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RESPONSE OF THREE CULTIVARS OF *Bougainvillea* MS.BUTTE PLANTS TO SALINE WATER IRRIGATION

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ABSTRACT

A pot experiment was carried out during two successive seasons,1998/1999 and 1999/2000 to study the response of three cultivars of *Bougainvillea* Ms.Butte plants to saline water irrigation. The data revealed that there were significant reductions in plant height, stem diameter, number of leaves and inflorescences with saline water treatments, the decreases were in proportion to the increase in salinity level. Also, the data indicated that plants of cv. Red Buttiana and cv. White Buttiana in the first and second seasons, respectively were the tallest. Plants. of cv. Gold Buttiana had the thickest stems in the two seasons. Whereas, plants of cv. White Buttiana showed the highest number of branches and inflorescences. Red Buttiana cv. had the highest number of leaves and the heaviest F.W. of leaves .

All saline water treatments decreased the content of chlorophyll a and b .Red Buttiana cv. in the first season and White Buttiana cv. in the second one contained the highest value of chlorophyll a and b. Growing plants under salinity stress of 1500, 3000, and 4500 ppm, markedly increased the caroteniods content. Most of the saline water treatments caused a remarkable increase in the proline content over the control plants . Red Buttiana cv. in the first season and Gold Buttiana cv. in the second one, had the highest value of proline content, whereas, the lowest value in both seasons, was recorded with plants of, cv. White Buttiana. In both seasons the N , P, Na, Ca, K and Cl percent of leaves and stems of the three bougainvillea cultivars decreased as salinity level increased.

In conclusion, comparing the values of vegetative growth, flowering and chemical constituents of the three cultivars of bougainvillea plants, the data obtained indicate that White Buttiana cv. in both seasons were the tallest, and had the highest number of branches and inflorescences, the heaviest dry weight of stems, the lowest content of proline, sodium., calcium, and chloride and the highest content of N and P, as compared with Gold Buttiana and Red Buttiana cvs.

INTRODUCTION

The bougainvillea (family Nyctaginaceae) is a very popular, magnificent plant, it is a robust and spectacular evergreen or semi-evergreen climber a native of South America. bougainvillea plant is a vigorous woody vine that when pruned properly can form a shapely shrub. If not pruned, the vine may reach up to 6-7 m, it is a great plant for a trellis, fence, to climb up or as a specimen plant. The bougainvillea blooms heavily throughout the year. The beauty of the bougainvillea lies in the bracts surrounding the small and inconspicuous flowers (Bailey,1962)

Plant growth is limited with different environmental conditions, one of these condition is salt stress. Soil salinity and saline water are the most important agricultural problems in arid and semiarid climate conditions in different parts of the world and can cause harm to plants if they are in high concentration. This effect is mainly indirect by pulling moisture out of roots and reducing the uptake of water and nutrients. Tip and edge burn of

leaves, slow growth, nutrient deficiencies, wilting and eventual death of the plant can occur if the salt level is excessive for the plant. Bernstein (1962) and Allison (1964) pointed out that growth of the plants grown under salinity stress may be checked or totally inhibited due to: (a) osmotic effect on plant roots, (b) the toxic effects of accumulated ions, or (c) the combination of them. Alam (1994) stated that high concentration of Na^+ and Cl^- in the soil solution may depress nutrient-ion activities ,and produce extreme ratios of Na^+/ Ca^{+2}, Na^+/ K^+, Ca^{+2}/Mg^{+2} and Cl^-/NO_3. Hasegawa *et al.* (2000) mentioned that salt salinity affects plant physiology through changes of water and ionic status in the cells. Ionic imbalance occurs in the cells due to excessive accumulation of Na^+ and Cl^- and reduces uptake of other mineral nutrients, such as K^+, Ca^{+2}, and Mn^{+2}. The role of K is vital for osmoregulation and protein synthesis, maintaining cell torpor and stimulating photosynthesis, higher levels of K^+ in young expanding tissue is associated with salt tolerance in many plants.

Several workers studied the effect of saline water irrigation on ornamental plants. Cahoon and Stevenson (1986) on some *Hibiscus species*, found that the root : shoot ratio was higher in most high salinity tolerant species than low salinity one. Francios *et al* (1988) on kenaf, found that treating the plants with salt levels > 4.0 ds/m severely restricted plant height and D. M. production. Risse and Schenk (1990) on azalea , obtained significant reductions in fresh and dry weights of plants with 150 mg Cl^- /litter irrigation water and flowering was delayed by 80-100 mg Cl^- /litter. Rais *et al* (1993) treated jojoba plants with 50,100 and 150 mM NaC1 for 4 months. They found that, with increasing salinity level, the leaves became thicker due to enlargement of the parenchyma cells, and the osmotic pressure and pigments content decreased. El-Khateeb (1994)on *Murraya exotica*, found that increasing the salinity level up to 3000 ppm significantly decreased plant height, stem diameter, number of leaves, and fresh and dry weights of leaves and stems. The contents of chlorophyll a,b and carotene were greatly reduced with salinity treatments (1500 - 7500 ppm), while the content of amino acid " proline " was markedly increased. Also, the contents of N, Ca, K, Na, and C1 in the different parts increased with increasing salinity level, but phosphorus content had no clear trend. Also ,El- Khateeb *et al.* (1994) on tuberose plants, found that increasing the level of salts in irrigation water gradually decreased the number of leaves, fresh and dry weights of leaves, whereas the contents of carotenoids and proline were increased. There were marked accumulations of K, Na , Ca and C1 in leaves with increasing salinity levels. El-Khateeb and Salim (1994) irrigated *Chyrsanthemum frutescens* plants with saline water at the concentrations of 1500 up to 7500 ppm (NaC1 + $CaC1_2$ at 1:1). They found significant decreases in the contents of chlorophyll a, b, carotene and indole compounds when the plants were irrigated with saline water at 4500-6000 ppm. The treatments of saline water increased the contents of proline, nitrogen, phosphorus, potassium, sodium, calcium and chloride. Sun *et al.* (1996) on *Phylostachys vivax,* stated that, salinity treatments affected the thickness and number of shoots and height of the plants as well as the accumilation of Ca, Na, Cl and K.

MATERIALS AND METHODS

This investigation was carried out at the Nursery of Ornamental Horticulture Department,Fac.of Agriculture, Cairo Univ, during the two successive seasons, 1998/1999 and 1999 / 2000. Uniform seedlings of *Bougainvillea* Ms.Butte cvs.White Buttiana, Gold Buttiana and Red Buttiana are individually planted on Spet.,5 th in both seasons, in 30 cm diameter earthenware pots filled with a mixture of clay + sand (2:1 v/v), (Table, A). After three weeks, the plants were treated by the different saline water treatments :Tap water (as a control), 1500, 3000, 4500, 6000, and 7500 ppm. The plants were irrigated weekly with artificial salinized water containing a mixture of sodium chloride (NaCl) and calcium chloride (Ca Cl_2) at (2:1 w/w). Each pot was irrigated with 1½ liters of saline water. The plants were held under natural condition for 7 months . The plants were fertilized with NPK (1:1:1) at 10 gm / plant after 2 and 4 months from planting, using ammonium nitrate (33%N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48%K_2O) as sources of N,P and K, respectively. The experimental design was a split – plot design, bougainvillea cvs were designed as main plots and salinity treatments as subplots. Each treatment was replicated three times, and each replicate contained 4 plants. The obtained data were statistically analyzed using LSD test (Steel and Torrie,1980). The following data were recorded at the end of each growing season:- Plant height (cm), stem diameter (cm), number of branches, and inflorescences ,fresh and dry weights of leaves, stems, and roots (g.). Contents of pigments (mg/gm F.W.), proline (µmole proline/100 g. fresh weight), N, P, K, Ca, Na and Cl (% D.W) in the leaves and stems of the plant .

Determinations: Chlorophyll a, b and total carotenoids were determined in leaf samples (mg/gm of fresh weight) according to Saric *et al* (1976). Amino acid "Proline" was determined according to the method of Bates *et al.* (1973) using a colorimetric method at 520 nm. The content of proline was calculated using the following equation:

$$\text{µmoles proline/100 gm fresh weight} = \frac{\text{Reading x ml. Toluene x 115.5}}{\text{g. sample x 5}}$$

Determination of minerals : The wet digestion procedure was performed (Piper, 1947).

Total nitrogen content in leaves and stems were determined using Nissler Method according to the procedure described by A.O.A.C. (1960). Phosphorus content was determined according to Trough and Mayer (1939). The contents of K, Ca and Na were determined by using operation chart of Shimadzu Atomic Absorption / Flame Spectrophotometer (AA - 646) with a boiling air - acetylene burner and recorded read out. Chloride content was determined according to the method of (Jackson, 1958). Table (A): The mechanical and chemical analysis of the mixture of clay + sand (2:1 v/v)

Mechanical analysis %				Chemical analysis			
Clay	Silt	Sand	Texture	pH	E.C.	CHO_3 %	O.M%.
31.6	26.9	41.5	clay loam	7.3	1.25	1.29	0.98

RESULTS AND DISCUSSION

1- Effect of saline water irrigation on vegetative growth and flowering

a- Plant height :

Data presented in Table (19) indicated that there was a significant reduction in plant height was resulting from using all saline water treatments. In the first season, all saline water treatments at the different levels significantly reduced the plant height. Raising the level of salinity significantly reduced the plant height and the decreases were in proportion to the increase in the salinity level. Thus, plant grown under salinity stress at 7500 ppm were the shortest (37.19 cm), whereas plants irrigated with 1500 ppm reached to the height of 49.38 cm. In the second season, a similar trend was observed , the tallest plants was recorded for the control, whereas, the shortest plants was obtained with the highest level of salinity.

As for the three cultivars of bougainvillea plants, data in Table (1) revealed that in both seasons the height of cv White Buttiana plants was less affected by saline water treatments, followed by plants of cv. Red Buttiana than cv. Gold Buttiana which was the shortest (43.08 and 26.93 cm, in the first and second seasons, respectively).

The interaction effects between bougainvillea cultivars and salinity treatments , revealed that, in the first season, although the control plants of cv Red Buttiana were the tallest (66.30 cm), it showed the greatest reduction with the highest level of salinity . In the second season, however the control plants of cv. White Buttiana were the tallest (41.50 cm), but under the highest salinity level became the shortest ones (18.37 cm). Similar findings were reported by Patil and Patil (1982) on *Punica granatum* and El-Khateeb *et al*(1989) on *Chrysanthemum carinatum* plants.

b-Stem diameter

The data presented in Table (1) showed that the control plants of the different cultivars of bougainvillea plants had the thickest stems, giving values of 0.97 and 0.95 cm in the first and second seasons, respectively. A clear reduction in stem diameter was recorded when plants were grown under the different salinity treatments, the reduction was in proportion with the level of salinity, i.e. the highest level (7500) gave the thinnest stems in both seasons. Plants of the cv Gold Buttiana had the thickest stems in the two seasons (0.88 and 0.86cm), respectively, with insignificant differences with the other two cultivars. Concerning the interaction effect between bougainvillea cultivars and salinity treatments, it can be noticed that plants of the cv. Gold Buttiana grown under salinity stress of 3000 ppm had the thickest stems in the first season (1.10 cm), while in the second one the thickest stems were recorded with the control plants of cv Red Buttiana (0.99cm), but plants of cv. Gold Buttiana had the thicker stems under different salinity treatments(except salinity treatment at 1500 ppm, in the second season) as compared with the other two cultivars. In conclusion, stem diameter was significantly affected by saline water irrigation. The reduction in stem diameter as a result of saline water treatments is in agreement with those reported by El-Leithy and El-Khateeb (1992) on *Theivetia nereifolia*, El-Khateeb (1994) on *Murraya exotica* and Sun *et al* (1996) on *Phylostachys vivax*.

Table (1): Effect of saline water irrigation on plant height and stem diameter (cm.), of three cultivars of Bougainvillea Ms Butte (cvs. White, Gold and Red Buttiana) plants, at 1998 /1999 and 1999/2000 seasons.

Saline water levels PPm	Season, 1998/1999				Season, 1999/2000			
	White	Gold	Red	Mean (A)	White	Gold	Red	Mean (A)
Plant height, cm								
Control	62.27	56.37	66.30	61.64	41.50	41.33	40.13	40.99
1500	52.07	44.53	51.53	49.38	30.23	27.33	31.27	31.27
3000	54.10	42.77	44.53	47.13	26.93	28.28	26.47	27.21
4500	45.27	39.50	40.53	41.77	24.90	23.53	22.80	23.74
6000	42.60	37.90	37.97	39.49	21.30	21.20	21.80	21.43
7500	40.63	37.40	33.53	37.19	18.37	19.07	19.13	18.86
Mean (B)	49.49	43.08	45.73		27.21	26.79	26.93	
LSD at 5%	A		0.46				0.90	
	B		1.48				1.16	
	A x B		2.56				2.01	
Stem diameter ,cm								
Control	1.03	0.85	1.04	0.97	0.97	0.90	0.99	0.95
1500	0.84	0.96	0.89	0.90	0.95	0.89	0.85	0.90
3000	0.82	1.10	0.86	0.92	0.78	0.88	0.74	0.80
4500	0.75	0.87	0.73	0.78	0.70	0.85	0.71	0.75
6000	0.74	0.77	0.76	0.75	0.74	0.76	0.66	0.72
7500	0.71	0.74	0.72	0.72	0.64	0.66	0.64	0.65
Mean (B)	0.81	0.88	0.83		0.80	0.82	0.77	
LSD at 5%	A		0.05				0.02	
	B		0.08				0.03	
	AxB		0.13				0.06	

c- Number of leaves

Data in Table(2) indicate that plants of cv. Red Buttiana formed the highest number of leaves (56.42) in the first season, whereas the least number of leaves was formed on the plants of cv. White Buttiana (41.91), and there were significant differences among the three cultivars in their ability of leaf formation. In the second season, a similar trend was obtained, as plants of the cv. Reed Buttiana formed the highest number of leaves (44.56) and the least number of leaves was formed on the plants of cv. White Buttiana (43.37). Regardless the effect of cultivars, the data indicated that there was a significant reduction the number of leaves resulting from using all saline water treatments as compared with the control plants, also the number of leaves was progressively decreased as the level of salinity increased. Data on the interaction effect between bougainvillea cultivars and salinity treatments, indicated that, plants of the cv Gold Buttiana irrigated with tap water (control plants formed the highest number of leaves (100.90), while, the plants of cv. White Buttiana formed the lowest number of leaves (21.37) when irrigated with 6000 ppm saline water. Red Buttiana cv plants were more affected with the highest level of salinity than the other two cultivars. Also, it can be noticed that there were no significant differences in the number of leaves of Red Buttiana and Gold Buttiana cv irrigated with tap water and those irrigated with saline water at 1500 ppm level. These findings are in agreement with those reported by Shaybany and Kashirad (1978) on

Acacia saligna and El-Leithy and El-Khateeb (1992) on *Theivitia nereifolia*, they reported that salinity caused a significant reduction in the formation of leaves.

Table (2): Effect of saline water irrigation on number of leaves, branches and inflorescences of three cultivars of Bougainvillea Ms Butte(cvs. White, Gold and Red Buttiana) plants, at 1998/1999 and 1999/2000 seasons.

Saline water levels PPm	Season, 1998/1999				Season, 1999/2000			
	White	Gold	Red	Mean(A)	White	Gold	Red	Mean (A)
				leaves				
Control	74.70	72.33	100.90	82.81	67.83	59.83	69.83	65.83
1500	60.10	65.43	70.10	65.21	47.77	57.97	63.37	55.37
3000	46.43	69.23	74.60	63.42	49.10	46.20	53.80	49.70
4500	27.20	41.90	36.57	39.22	33.90	42.83	34.87	37.20
6000	21.37	31.43	31.17	27.99	34.77	36.93	25.70	32.47
7500	21.63	21.50	22.20	21.78	26.87	24.10	19.77	23.58
Mean(B)	41.91	50.39	56.42		43.37	44.14	44.56	
LSD at 5%	A		3.40				1.90	
	B		2.19				4.40	
	AxB		3.79				7.61	
				Branches				
Control	4.65	4.40	4.13	4.39	4.47	4.65	4.32	4.48
1500	5.28	4.13	4.93	4.78	3.29	3.61	3.71	3.54
3000	6.83	4.73	3.68	5.08	3.43	3.47	2.90	3.27
4500	4.30	4.72	4.38	4.47	3.93	2.57	3.44	3.28
6000	4.37	3.63	3.84	3.95	2.47	2.46	3.14	2.69
7500	3.73	3.00	2.43	3.06	2.81	3.24	2.91	2.99
Mean(B)	4.86	4.10	3.90		3.38	3.33	3.40	
LSD at 5%	A		0.10				0.24	
	B		0.61				0.44	
	A x B		1.06				0.76	
				inflorescences				
Control	40.93	39.03	27.90	35.96	45.17	34.97	34.50	38.21
1500	42.83	29.17	15.70	29.23	38.17	21.10	11.83	23.70
3000	15.23	16.83	9.63	13.90	10.00	14.93	8.20	11.04
4500	12.77	11.70	7.70	10.72	10.57	9.19	6.63	8.79
6000	14.57	6.77	5.90	9.08	8.53	5.50	5.80	6.61
7500	4.77	5.13	3.37	4.42	3.60	4.13	2.53	3.42
Mean	21.85	18.11	11.70		19.34	14.97	11.85	
LSD at	A		1.37				1.29	
	B		3.04				1.54	
	Ax B		5.26				2.67	

d- Number of branches

As shown in Table (2) in the first season ,growing plants under the levels of salinity from 1500 to 4500 ppm encouraged the formation of branches giving 4.78, 5.08 and 4.47 branches / plant, respectively, as compared with the control (4.39), and the number of branches reached to 3.06 branches when the plants were grown under the highest level of salinity (7500ppm). On the other hand, plants of. White Buttiana cv showed a significant increase in the number of branches as compared with the other

two cultivars. Concerning the interaction effect between bougainvillea cultivars and salinity treatments, the data revealed that plants of cv. White Buttiana irrigated with saline water at the level of 3000 ppm, produced the highest number of branches (6.83), whereas plants of cv. Red Buttiana grown under the highest salinity stress (7500 ppm) formed the lowest number of branches (2.43). In the second season, no clear trend was noticed. In this regard , Patil and Patil (1982) on *Punica granatum* and El-Khateeb *et al.* (1989) on *Chrysanthemum carinatum* obtained similar results.

e-Number of inflorescences

Data presented in Table (2) showed that the number of inflorescences/ plant was greatly affected by the different levels of salinity. Treating the plants with different levels of salinity produced significantly lower number of inflorescences, during the two seasons, as compared with the control. The data also indicated that there was a significant reduction in the number of inflorescences as the level of salinity increased,. White Buttiana cv produced the highest number of inflorescences/ plant during the two seasons compared with the other two cultivars. As for the interaction effect between bougainvillea cultivars and salinity treatments, the data revealed that plants of cv. White Buttiana irrigated with saline water at the level of 1500 ppm, produced the highest number of inflorescences (42.83), in the first season and the control plants of this cultivar formed the highest number of inflorescences (45.17) in the second season. Whereas, plants of cv. Red Buttiana grown under the highest salinity stress (7500 ppm) formed the lowest number of inflorescences (3.37 and 2.53 in the first and second seasons, respectively). In this regard, Patil and Patil (1982) on *Punica granatum* and El-Khateeb *et al.*(1989) on *Chrysanthemum carinatum* obtained similar results.

f-Fresh and dry weight of leaves

In the first season (Table ,3) there were a significant decrease in fresh weight of leaves as the level of salinity increased as compared with the control. The data revealed also that, plants of cv. Red Buttiana produced the heaviest fresh weight of leaves (45.26 gm),and plants of cv. Gold Buttiana showed the least value(38.06 gm). Concerning the interaction effect between bougainvillea cultivars and salinity treatments, the greatest reduction in fresh weight of leaves (21.85 gm), was obtained when plants cv. Gold Buttiana were grown under the highest salinity stress (7500 ppm) while the control plants of cv. Red Buttiana produced the heaviest fresh weight of leaves(72.51 gm). A similar trend was obtained in the second season .

As shown in Table (3), the dry weight of leaves of the different cultivars of Bougainvillea plant decreased as the level of salinity increased . and the decrease in dry weight of leaves was statistically significant as compared with the control.. In both seasons , the dry weight of leaves reached to the minimum values (6.45 and 6.55 gm, respectively) when the plants were grown under the highest salinity stress (7500 ppm) .

Concerning the interaction effect between Bougainvillea cultivars and salinity treatments, it can be mentioned that, irrigating plants of cv. Red

Buttiana with lowest level of saline water (1500 ppm) significantly increased the dry weight of leaves , in both seasons, compared with the two other cultivars grown under the same level of salinity, but this cultivar showed an opposite trend when plants were grown under the highest salinity level (7500ppm) .

Table (3): Effect of saline water irrigation on fresh and dry weight of leaves (gm) of three cultivars of Bougainvillea Ms Butte (cvs. White, Gold and Red Buttiana) plants, at1998 /1999 and 1999/2000 seasons.

Saline water levels PPm	Season, 1998/1999				Season, 1999/2000			
	White	Gold	Red	Mean (A)	White	Gold	Red	Mean (A)
	Fresh weight							
Control	63.48	53.14	72.51	63.04	62.03	52.61	69.94	61.53
1500	53.04	48.74	53.41	51.70	51.31	49.81	57.59	52.90
3000	41.20	71.77	45.54	42.84	41.57	41.32	51.30	44.73
4500	41.30	36.84	41.10	39.75	36.34	35.80	46.49	39.54
6000	38.44	25.98	35.80	33.41	35.57	23.94	36.62	32.04
7500	27.24	21.85	23.35	24.15	20.71	22.00	24.91	22.21
Mean (B)	44.12	38.06	45.26		41.26	37.58	47.64	
LSD at 5%	A		0.78				1.10	
	B		2.47				2.28	
	A x B		4.28				3.96	
	Dry weight							
Control	20.48	16.43	19.00	18.64	20.43	15.94	22.11	19.50
1500	13.78	14.04	15.74	14.52	13.54	13.04	15.88	14.15
3000	10.91	10.92	12.20	11.35	11.04	10.71	13.06	11.60
4500	12.33	10.84	9.88	11.02	8.54	10.89	10.24	9.89
6000	10.10	7.64	8.33	8.69	8.00	7.00	8.17	7.73
7500	6.44	6.51	6.40	6.45	6.70	6.67	6.27	6.55
Mean (B)	12.39	11.06	11.93		11.38	10.71	12.62	
LSD at 5%	A		0.79				0.47	
	B		1.07				0.94	
	A x B		1.85				1.63	

g-Fresh and dry weight of stems

As shown in Table (4), the fresh weight of stems of the different cultivars of bougainvillea plant was significantly decreased as the level of salinity increased.. Concerning the interaction effect ,it can be noticed that , the heaviest fresh weight of stems in the first season was recorded for the control plants of cv White Buttiana (45.49 gm), and for the control plants of cv Red Buttiana (48.51 gm) in the second season.

As for the effect on dry weight , data indicated that the dry weight of stems of the different cultivars of bougainvillea plant was significantly decreased as the level of salinity increased, as compared with the control. White Buttiana cv.had the heaviest dry weight of stems was in most salinity treatments in both seasons, as compared with the dry weight of the other two cultivars .

Table (4): Effect of saline water irrigation on fresh and dry weight of stem (gm) of three cultivars of Bougainvillea Ms Butt (cvs. White, Gold and Red Buttiana) plants at 1998 /1999 and 1999/2000 seasons.

Saline water levels PPm	Season, 1998/1999				Season, 1999/2000			
	White	Gold	Red	Mean (A)	White	Gold	Red	Mean (A)
Fresh weight								
Control	45.49	45.11	43.11	44.54	46.80	47.06	48.51	47.46
1500	35.66	35.83	33.48	34.99	39.15	36.81	38.98	38.32
3000	25.72	29.34	29.79	28.28	35.45	23.38	34.72	34.20
4500	26.14	26.87	25.47	26.16	29.60	29.87	30.80	30.09
6000	17.02	18.47	22.14	19.21	17.81	17.35	25.46	20.21
7500	14.59	15.52	14.42	14.84	15.33	14.15	15.78	15.09
Mean (B)	27.44	28.52	28.07		30.69	29.60	32.38	
LSD at 5%	A			0.49				1.29
	B			1.45				1.55
	A x B			2.50				2.68
Dry weight of								
Control	16.80	14.83	14.18	15.27	16.21	15.20	14.21	15.21
1500	10.74	9.18	9.52	9.81	11.18	10.54	10.68	10.80
3000	6.55	7.80	8.85	7.73	10.14	8.81	9.21	9.39
4500	6.31	7.38	5.47	6.39	8.19	6.84	8.12	7.71
6000	5.41	5.61	4.79	5.27	6.09	6.19	6.55	6.28
7500	3.10	4.00	4.20	3.77	4.56	3.97	4.41	4.31
Mean (B)	8.15	8.13	7.83		9.39	8.59	8.86	
LSD at 5%	A			0.42				0.67
	B			0.35				0.75
	A x B			0.61				1.31

h-Fresh and dry weight of roots

The fresh weight of roots (Table,5) in both seasons (except salinity treatment 1500ppm, in the second season), was significantly decreased with salinity treatments ,as compared with the control. In the second season , the fresh weight of roots reached to the maximum values (25.23gm) when the plants were grown under the lowest salinity stress (1500 ppm). Comparing the values of the fresh weight of roots of the different cultivars, regardless of salinity stress, data obtained indicated that plants of cv. White Buttiana in both seasons showed the heaviest fresh weight of roots, giving 21.77 and 19.34 gm, respectively. Concerning the interaction effect ,it can be noticed that , the heaviest fresh weight of roots in the first season was recorded for the control plants of cv. White Buttiana (28.79 gm), and plants of cv. White Buttiana (48.51 gm) irrigated with 1500ppm saline water ,in the second season.

As for the effect of salinity on dry weight of roots, data recorded in the first season was similar to that recorded in case of fresh weight . In the second season, however, plants of cv. Gold Buttiana had heavier dry weight of roots than the other two cultivars under all salinity treatments.

2- Effect of saline watwer irrigation on chemical composition:

a- Pigment content

The response of chlorophyll a, b and carotenoids contents of the different bougainvillea cultivars to the application of saline water irrigation are presented in Table (6). In both seasons, all saline water treatments decreased the content of chlorophyll- a and b, as compared with the control plants. The decrement in the content of chlorophyll a and b was more pronounced with the high salinity levels. Comparing the values of chlorophyll a of the three cultivars of bougainvillea plants, regardless salinity stress,. Red Buttiana cv. in the first season, White Buttiana cv. in the second one contained the highest values giving 2.69 and 2.58mg/ gm F.W. respectively, the corresponding values for chlorophyll-b were 3.85 and 2.88mg/ gm F.W. respectively.

Concerning the effect of salinity on caroteniods content, the data revealed that growing plants under salinity stress of 1500, 3000, and 4500 ppm, markedly increased it, as compared with the control and other salinity levels. On the other hand, the values of caroteniods content of the three cultivars of bougainvillea plants showed different responces with the different salinity levels . These results were in agreement with those obtained by El-Khateeb (1994) on *Murraya exotica*, El-Khateeb and Salim (1994) on *Chrysanthemum frutescens*, , they reported that increasing salinity levels caused a steady reduction in the content of pigments in the leaves.

Table (5): Effect of saline water irrigation on fresh and dry weight of roots, gm of three cultivars of Bougainvillea Ms Butte (cvs. White, Gold and Red Buttiana) plants at 1998 /1999 and 1999/2000 seasons.

Saline water levels PPm	Season, 1998/1999				Season, 1999/2000			
	White	Gold	Red	Mean (A)	White	Gold	Red	Mean (A)
				Fresh weight				
Control	28.79	24.22	24.50	25.84	27.68	24.04	21.51	24.42
1500	26.22	18.98	20.12	21.77	28.47	22.13	25.09	25.23
3000	24.47	15.89	19.58	19.98	19.77	22.98	19.37	20.71
4500	19.17	14.82	15.31	16.43	18.82	18.93	13.87	17.18
6000	17.34	12.41	13.18	14.31	12.67	12.48	9.56	11.57
7500	14.64	12.82	7.84	11.76	8.61	7.44	6.94	7.66
Mean (B)	21.77	16.52	15.08		19.34	18.01	16.04	
LSD at 5%	A		0.49			1.29		
	B		1.45			1.55		
	A x B		2.50			2.68		
				Dry weight				
Control	9.76	8.46	8.25	8.82	7.54	8.78	7. 54	7.95
1500	8.50	6.74	6.81	7.82	6.27	8.41	8.26	8.31
3000	8.03	5.77	6.66	6.82	7.05	7.48	6.05	6.86
4500	7.12	5.68	6.35	6.39	6.23	6.28	4.48	5.66
6000	5.19	4.54	4.80	4.85	4.21	4.66	3.58	4.15
7500	3.66	2.50	2.68	2.95	2.92	2.62	2.49	2.68
Mean (B)	7.04	5.62	5.93		6.03	6.37	5.40	
LSD at 5%	A		0.42			0.67		
	B		0.35			0.75		
	A x B		0.61			1.31		

Amino acid " Proline " content

The response of the amino acid " Proline " of the of the different bougainvillea cultivars. plant to saline water irrigation are presented in Table (6)The content of amino acid " proline " in stems ranged between 24.70 and 40.57 μ moles/100 gm F.W. in the first season and between 18.25 and 34.08μmole/100 gm F.W. in the second one. The obtained data clearly indicated that most of the saline water treatments caused a remarkable increase in the proline content over the control. Plants of cv. Red Buttiana in the first season and plants of cv. Gold Buttiana in the second one had the highest value of proline content, whereas the lowest values in both seasons were recorded with plants of, cv. White Buttiana. Under salinity stress, proline accumulation is controlled by a gene called OSM (osmotic tolerance) gene, which governs the production of betaine and proline that protect cells against dehydration. Begum and Karmoker (1999) suggested that proline produced in leaf is transported to the roots to regulate the osmotic potential in cells under salinity. These results are in agreement with those obtained by El-Khateeb *et al* (1994) on tuberose, El-Khateeb and Salim (1994) on *Chrysanthemum frutescens*, who reported that increasing salinity level of irrigation water gradually increased the content of amino acid " proline.

Minerals content :

The data in Tables (7,8 and 9) showed the percentages of nitrogen, phosphprus , potassium, sodium., calcium and chloride in leaves and stems, of three bougainvillea cultivars as affected by saline water irrigation.

N content

The obtained results (Table 7) indicated that in both seasons, the N percent of leaves and stems for three bougainvillea cultivars decreased as salinity levels increased . N percent of White Buttiana cv. leaves and stems was higher than cvs Gold and Red Buttiana.

P content

In both seasons (Table 7), the P content of leaves and stems of bougainvillea cultivars decreased as salinity level increased and the P content of leaves and stems were lower as compared with the control. The values of P content of the three cultivars of bougainvillea plants showed that cv." White Buttiana, in the firest season, had the highest content of P in leaves and stems, whereas cv." Red Buttiana" showed the least content of P in their leaves and stems.

Table (6): Effect of saline water irrigation on pigments (mg/g F.W) **and proline (u** moles / 100 g F.w) **contents of leaves, on three cultivars of Bougainvillea Ms Butte (cvs. White, Gold and Red Buttiana) plants, at 1998 /1999 and 1999/2000** ***seasons.***

Saline water levels PPm	Season, 1998/1999				Season, 1999/2000			
	White	Gold	Red	Mean (A)	White	Gold	Red	Mean (A)
Chlorophyll –a								
Control	2.90	2.94	2.98	2.94	2.99	2.98	2.89	2.92
1500	2.85	2.89	2.90	2.88	2.94	2.78	2.73	2.82
3000	2.67	2.73	2.83	2.74	2.83	2.65	2.60	2.69
4500	2.43	2.65	2.73	2.60	2.74	2.45	2.35	2.51
6000	2.39	2.45	2.53	2.46	2.09	2.05	2.10	2.08
7500	1.98	2.10	2.20	2.09	1.89	1.80	1.70	1.79
Mean (B)	2.54	2.63	2.69		2.85	2.45	2.39	
Chlorophyll – b								
Control	1.39	1.35	1.36	1.37	1.38	1.25	1.30	1.31
1500	1.16	1.28	1.30	1.25	1.36	1.16	1.25	1.26
3000	1.19	1.17	1.25	1.20	1.25	1.10	1.19	1.18
4500	1.15	1.05	1.19	1.13	1.17	1.01	1.07	1.08
6000	0.98	1.00	0.99	0.99	1.05	0.99	0.93	0.99
7500	0.97	0.95	0.87	0.93	0.99	0.87	0.80	0.89
Mean	1.14	1.14	1.16		1.20	1.06	1.09	
Caroteniods								
Control	0.98	0.96	0.83	0.92	0.99	0.93	0.90	0.94
1500	1.03	0.99	0.96	0.99	1.01	0.99	0.98	0.99
3000	1.11	1.05	1.09	1.08	1.18	1.05	1.10	1.11
4500	1.15	1.03	0.98	1.05	1.09	1.10	1.03	0.07
6000	0.87	0.89	0.79	0.85	0.78	0.85	0.90	0.84
7500	0.79	0.85	0.69	0.78	0.63	0.80	0.87	0.77
Mean (B)	0.99	0.96	0.89		0.95	0.95	0.96	
Proline								
Control	24.86	26.12	23.13	24.70	18.11	17.13	19.51	18.25
1500	26.01	30.21	38.17	31.46	20.91	21.63	21.10	21.21
3000	30.63	32.86	34.11	32.53	21.19	27.20	24.18	24.19
4500	32.90	36.73	38.05	35.90	24.53	29.19	27.15	26.16
6000	38.31	40.15	38.95	39.14	29.11	29.17	28.10	28.97
7500	40.34	41.25	40.12	40.57	33.93	36.15	32.17	34.08
Mean (B)	32.18	34.55	35.42		24.63	26.75	25.39	

K content

The obtained data (Table 8)clearly indicated that, all saline water treatments caused a remarkable increase in the K content of leaves and stems over the control. Plants of cv. Gold Buttiana in the first season had the highest value of K content in their leaves and stems (2.079 and 1.948 K %D.W), the same cultivar had the highest value of K content in leaves in the second season(1.889 K% D.W), whereas plants of cv. White Buttiana, in the second season showed the highest value of K content in stems (1.839 K %D.W).Generally, it can be concluded that irrigating bougainvillea plants with saline water at the different levels decreased the content of N and P and increased the content of K in leaves and stems. The decrease in N and P , and the increase in K contents were in proportion with the level of salinity. These findings were in agreement with those obtained by El-Khateeb *et al* (1994) on tuberose, El-Khateeb and Salim (1994) on *Chrysanthemum frutescens*,

Table (7): Effect of saline water irrigation on nitrogen and phosphorus percent in leaves and stems of three cultivars of Bougainvillea Ms. Butte (cvs. White, Gold and Red Buttiana)1998 /1999 and 1999/2000 at seasons .

Saline water levels PPm	Season, 1998/1999			Mean	Season, 1999/2000			Mean
	White	Gold	Red		White	Gold	Red	
N % in leaves								
Control	1.93	1.83	1.86	1.87	1.82	1.75	1.63	1.73
1500	1.88	1.61	1.73	1.74	1.73	1.43	1.51	1.56
3000	1.79	1.36	1.23	1.46	1.60	1.35	1.41	1.45
4500	1.71	1.23	1.16	1.37	1.53	1.19	1.21	1.31
6000	1.66	1.15	1.13	1.31	1.49	1.21	1.20	1.30
7500	1.60	1.13	1.06	1.26	1.46	1.10	1.19	1.25
Mean	1.76	1.39	1.36		1.61	1.34	1.36	
N % in stems								
Control	1.79	1.23	1.32	1.45	1.56	1.31	1.40	1.24
1500	1.61	1.16	1.21	1.33	1.43	1.21	1.31	1.32
3000	1.45	1.12	1.16	1.24	1.39	1.13	1.21	1.24
4500	1.43	1.13	1.10	1.22	1.33	1.14	1.16	1.21
6000	1.38	1.01	1.09	1.16	1.31	1.09	1.09	1.16
7500	1.36	1.06	1.06	1.01	1.20	1.00	1.05	1.08
Mean	1.50	1.12	1.15		1.37	1.15	1.20	
P % in leaves								
Control	0.231	0.201	0.196	0.209	0.210	0.196	0.181	0.195
1500	0.210	0.210	0.193	0.204	0.200	0.198	0.173	0.190
3000	0.198	0.198	0.181	0.192	0.183	0.183	0.170	0.178
4500	0.178	0.191	0.173	0.181	0.169	0.196	0.165	0.177
6000	0.185	0.180	0.169	0.178	0.169	0.170	0.160	0.166
7500	0.170	0.176	0.168	0.171	0.159	0.173	0.153	0.162
Mean	0.195	0.192	0.180		0.182	0.186	0.167	
P % in stems								
Control	0.163	0.180	0.173	0.172	0.170	0.173	0.168	0.170
1500	0.182	0.173	0.165	0.173	0.173	0.164	0.165	0.169
3000	0.190	0.163	0.153	0.169	0.166	0.150	0.143	0.153
4500	0.163	0.158	0.143	0.155	0.153	0.145	0.140	0.146
6000	0.156	0.163	0.122	0.147	0.143	0.150	0.126	0.140
7500	0.150	0.140	0.120	0.137	0.140	0.140	0.119	0.133
Mean	0.167	0.163	0.146		0.156	0.155	0.144	

Ca, Na and Cl contents

(Tables 8 and 9) showed that, all saline water treatments increased the contents of Ca, Na, and Cl in the leaves and stems, as compared with the control plants. The increment in the content Ca, Na, and Cl were more pronounced with the higher salinity levels.

Comparing the values of Na content of the three cultivars of bougainvillea plants, the data obtained indicated that plants of cv. Red Buttiana in the both seasons contained the highest value of Na in the leaves and the highest Na value in stems in the first season, whereas plants cv. Gold Buttiana in the second one contained the highest value Na. The Ca content in leaves and stems of the three cultivars of bougainvillea in response to salinity treatments followed the same trend as Na content . The data obtained indicated that plants of cv. Red Buttiana in the both seasons contained the highest value of Ca in the leaves, and the highest value of Ca

in stems in the first season, whereas the highest value Ca. in the second season was recorded with, cv. White Buttiana. Concerning the effect of saline water irrigation on the Cl content of the three cultivars of bougainvillea, data indicated that plants of cv. Red Buttiana in the both seasons contained the highest value of Cl in the stems and the highest value of Cl in the leaves in the first season. Generally, it can be concluded that irrigating bougainvillea, plants with saline water at all levels (1500-7500 ppm) increased the content of Na, Ca and Cl in leaves and stems, the increases were in proportion with the level of salinity. Similar results were obtained by El-Khateeb *et al* (1994) on tuberose, El-Khateeb and Salim (1994) on *Chrysanthemum frutescens* and Sun *et al* (1996) on *Phylostachys vivax* plants .

Table (8): Effect of saline water irrigation on potassium and sodium percent in leaves and stems of three cultivars of Bougainvillea Ms. Butte (cvs. White, Gold and Red Buttiana) at 1998 /1999 and 1999/2000 seasons.

Saline water levels PPm	Season, 1998/1999				Season, 1999/2000			
	White	Gold	Red	Mean	White	Gold	Red	Mean
K% in leaves								
Control	1.530	1.713	1.552	1.598	1.451	1.550	1.462	1.488
1500	1.661	1.916	1.637	1.738	1.403	1.835	1.567	1.602
3000	1.945	2.310	1.711	1.988	1.766	1.963	1.839	1.856
4500	2.061	2.161	1.905	2.042	1.967	1.815	1.961	1.914
6000	2.510	2.186	2.161	2.288	2.061	2.051	1.991	2.034
7500	2.431	2.188	2.310	2.309	2.113	2.119	2.100	2.111
Mean	2.023	2.079	1.880		1.794	1.889	1.800	
K % in stems								
Control	1.400	1.600	1.413	1.471	1.332	1.456	1.351	1.379
1500	1.303	1.362	1.400	1.355	1.653	1.400	1.367	1.473
3000	1.836	1.961	1.653	1.817	1.916	1.759	1.436	1.704
4500	2.163	1.990	1.911	2.021	2.003	1.799	1.753	1.852
6000	2.173	2.361	1.965	2.166	2.111	1.969	1.891	1.990
7500	2.163	2.413	2.110	2.229	2.018	2.015	1.952	1.995
Mean	1.839	1.948	1.742		1.839	1.733	1.625	
Na % in leaves								
Control	0.730	0.780	0.810	0.773	0.650	0.650	0.830	0.710
1500	0.790	0.910	0.890	0.863	0.830	0.960	0.890	0.893
3000	1.003	0.990	1.001	0.998	1.001	1.030	1.031	1.020
4500	1.008	1.030	1.050	1.029	1.008	1.063	1.063	1.045
6000	1.059	1.123	1.163	1.113	1.023	1.130	1.250	1.134
7500	1.101	1.125	1.203	1.143	1.068	1.163	1.330	1.187
Mean	0.948	0.993	1.019		0.930	0.999	1.065	
Na % in stems								
Control	0.880	0.800	0.980	0.887	0.730	0.830	0.650	0.737
1500	0.900	0.810	0.990	0.900	0.880	0.880	0.850	0.870
3000	1.060	0.830	1.030	0.973	1.005	1.053	1.013	1.024
4500	1.093	1.030	1.161	1.095	1.063	1.101	1.015	1.059
6000	1.096	1.020	1.125	1.080	1.083	1.153	1.109	1.115
7500	1.113	1.119	1.350	1.194	1.093	1.430	1.235	1.253
Mean	1.024	0.934	1.106		0.976	1.075	0.979	

Table (9): Effect of saline water irrigation on calcium and chloride percent in leaves and stems of three cultivars of Bougainvillea Ms. Butte (cvs. White, Gold and Red Buttiana) at 1998 /1999 and 1999/2000 seasons.

Saline water levels PPm	Season, 1998/1999				Season, 1999/2000			
	White	Gold	Red	Mean	White	Gold	Red	Mean
Ca % in leaves								
Control	0.63	0.69	0.88	0.73	0.73	0.83	0.90	0.82
1500	0.69	0.89	0.91	0.83	0.79	0.93	0.99	0.90
3000	0.78	0.88	0.99	0.88	0.81	1.05	1.05	0.97
4500	0.99	1.04	1.01	1.01	1.30	1.08	1.10	1.16
6000	1.01	1.11	1.36	1.16	1.10	1.15	1.23	1.16
7500	1.04	1.21	1.31	1.19	1.16	1.19	1.25	1.20
Mean	0.86	0.97	1.08		0.98	1.04	1.09	
Ca % in stems								
Control	0.78	0.85	0.80	0.81	0.83	0.93	0.99	0.97
1500	0.79	0.96	0.87	0.87	0.98	0.95	1.01	0.98
3000	0.91	1.08	1.06	1.017	1.10	0.99	1.01	1.03
4500	1.05	1.22	1.11	1.127	1.16	1.13	1.20	1.16
6000	1.08	1.25	1.36	1.23	1.16	1.13	1.20	1.16
7500	1.21	1.35	1.45	1.34	1.19	1.19	1.29	1.22
Mean	0.97	1.12	1.11		1.081	1.073	1.15	
Cl % in leaves								
Control	0.58	0.68	0.53	0.60	0.59	0.58	0.81	0.66
1500	0.68	0.88	0.83	0.80	0.63	0.61	0.95	0.73
3000	0.91	1.06	0.89	0.95	0.90	1.01	0.96	0.95
4500	1.11	1.09	1.03	1.08	1.02	1.02	1.06	1.03
6000	1.15	1.13	1.25	1.18	1.11	1.18	1.26	1.18
7500	1.23	1.28	1.40	1.30	1.26	1.25	1.36	1.29
Mean	0.94	1.02	0.99		0.92	0.94	1.07	
Cl % in stems								
Control	0.60	0.65	0.59	0.61	0.58	0.53	0.75	0.62
1500	0.64	0.86	0.73	0.74	0.68	0.69	0.81	0.73
3000	0.83	0.95	0.99	0.92	0.88	0.73	0.99	0.87
4500	0.88	0.99	1.10	0.99	1.10	0.88	1.05	1.01
6000	1.09	1.10	1.20	1.13	1.12	1.10	1.20	1.14
7500	1.13	1.25	1.31	1.23	1.20	1.23	1.31	1.27
Mean	0.86	0.97	0.99		0.93	0.86	1.02	

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استجابة ثلاثة أصناف لنبات الجهنمية للرى بالماء الملحى

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أجريت تجربة أصص خلال موسمي ١٩٩٨/١٩٩٩ ، ١٩٩٩/ ٢٠٠٠ لدراسة مدى استجابة ثلاثة أصناف من الجهنمية للري بالماء المالح. وأظهرت النتائج وجود نقص معنوي في طـــول النباتـــات وســـمك الساق وعدد الأوراق والنورات، مع معاملات الري بالماء المالح.

وكانت نتائج الصنف بوتيانا الأبيض وبوتيانا الأحمر هي أطول النباتات، أمـــا الصنـــف بوتيانـــا الذهبي أعطى أكبر سمك للساق في الموسمين. كما أن الصنف الأبيض أعطى أكبر عـــدد للأفـــرع وكذلـــك النورات. بينما الصنف الأحمر أعطى أكبر عدد للأوراق.

ووجد أن جميع معاملات الري الملحي أدت إلى نقص محتوى كلوروفيـــل أ،ب وكـــانت نباتـــات الصنف الأحمر في الموسم الأول ، والأبيض في الموسم الثاني تحتوى على أعلى قيم لصبغـــة الكلوروفيـــل. وكانت هناك زيادة في محتوى الكاروتينات للنباتات المعاملة بالمـــاء الملحـــي بتركـــيزات ١٥٠٠، ٣٠٠٠، ٤٥٠٠ جزء في المليون. وزيادة في محتوى النباتات للبرولين تحت جميع مســـتويات الملوحـــة. واحتـــوت نباتات الصنف الأحمر والذهبي على أعلى قيم للحمض الأميني برولين في الموسم الأول والثاني على التوالي فيما الصنف الأبيض كان محتوى البرولين به منخفض في الموسمين.

وأدت الملوحة على نقص محتوى النتروجين والفوسفور وزيادة محتوى البوتاســـيوم والكالســـيوم والصوديوم والكلوريد في الأوراق والسيقان الأصناف الثلاثة لنباتات الجهنمية.

والخلاصة أن نباتات الجهنمية الصنف بوتيانا الأبيض أعطى أعلى القيم بطول النباتـــات وعـــدد الأفرع والأزهار، والأوزان الجافة للسوق وأقل قيم للبرولين والصوديوم، والكالسيوم. ويعتبر أكـــثر تحمـــلا للملوحة من الصنفين الآخرين الأحمر والذهبي.