	386.3	400.3	419.3	432.4	---
L.S.D at 5%	A: 6.43		B: 6.43		AB: 12.87	A: 6.19		B: 6.19		AB: N.S

Regarding the effect of GA_3 treatments, it is clear that the three pigment contents were significantly increased parallel to the increase in the concentration of applied GA_3, in both seasons compared with the control. These results are in agreement with those of Shehata and EL-Tantawy (1994) on *Melia azederach* and Abdel-Wahid (1995) on *Sterelizia reginae* and *Polianthes tuberose*.

The interaction effect between the treatments of salinity levels and GA_3 concentrations was not significant in both seasons except of carotenoids in the first season. The highest chlorophyll a, b and carotenoids contents were obtained from plants grown under 2.5 % salinity level and treated with 100 ppm GA_3.

III. Effect of different salinity levels of diluted sea water and GA_3 spray on minerals percentage :

Relevant data in Table (7) show the percentages of nitrogen, phosphorus and potassium in the leaves of marigold plants as affected by salinity levels in water irrigation. In both seasons, the data reveal that there was a significant reduction in nitrogen, phosphorus and potassium percentages as a result for using all saline water treatments. Generally, it can be concluded that the decrease in N, P and K contents were in proportion with the level of salinity. These findings are in agreement with those obtained by EL-Khateeb and Salim (1994) on *Chrysanthemum frutescence* and EL-Hindi and EL-Ghamry (2005) on cherrygold plants.

Concerning the effect of GA_3 spraying, it is obvious that spraying plants with GA_3 at all tested concentrations significantly increased minerals percentage and the rate of increase was raised as concentration was increased in both seasons compared with the control Table (7). This increment in mineral composition may be attributed to the role of GA_3 in stimulating the synthesis of protein (Broughton and McComb, 1967) which was reflected in increasing the plant growth, consequently the uptake of N, P and K was increased. Moreover, the obtained results were similar to those obtained by Eid and Azza (2004) on *Casuarina glauca*.

As for the combination of salinity levels and GA_3 spray, this effect did not reach the level of significance at 5 % due to minerals percentages in any of the two seasons.

In conclusion, it could be observed that results of the present study show that marigold plants (*Calendula officinalis*) could tolerate salinity, to some extent, since highest salinity concentration of 10 % seas water caused a reduction in the vegetative, flowering and its components. As spraying with gibberellic acid was concerned, it was found that application of GA_3 favoured the growth and chemical composition of plants in both seasons of the study, especially when GA_3 was sprayed at medium and high concentrations (50 and 100 ppm). Accordingly, it could be concluded that spraying marigold plants with such GA_3 may reduce the undesirable effect of salinity through improving growth and development or alleviate the harmful effects imposed by salinity on different plant metabolism and physiological process which in turn, reflects on plant growth.

Table (7) : Effect of different salinity levels of diluted sea water and GA_3 concentrations on minerals percentage of *Calendula officinalis* during 2003/04 and 2004/05 seasons.

Salinity level% (A)	First season					Second season				
	GA_3 concentration (ppm) (B)					GA_3 concentration (ppm) (B)				
	0	25	50	100	Mean A	0	25	50	100	Mean A
					Nitrogen (%)					
0.0	1.34	1.40	1.37	1.43	1.39	1.41	1.48	1.55	1.71	1.54
2.5	1.32	1.38	1.35	1.39	1.36	1.40	1.45	1.52	1.69	1.52
5.0	1.29	1.34	1.31	1.35	1.32	1.36	1.42	1.49	1.64	1.48
10.0	1.10	1.14	1.18	1.28	1.18	1.17	1.23	1.29	1.49	1.30
Mean B	1.26	1.315	1.30	1.36	---	1.34	1.40	1.46	1.63	---
L.S.D at 5%	A: 0.05		B: 0.05		AB: N.S	A: 0.15		B: 0.15		AB: N.S
					Phosphorus (%)					
0.0	0.204	0.209	0.218	0.259	0.223	0.212	0.227	0.236	0.268	0.236
2.5	0.192	0.196	0.200	0.251	0.210	0.204	0.214	0.225	0.256	0.225
5.0	0.182	0.186	0.192	0.244	0.201	0.198	0.208	0.218	0.244	0.217
10.0	0.173	0.176	0.183	0.206	0.185	0.188	0.200	0.210	0.237	0.209
Mean B	0.188	0.193	0.198	0.240	---	0.201	0.212	0.222	0.251	---
L.S.D at 5%	A: 0.015		B: 0.015		AB: N.S	A: 0.014		B: 0.014		AB: N.S
					Potassium (%)					
0.0	2.39	2.47	2.59	2.70	2.54	2.75	2.90	3.02	3.26	2.98
2.5	2.29	2.36	2.45	2.59	2.42	2.64	2.81	2.92	3.10	2.87
5.0	2.18	2.27	2.34	2.50	2.32	2.58	2.70	2.84	2.98	2.78
10.0	2.08	2.18	2.24	2.39	2.22	2.51	2.63	2.78	2.88	2.70
Mean B	2.24	2.32	2.41	2.55	---	2.62	2.76	2.89	3.06	---
L.S.D at 5%	A: 0.07		B: 0.07		AB: N.S	A: 0.10		B: 0.10		AB: N.S

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تأثير الرش بالجبرالين على النمو وبعض المكونات الكيماوية لنباتات الأقحوان النامية تحت ظروف ماء البحر المخفف.

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تم إجراء هذه الدراسة بمحطة البحوث الزراعية بقسم الخضر والزينة – كلية الزراعة – جامعة المنصورة خلال موسمى ٢٠٠٣/٢٠٠٤ و ٢٠٠٤/٢٠٠٥ على نبات الأقحوان.

بهدف دراسة تأثير مستويات الملوحة المختلفة لماء البحر المخفف بمعدل (٢,٥ ، ٥ ، ١٠ %) والتى تعادل ٨٢٥ ، ١٦٥٠ ، ٣٣٠٠ جزء فى المليون على التوالى ، والرش بالجبرالين بتركيزات (٢٥ ، ٥٠ ، ١٠٠ جزء فى المليون) بالإضافة إلى تأثير التداخل بينهما على النمو والتركيب الكيماوى لنباتات الأقحوان .

ويمكن تلخيص النتائج المتحصل عليها فيما يلى :

- أدت معاملات ملوحة ماء الرى إلى حدوث نقص معنوى فى طول النبات وعدد الفروع والوزن الجاف للعشب وقطر الزهرة وعدد الأزهار ووزنها الطازج والجاف ومحتوى الأوراق من كلوروفيل أ ، ب وكذا محتوى الأزهار من الكاروتينويدات . بالإضافة إلى ذلك فقد إنخفضت النسبة المئوية لكل من النتروجين والفوسفور والبوتاسيوم فى الأوراق بزيادة مستويات الملوحة.
- رش النباتات بالجبرالين سبب وبكل التركيزات المستعملة تحسنا كبيرا فى صفات النمو الخضرى والزهرى المذكورة سالفا . وقد كانت أكثر المعاملات فعالية فى معظم الحالات هى التركيز المتوسط والعالى (٥٠ ، ١٠٠ جزء فى المليون) خلال موسمى الدراسة ، علاوة على ذلك فإن جميع التركيزات المستخدمة من حامض الجبريليك قد سببت زيادة فى محتوى الأوراق من صبغات التمثيل الضونى الثلاثة وفى النسبة المئوية لكل من النتروجين والفوسفور والبوتاسيوم .
- يمكن القول بأن رش النباتات بالجبرالين بتركيزات ٥٠ ، ١٠٠ جزء فى المليون كان فعالا فى التغلب على أو تخفيف التأثيرات الضارة للملوحة على الصفات الخضرية المختلفة والتركيب الكيماوى والذى إنعكس بدوره على النمو والتطور للنباتات.