Effect of Compost Application and Salina Irrigation Water on the Production of Roselle Plants Cultivated in Lacustrine Soil

EL- Kouny, H. M. [1], A. I. Sharaf [2] and A. H. EL-Naggar [3]
[1] Soil, Water and Environment Res. Inst., Agric. Res. Station, El-Sabhia, Alexandria, Egypt;
[2] Soil & Water Sci. Dept., Faculty of Agriculture, EL-Shatby, Alexandria Univ., Alexandria, Egypt;
[3] Floriculture, Ornamental Horticulture and Landscape Gardening Dept., Faculty of Agriculture,EL- Shatby, Alexandria Univ., Egypt

ABSTRACT

In open field, two pot experiments were carried out for two successive growing seasons of 2001 and 2002 on a Lacustrine soil, at Soil Salinity and Alkalinity Laboratory, Agric. Res. Center, El-Sabahia (at Abis), Alexandria, Egypt to investigate the effects of compost rates (0.0, 12.0, 17.9 and 23.8 m^3 ha^{-1}) on the growth, yield and quality of Roselle (Karkade) plants (*Hibiscus sabdariffa*, L.) cv. "Sabahia 17" which irrigated with different levels of water salinity (190 (tap water), 2000, 4000 and 8000 mg l^{-1}) and on soil fertility. The best results of plant growth, yield and quality were obtained from using saline irrigation water levels of 2000 and 4000 g l^{-1} in combination with 17.9 and/or 23.8 m^3 ha^{-1} of compost rates, in both the two growing seasons. The increment applications of compost rates significantly decreased the soil EC and SAR; and also the significantly increased CEC with any of saline irrigation water levels. The obtained results indicated that addition of compost rates with saline irrigation water levels up to 8000 mg l^{-1}, improved the fertility (significantly increase of available N, P and K); and chemical soil properties and prevent the increase of soil salinity as well as increased the plant growth parameters (height, number of branches/plant, number and dry weight of leaves/plant, yield (number and fresh weight of fruit/plant; fresh and dry weight of sepals/plant) and quality (anthocyanine and vitamin C) of Roselle plants grown in Lacustrine soil.

Key words: Saline irrigation water, Roselle plant, Compost rates, Medicinal plant, Lacustrine soil, Anthocyanine and Vitamin C.

INTRODUCTION

Salinity has long been recognized as a problem in arid and semiarid regions of the world. Groundwater and agriculture drainage water are the two main forms of water used besides the Nile water in Egypt. Nowadays, about 4 billion m^3 $year^{-1}$ of agriculture drainage water is officially used in irrigation, either after mixing with fresh water or directly if its salinity is low (Morsy, 2003). Irrigation with marginal quality water, such as brackish water, treated and untreated waste water and even sea water, without proper management could produce adverse effects on crop production and soil productivity through deterioration of soil quality (Afifi *et al.*, 1998).

In Egypt, especially in the new reclaimed lands, soil salinity is considered one of the problems facing agricultural production and about 30 – 35% of irrigated soils of Egypt are affected by salinity and waterlogging (FAO, 1970). The use of saline water for irrigation affects growth and chemical analysis of plants and many soil characteristics (Wilcox & Durum 1967). There were many studies to avoid the risk of soil water salinity, a fair number of investigations were carried out using organic materials e.g,. animal manure, poultry manure and compost (Wasif *et al.*, 1995).The stabilized compost is widely used as a soil amendment to improve soil structure, provide plant nutrients, and facilitate the re-vegetation of disturbed or eroded soil (Cole *et al.*, 1994 and Cole *et al.*, 1995). When mature compost is added to saline and contaminated soils, remediation costs are quite modest in comparison to conventionally used methods. Mature compost also controls several plant diseases without the use of synthetic fungicides or fumigants (Cole *et al.*, 1995).

The compost has a high microbial diversity (Beffa, 1996), with microbial populations much higher than fertile, productive soils and many times higher than in highly disturbed or contaminated soils.In most cases, the addition of compost greatly increases microbial populations and activity.The organic fertilization is a very important factor for providing plants with their nutritional requirements without having an undesirable impact on the environment (Kandeel and Naglaa Abou-Taleb, 2002); Organic fertilization also provides the means for stabilizing soil fertility (especially in newly reclaimed desert land) by sustainably improving the chemical and physical characteristics of the soil (El-Sayed *et al.*, 2002).

Medicinal plants occupied a prominent economic position because of the continuous increasing demand for these medicinal is products from the local and foreign markets. Among these medicinal Roselle plant (*Hibiscus sabdariffa*, L.), which is a small cultivated shrub about 2 m height. This plant belongs to family of *Malvaceae* and has a common name in Egypt as Karkade.It is used as a source of vitamin C, diuretic, mild laxative and intestinal antiseptic. It reduces blood pressure, and stimulates intestinal peristalsis. The red colouring matter is used cosmetics, jams, and used as a poultice on abscess. The dried red sebals and bractedes are used for preparing cold and hot soft drink. Also Roselle (*Hibiscus sabdariffa*, L.) is an important plant for its high anthocyanin contents (Sharaf, 1962).

The objective of this work was to investigate the effect and efficiency of compost application rates under irrigation with saline water levels on the growth analysis and yield of *Hibiscus sabdariffa* L. cv. "Sbahia 17" plant grown on Lacustrine clay loam soil.

MATERIALS AND METHODS

Pot experiments, under open field condution, were conducted during two summer seasons of 2001 and 2002 using Lacustrine soil at the experimental station of Soil Salinity and Alkalinity Laboratory, Agric. Res. Centre, El-Sabahia (at Abis), Alexandria, Egypt.

Composite soil sample was collocated (0 – 30 cm) for the determination of thre main chemical and physical characteristics of the soil. The source of organic compost was prepared from a mixture of animal wastes and plant residues (EL-Kouny, 1999).

Experimantal layout:

Each experiment was consisted of combinations of four levels of water salinity and four compost application rates. The experimental layout was split-plot design for arrangement of pots with four replicates. Ten plants were used for each treatment in the replicate (Snedecor and Cochran, 1981). Water salinity treatments were arranged in the main treatments, while the compost application rates were randomly distributed in the sub- treatments and all were treated under open filed condition.

Four levels of water salinity were obtained by diluting and mixing the suitable quantity of tap water with sea water to reach the required concentrations of water salinity levels [190 (tap water), 2000, 4000 and 8000 mg l^{-1}]. The tap water was used for the control treatment (E.C. varied from 165 to 215 mg l^{-1} during the experiment period of both the two seasons). The ratio of the soluble cations cocentrations of the irrigation water was 1: 1.2: 25.6: 4.8 for Ca^{2+}, K^{+}, Na^{+}, and Mg^{2+}, respectively, for all salinity levels used.

Four rates of air-dried compost (0.0, 0.10, 0.15 and 0.20 m^3 per 20 kg soil) were mixed together with the soil before packing into the pots. These rates repersent approximately 0, 12.0, 17.9 and 23.8 m^3 ha^{-1}, respectively.

Each pot was fertilized with 3 grams of superphosphate fertilizer (15.5 % P_2O_5) and 1.5 grams of potassium sulfate fertilizer (48.0 % K_2O). These fertilizers were mixed with the soil, as the basic treatments, before packing the pot. These doses were approximately equivalent to fertiliztion rates of 55.80 kg of P_2O_5 and 86.40 kg of K_2O per hectare, respectively. Ammonium sulfate fertilizer (20.5 % N) was applied at a rate of 5 grams per pot, in two equal doses, after 40 and 70 days from sowing, respectively. These doses were equavelant a rate of 600 kg N ha^{-1} .

Subsamples of unamended and amended soil and compost materials were collected, air-dried, ground and passed through a 2 mm sieve. These subsamples were prepared for the determination of the bulk density and water holding capacity (WHC) as described by Wright (1954), pH (1: 2.5 soil: water) using glass-electrode pH meter, Electrical conductivity (E.C) of the saturated extract of soil paste, and water soluble cations and anions of extract of the saturated soil paste (Richards, 1954). Available P was extracted by 0.5 N $NaHCO_3$, at pH 8.5, according to Olson and determined calorimetrically using stannus chloride (Jackson, 1958). Organic matter was determined by Walkley and Black method and total N by Kjeldahl method according to Jackson (1967). The percentage of total carbonates was determined volumetrically using Collin's calcimeters and available N (Av-N), P (Av-P) and K (Av-K) were determined as outlined by Black *et al.*, (1982). Cation exchangeable capacity (CEC) were determined using NH_4-OAc method and the mechanical analysis of soil were determined according to (Page *et al.*, 1982). The compost analysis was carried out as described by EL-Kouny (1999). DTPA was used for extracting Fe, Zn and Mn (Lindsay and Norvell, 1978). The data obtained are given in Tables (1), (2) and (3).

At the harvesting stage, soil samples were taken from each treatment for the determination of the different chemical properties.

Table 1. The main physical properties of the used soil before addition of compost .

Particle size distribution %				Texture	Water holding capacity,%	Bulk density, g/cm^3	Total Carbonate, %
C. sand	F. sand	Silt	Clay				
3.00	12.00	22.50	62.50	Clay loam	38.0	1.67	8.50

Table 2. The main chemical properties of the soil before addition of compost.

pH (1:2.5)	E.c (dS m^{-1})	Cations (me/l)				Anions (me/l)			O.M, %	C.E.C, C mol/kg	Av-N, ppm	Av- P, ppm	Av- K, ppm
		Ca^{+2}	Mg^{+2}	Na^{+2}	K^+	HCO_3^{-2}	Cl^-	SO_4^{-2}					
8.2	2.5	4.2	2.2	17.6	0.8	3.8	14.7	4.5	1.8	62.5	21.0	10.0	76.5

Table 3. The main chemical characteristics of the used compost.

Bulk density, Kg/m^3	pH*	EC*, dSm^{-1}	T-N, %	T-C, %	C/N Ratio	T-P, %	T-K, %	C.E.C, Cmol/kg	DTPA-extraction, ppm		
									Fe	Zn	Mn
440	7.06	4.01	1.95	36.5	18.7	1.71	1.11	180	850	110	250

*Determination of pH and EC of compost was made in compost: water suspension (1:10)

Planting practies:

Clay pots of 40 cm depth and 30 cm diameter was filled with 20 kg soil or with soil and mixed with the compost rate. All pots were placed before planting to open field during the summer season at temperature between 24 and 33 °C.

seeds of Roselle plant, cultivars "Sabhia 17", were sown in each pot at about 3 cm depth from soil surface, on June 3, 2001 and June 9, 2002 in the first and second growing seasons, respectively. The pots were lightly irrigated, for two weeks before planting with tap water, to establish a good microbial activity for decomposing compost material before sowing of seeds. The seedling were thinned out to one plant in each pot after four weeks from sowing. The pots were then irrigated every two days the tested water treatments. The moisture content was kept at 70 % of soil water- holding capacity.

Measurements of plant height (cm), number of branches/plant, number and dry weight of leaves/plant, number of sebals and fresh and dry weight of sepals/plant were recoreded at the maturity of sebals. Whereas, the determinations of the anthocyanin pigment and Vitamin C (mg/100 gm) were carried out as described by Fahmy, (1970).

The obtained data were statistically analyzed for L.S.D (Snedecor and Cochran, 1981).

RESULTS AND DISCUSSION

I- Vegetative growth:

plant height (cm):

Table (4) showed that the height of Roselle plant (*Hibiscus sabdariffa*, L.), at harvest time, significantly increased with increasing compost application rates (12.0, 17.9 and 23.8 m^3 ha^{-1}) in combined with levels of water salinity at 2000 and 4000 mg l^{-1}, as compared with the control treatment in the two growing seasons. However, the plant height significantly decreased at water salinity of 8000 mg l^{-1}only, as compared with the control treatment, in the two

Table 4. Plant height (cm), number of branches/plant, number of leaves/plant and leaves dry weight (g) of *Hibiscus sabdariffa*, L. cv., "Sabafia 17" cultivated in two successive seasons (2001 and 2002).

Plant Parameters	Plant height, (cm)									
Seasons	2001					2002				
Treatments	Water Salinity, mg L^{-1}					Water Salinity, mg L^{-1}				
Compost rate, $M^3 ha^{-1}$	Control	2000	4000	8000	Mean	Control	2000	4000	8000	**Mean**
00.0	77.2	82.6	79.2	64.4	75.9	75.4	84.2	79.8	68.4	**77.0**
12.0	109.2	132.2	138.3	124.2	126.0	110.8	134.4	141.3	129.2	**128.9**
17.9	122.6	139.4	144.6	137.2	136.0	125.4	144.2	147.6	142.4	**139.9**
23.8	126.4	149.6	156.2	128.7	140.2	123.2	154.6	156.7	125.8	**140.1**
Mean	108.9	126.0	129.6	113.6	119.5	108.7	129.4	131.4	116.5	**121.5**
LSD 0.05	Salinity		7.2					8.1		
	Compost		17.8					18.2		
	Interaction		21.52					22.9		
	Number of branches/plant									
00.0	3.12	3.79	4.46	3.17	3.64	3.22	3.84	3.52	3.26	**3.46**
12.0	4.22	4.32	6.62	6.12	5.32	4.20	4.62	6.74	5.16	**5.18**
17.9	4.42	5.53	7.42	6.90	6.07	4.53	4.32	7.38	5.82	**5.51**
23.8	5.54	4.74	7.62	5.72	5.91	5.52	4.28	7.82	5.22	**5.71**
Mean	4.33	4.60	6.53	5.48	5.23	4.37	4.27	6.37	4.87	**4.97**
LSD 0.05	Salinity		1.22					1.25		
	Compost		2.51					2.67		
	Interaction		3.65					3.66		
	Number of leaves/plant									
00.0	43.56	45.34	46.15	44.72	44.94	42.25	45.90	43.50	40.56	**43.05**
12.0	54.86	70.12	70.16	69.46	66.15	52.81	77.38	75.95	64.88	**67.76**
17.9	64.81	78.00	69.10	68.35	70.07	63.12	70.68	69.61	65.24	**67.16**
23.8	66.90	76.25	64.25	62.92	67.58	65.89	75.81	74.38	60.66	**69.19**
Mean	57.53	67.43	62.42	61.36	62.18	56.02	67.44	65.86	57.84	**61.79**
LSD 0.05	Salinity		1.44					1.45		
	Compost		3.46					3.66		
	Interaction		5.56					5.85		
	Leaves dry weight, (g/plant)									
00.0	7.18	9.45	7.22	7.00	7.71	7.16	9.42	7.17	7.15	7.73
12.0	8.15	11.67	10.16	10.12	10.03	8.10	13.95	10.50	9.21	**10.44**
17.9	9.01	13.92	10.40	10.28	10.90	9.12	12.19	10.43	10.15	**10.47**
23.8	9.14	12.16	10.31	9.18	10.20	9.20	11.56	10.15	9.81	**10.18**
Mean	8.37	11.80	9.52	9.15	9.71	8.40	11.78	9.56	9.08	**9.70**
LSD 0.05	Salinity		2.29					2.31		
	Compost		2.10					2.23		
	Interaction		3.40					3.21		

growing seasons. The highest values of plant height were obtained by addition of compost at a rate of 23.8 m^3 ha^{-1} and at water salinity level of 4000 mg l^{-1} as compared with the other treatments, in the two growing seasons. There were no significant difference of plant hight between the treatments of water salinity namely 2000 and 4000 mg l^{-1} at any compost rate. These results were similarly found in the both the two growing seasons.

These results may be related to the effect of the water salinity, with addition of compost which improved the availability and absorption of the nutrient elements leading to increase the growth of plant. On the other hand, the reduction of plant height under high salinity (8000 mg l^{-1}) without compost application may be due to the accumulation of the salts in the soil which increased the osmotic pressure of tissue cells of plant and depressed water absorption. This is elso related to the reduction in cambium activity and maturation of smaller cell size (Wareing and Phillips, 1974).Similar results were obtained by Osbrien and Barker (1996) on *Mentha piparita* plants.

Number of main branches per plant:

Table (4) showed that irrigation water salinity at level of 4000 mg l^{-1} in combination with compost rates of 17.9 and 23.8 m^3 h^{-1}, gave increased the number of branches per plant (as an average of the treatments) compared with the other treatments in both two seasons. The highest number of branches/plant was obtained by irrigation with saline water of 4000 mg l^{-1} in combination with 23.8 m^3 h^{-1}. The relative increases were 2.16 and 3.30 in the two seasons, respectively, as compared with the control treatment. These increases may be due to the effect of the optimum level of salinity as well as to the applied compost rate which was suitable to increase the amount of nitrogen absorbed and also to increase the biosynthesize rate (Hewitt and Cutting, 1979).The obtained results (Table 4) are in agreement with those reported by Hwang and Yoon (1995) on chrysanthemum and carnation plants and Osbrien and Barkar (1996) on pippermint plants.

Number and dry weight of leaves /plant:

Table 4 showed that the average number and dry weight of leaves/plant significantly increased by using 2000 mg l^{-1} level of water salinity with compost application at the same rate (12.0, 17.9 and 23.8 m^3 ha^{-1}). The best results were found by using saline water at 2000 mg l^{-1} with compost application rate at 17.9 m^3 ha^{-1}, during the first season, and 12.0 m^3 ha^{-1} during the second season, as compared with the other treatments. The percent increase of the leaves number were 27.97 % and 31.42 %, in the first and second seasons, repectively. At the harvest time, the highest dry weight of the leaves were produced by using saline irrigation water of 2000 mg l^{-1} plus 17.9 or 12.0 m^3 ha^{-1} in the first and second seasons, respectively. These treatments lead to an increase of the leaves dry weight by 47 30 % and 48 08 % as the percent increase relative to the control for both the first and second seasons, respectively.

These finding may be attributed to the roles of the compost for improving the chemical properties of the soil, as well as keeping the suitable amount of water in the soil. At high saline condition, the leaf area and leaves dry weight per plant was decreased due to inhibition of cell division due to of toxicity of Cl^-. These results are in agreement with those reported by Ponchia and Zanin (1998) on *Prunus laurocevosus* plants.

II- Yield production

Number and fresh weight of fruits plant:

The obtained results revealed that the mean of number and fresh weight of fruit markedly increased as a result of irrigation with suitable levels of saline water(2000 mg L^{-1}) in combination with compost application(23.8 m^3 ha^{-1})as compared with the control treatment (Table 5). The highest number of fruits/plant, on the average, was 23.00 and 25.00 in the first and second seasons, respectively. Also, the heaviest fresh weight of fruits/plant, on the average, was 80.02 and 82.12 (g) in the first and second seasons, respectively. The number and fresh weight of fruits/plant tended to decrease with increasing water salinity level and observed as a result of supplying the plants with high level of salinity in both two seasons.

The increment in the number and fresh weight of fruits, as a result of using the low level of water salinity (2000 mg L^{-1}) plus suitable rate of compost (23.8 m^3 ha^{-1}), may be related to an improvement of the hydrophysical and chemical characterisrtics of the soil, which would lead to increase the availability and uptake of nutrient elements such as nitrogen and phosphorus. On the other hand, the observed decrease in this respect as a result of using high level of salinity up to 8000 mg L^{-1} may be due to the presence and accumulation of toxic ions (Na^+ and Cl^-) in the plant tissues which may raise the respiration and reduced the photosynthetic process and leading to a poor production of fruits number, consequntly fruit dry weight could be decreaed (Green way, 1973). Similar results were reported by Holcomb (1984) on *Tagetes sp* and Devitt *et al.*, (1991) on *Catharanthus roseus.*

Fresh and dry weights of sepals/plant :

Table (5) showed that there was significantly increase of fresh and dry weights of sepals by using saline irrigation water at low level (2000 mg L^{-1}) with compost applications rates at 17.9 and 23.8 m^3 ha^{-1} in the two seasons as compared with that of the control treatment. While, the fresh and dry weights of sepals were significantly decreased with increasing levels of water salinity at 4000 or 8000 mg l^{-1} compared with the water salinity at 2000 mg l^{-1}. Futher more, the heaviest fresh and dry weights were obtained by using water salinity at 2000 mg L^{-1} in combination with 17.9 or 23.8 m^3 ha^{-1}, during the both seasons compared with the other treatments. There were insignificant difference between treatments of water salinity of 2000 mg L^{-1} in combination with compost rates of 17.9 or 23.8 m^3 ha^{-1}, for the fresh or dry weights, in the two growing seasons. The decompostion of compost in the soil produces soluble nutrient elements and humic acid contained functional groups, which are responsible for complexation of elements in soil and concequantly, they are expected that the suppling power for more available nutrient elements in the soil (Abdel-Latif, 1973). This result could be attributed to the effect of low salinity at the compost rates which contain the required nutrients for optimum growth of the plants leading to more accunulation of biosynthesates; thus enhancing the formation of sepals per plant and consequently the fresh and dry weights of sepals could be increased. Similar results were found by El-Sayed (1991) and Pinamonti *et al.*, (1997).

The reduction in the fresh and dry weight of sepals as a result of using highest saline irrigation water level (8000 mg L^{-1}) produced growth with smaller spales and consequently the fresh and dry weight could be decreased. These results were in harmony with those obtained by Nieman (1965) on bean and Dawh *et al* (1985) on chrysanthemum plants.

III- Chemical analysis of sepals

Table (6) showed that the anthocyanine percentage of dried sepals and vitamin C content (mg /100 g sepals dry weight) of Roselle plants (*Hibiscus sabdariffa*, L.) tented to significant increase with increasing compost rates at any levels of salinily of irrigation water. Generally, the highest significant increase of anthocyanine percentage and vitamin C content resulted from using water salinity of 2000 mg l^{-1}, and significantly increased with increase rates of compost up to 17.9 or 23.8 m^3 ha^{-1} , as compared with the other treatments, during the two growing seasons.

These results could be attributed to enhancing effect of the suitable levels of water salinity at 2000 mg l^{-1} in combination with the suitable rate of compost, directly or indirectly, on increasing the availability and absorption of the essential nutrient elements, specially iron (Fe^{2+}) magnesium (Mg^{2+}) nitrogen (NH_4^{2+}) and soluble phodphorus, which are necessary in synthesis of phospholipids of membranes, sugar phosphates various nucleotides and co-enzymes. These results agree with those of Moore (2000) on *Salvia splendens* plants. These increases varied from 1.69 to 2.37 % and from 5.57 to 13.30 (mg/100 g sepals dry weight) for anthocyanine percentage and vitamin C,respectively. Furthermore, the anthocyanine percentage and vitamin C content decreased with increasing the levels of water salinity more than 2000mg l^{-1}.

Table 5. The fruit yield of *Hibiscus sabdariffa*, L. cv., "Sabafia 17" cultivated in the two successive seasons (2001 and 2002).

Plant Parameters	Number of fruits /plant									
Seasons	2001					2002				
Treatments	Water Salinity, mg L^{-1}				Mean	Water Salinity, mg L^{-1}				Mean
Compost rate, m^3 ha^{-1}	Control	2000	4000	8000		Control	2000	4000	8000	
0	6.00	9.75	7.00	6.45	7.30	6.25	10.50	7.75	6.53	7.76
12	12.25	18.00	14.75	12.00	14.25	12.00	18.00	14.50	12.05	14.14
17.9	12.75	20.25	16.00	12.00	15.25	18.00	21.00	15.75	13.55	17.08
23.8	15.50	23.00	16.00	12.50	16.75	16.50	25.00	16.00	13.75	17.81
Mean	11.63	17.75	13.44	10.74	13.39	13.19	18.63	13.50	11.47	14.20
LSD 0.05	Salinity 3.03- Compost 2.51-Inter*. 8.11					Salinity 2.61- Compost 3.17-Inter.6.87				
	Fresh weight of fruits/plant, (g)									
0	40.21	46.30	42.00	40.00	42.13	41.24	48.86	43.30	39.20	43.15
12	60.90	73.88	65.81	61.20	65.45	60.10	75.31	66.30	63.30	66.25
17.9	71.80	78.91	67.00	65.30	70.75	73.81	80.86	65.50	61.80	70.49
23.8	68.96	81.52	66.02	63.50	70.00	69.95	82.12	64.37	62.30	69.69
Mean	60.47	70.15	60.21	57.50	62.08	61.28	71.79	59.87	56.65	62.40
LSD 0.05	Salinity7.22- Compost 5.72-Inter.6.72					Salinity 6.87- Compost 7.33-Inter.7.75				
	Fresh weight of sepals/plant, (g)									
0	28.00	42.25	37.72	34.40	35.59	25.30	27.00	20.46	20.70	23.37
12	50.50	72.36	46.26	44.30	53.36	41.06	71.50	46.51	44.50	50.89
17.9	51.23	77.73	56.51	55.80	60.82	42.82	78.85	50.32	47.30	54.82
23.8	64.41	80.40	54.37	52.50	63.20	65.77	75.96	59.80	52.70	63.56
Mean	48.54	68.96	48.72	46.75	53.24	43.74	63.33	44.27	41.30	48.16
LSD 0.05	Salinity 3.42- Compost 5.24-Inter.6.87					Salinity 5.86- Compost 5.36-Inter.7.54				
	Dry weight of sepals/plant (g)									
0	3.15	3.61	3.10	2.80	3.17	3.13	3.73	3.12	2.73	3.18
12	4.18	6.21	3.75	3.84	4.50	4.16	5.96	3.79	3.52	4.36
17.9	5.19	7.25	5.29	4.65	5.60	4.18	6.20	3.80	3.45	4.41
23.8	4.92	7.49	3.83	3.75	5.00	5.00	6.47	3.76	3.41	4.66
Mean	4.36	6.14	3.99	3.76	4.56	4.12	5.59	3.62	3.28	4.15
LSD 0.05	Salinity 0.50- Compost 1.25-Inter.0.75					Salinity 0.60- Compost 1.26-Inter.0.88				

- Inter=interaction

Table 6. The values of Anthocyanin (%) and Vitamin C (mg/100 g of sepals dry weight) of *Hibiscus sabdariffa*, L. cv., "Sabafia 17" cultivated in the two seasons (2001 & 2002).

Plant Parameters	Anthocyanine, (%)									
Seasons	2001					2002				
Treatments	Water Salinity, mg L^{-1}				Mean	Water Salinity, mg L^{-1}				Mean
Compost rate, m^3 ha^{-1}	Control	2000	4000	8000		Control	2000	4000	8000	
0	1.12	1.69	1.30	1.18	1.32	1.13	1.71	1.60	1.55	1.49
12	1.28	1.88	1.79	1.67	1.66	1.32	1.91	1.75	1.69	1.67
17.9	1.36	2.12	1.87	1.76	1.78	1.64	2.15	1.93	1.86	1.85
23.8	1.51	2.37	1.89	1.79	1.89	1.73	2.40	1.90	1.87	1.82
Mean	1.32	1.92	1.59	1.49	1.66	1.46	1.95	1.78	1.62	1.71
LSD 0.05	Salinity	0.52				0.48				
	Compost	0.12				0.14				
	Interaction	1.10				1.21				
	Vitamin C (mg/ 100 g sepals dry weight)									
0	5.36	5.57	5.00	4.58	5.13	5.39	5.56	5.09	5.00	5.26
12	6.26	10.62	6.72	6.00	7.40	6.30	10.51	6.18	6.03	7.26
17.9	7.85	12.62	8.88	7.72	9.27	7.90	12.34	6.39	6.12	8.19
23.8	8.97	13.30	7.59	7.28	9.29	8.98	13.38	6.41	6.10	8.72
Mean	7.11	10.56	7.05	6.40	7.77	10.48	10.45	6.02	5.81	7.36
LSD 0.05	Salinity	3.30				3.11				
	Compost	1.70				1.53				
	Interaction	3.94				3.73				

IV- Chemical composition of the soil after plant harvest:

Table (7) showed that the soil EC significantly increased, as well as SAR, with increasing ths levels of water salinity from 2000 to 8000 mg l^{-1} at any rate of the applied compost compared with that of the control.

Application of compost significantly decreased soil E.C with increasing rates of compst up to 23.8 m^3 ha^{-1} at any water salinity levels. The relative decreases of soil E.C were 13.01, 8.84 and 5.52 % at water salinity level of 2000 mg l^{-1}; while the relative decreases were 17.47, 20.72 and 21.38 % at water salinity level of 4000 mg l^{-1}; and were 25.65, 29.01 and 31.03 % at water salinity level of 8000 mg l^{-1}, compared with the control, by using the compost rates of 12.0, 17.9 or 23.80 m^3 ha^{-1}, respectevily (Fig., 1). The same trend occurred at the second season (Fig. 2). The highest percent decrease of soil E.C. (31.03 and 33.54 % for the first and second season, respectively) were found with the high level and high rate of water salinity and compost, respectively. The low rate of applied compost was more effective on decreasing soil E.C. at water salinity levels of 2000 mg l^{-1} than 8000 mg l^{-1}, whereas the high rate of comopst was more effective on decreasing the soil E.C. at high level of water salinity in the two seasons (Figs, 1 and 2).

The significant increment of soil EC and as well as SAR of studied soil (Table, 7), specially at the heighest level of water salinity (8000 mg l^{-1}), may be due to increase soluble cations and anions and accumulation of ions in the soil solution resulted from irrigation with saline water.

Increment rates of compost to the soil would improve soil structure since the compost materials act as soil conditioners and enhance physical and chemical soil properties. This action may perform movement and leaching of the soluble salts out of root zoon, specially, at high rates of compost application.

The decrease of soil EC were from 2.69 to 2.00; 3.62 to 2.57 and 4.35 to 3.00 dS/m at irrigation water salinity of 2000, 4000 and 8000 mg L^{-1} , respectively. Also, the reduction of SAR values were from 12.25 to 7.25; 13.75 to 12.50 and 14.30 to 13.10 at irrigation water salinity of 2000, 4000 and 8000 mg L^{-1}, respectively. These results are due to increasing rates of compost application from 12.0 to 23.8 m^3 ha^{-1} (Table, 7). These results agree with those obtained by Awad (1994).

Table (7) showed that CEC significantly increased with increasing compost rates when using saline water at 2000 mg L^{-1}, and also with increasing water salinity from 4000 to 8000 mg L^{-1}, in both two seasons. Whereas, increasing compost rates significantly increased CEC of soil at any levels of saline irrigation water (Table, 7). More than 25 % increasing of CEC were observed in the highest rate of compost applisation at any level of water salinity, in the two seasons, compared with that of the control treatments (Fig., 3 and 4). These may be due to that compost materials had high CEC value (Table, 3) and also having functional groups that responsible for increasing the CEC of the soil.

Table (8) showed that compost application significantly increased available nitrogen (Av-N), phosphorus (Av–P) and potassium (Av–K) with increasing the rates of compost. The low levels of available N or available P of untreated soil with compost were significant with increasing of water salinity levels. However, these decreases of availability of N or P with increasing water salinity were insignificant with application any rate of compost. Moreover, the effect of salinity and compost on the levels of available N, P or K were dependent on each other, as there were significant interactions. It is clear also, that there was significant increase of available K with increasing water salinity up to 8000 mg l^{-1}. This may be due to the decomposition of compost which would supplyed more available nutrient elements, and the formation of organic and inorganic acid during the decomposition which slighty reduce the soil pH which affected the solubility and availability of N, P and K. This beneficial effect is in agreement with that reported by Nishita and Alexander (1973) and Wasif *et al.*, (1995).

Conclusion

Application of compost to cultivated land significantly hindered the harmful effect of irrigation with saline water.It also improved growth, yield and quality of Roselle plants and enhance the ionic and availability of N, P and K in the Lacustrine soil. The efficiency of compost on improving the quality of salt affected soil depends mainly on the compost application rate and salinity level of irrigation water.

Table 7. Values of E.C (dS/m), SAR and C.E.C (Cmol/ kg) of Lcaostarine soil and cultivated with *Hibiscus sabdariffa*, L. cv., "Sabafia 17" in the two seasons (2001 and 2002).

Plant Parameters	E.C. (dS/m)									
Seasons	2001					2002				
Treatments	Water Salinity, mg L^{-1}				Mean	Water Salinity, mg L^{-1}				Mean
Compost rate, m^3 ha^{-1}	Control	2000	4000	8000		Control	2000	4000	8000	
0.0	2.50	2.69	3.62	4.35	3.29	2.50	2.73	3.92	4.95	3.53
12.0	2.25	2.34	3.30	4.11	3.00	2.25	2.48	3.70	4.69	3.28
17.9	2.02	2.22	2.87	3.42	2.63	2.02	2.25	3.29	3.56	2.78
23.8	1.77	2.00	2.57	3.00	2.34	1.77	2.07	3.12	3.29	2.56
Mean	2.14	2.31	3.09	3.72	2.81	2.14	2.38	3.51	4.12	3.04
LSD 0.05	Salinity	0.18				0.19				
	Compost	0.20				0.21				
	Interaction	0.23				0.24				
	SAR									
0.0	8.15	12.25	13.75	15.31	12.37	8.18	12.52	14.65	15.84	12.80
12.0	7.85	9.67	13.25	14.22	11.25	8.14	10.51	13.16	15.13	11.74
17.9	7.10	9.15	12.64	13.75	10.66	7.15	9.87	11.97	13.84	10.71
23.8	6.20	7.25	12.22	13.10	9.69	7.00	9.41	11.58	13.38	10.34
Mean	7.33	9.58	12.97	14.10	10.99	7.62	10.58	12.84	14.55	11.40
LSD 0.05	Salinity	1.34				1.41				
	Compost	0.33				0.35				
	Interaction	1.72				1.76				
	C.E.C. (C mol/kg)									
0	80.65	89.98	86.13	81.67	84.61	82.25	89.44	86.23	83.62	85.39
12.0	86.20	96.86	93.80	89.82	91.67	90.61	97.85	95.25	93.61	94.33
17.9	95.40	106.75	103.78	100.43	101.59	99.34	108.20	107.32	105.16	105.01
23.8	103.90	114.92	111.80	108.40	109.76	105.75	114.74	112.35	110.62	110.87
Mean	91.54	102.13	98.88	95.08	96.91	94.49	102.56	100.29	98.25	98.90
LSD 0.05	Salinity	4.70				3.14				
	Compost	2.21				2.11				
	Interaction	4.51				4.17				

Fig. 1. The relative decrease in EC (%) with irrigation water salinity and compost application rates of soil (season 2001).

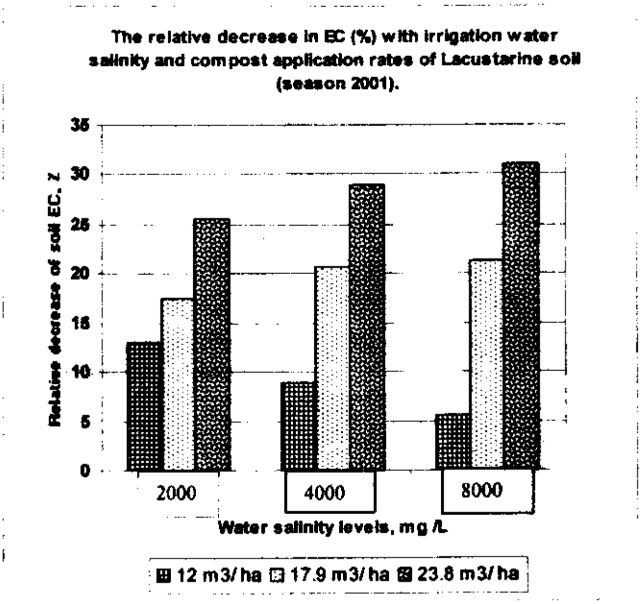

Fig. 2. The relative decrease in EC (%) with irrigation water salinity and compost application rates of soil (season 2002).

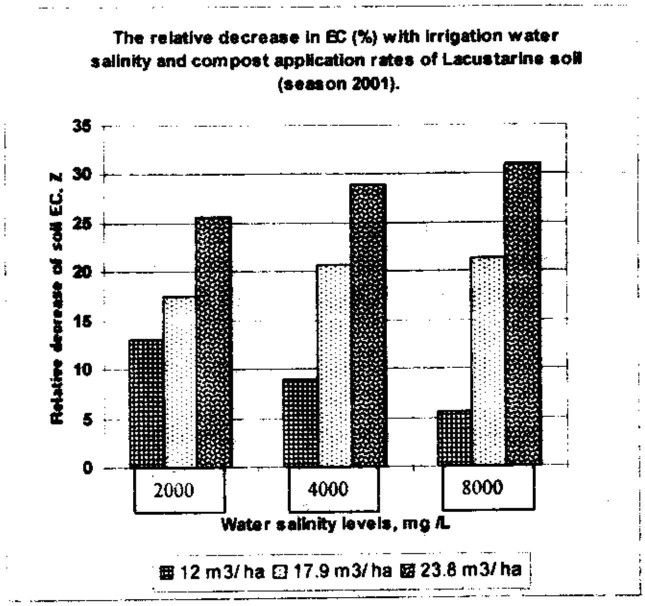

Fig. 3. Relative increase of C.E.C of the soil affected with compost rates and irrigation water salinity (season 2001).

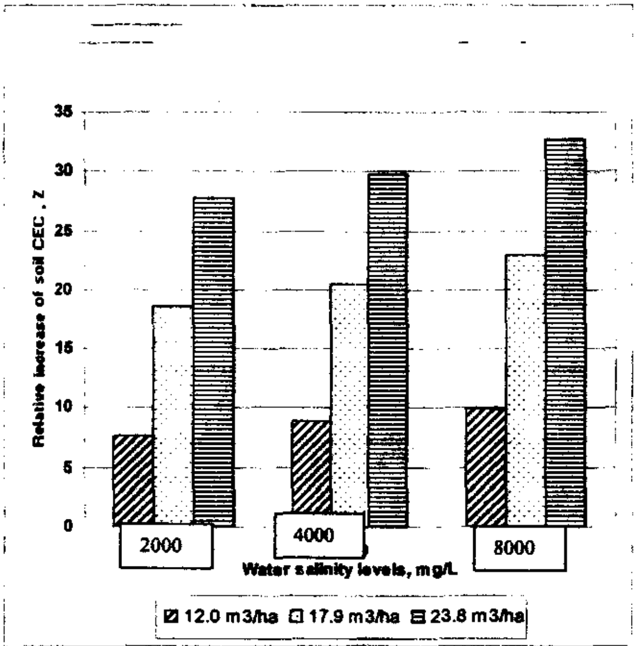

Fig. 4. Relative increase of C.E.C of the soil affected with compost rates and irrigation water salinity (season, 2002).

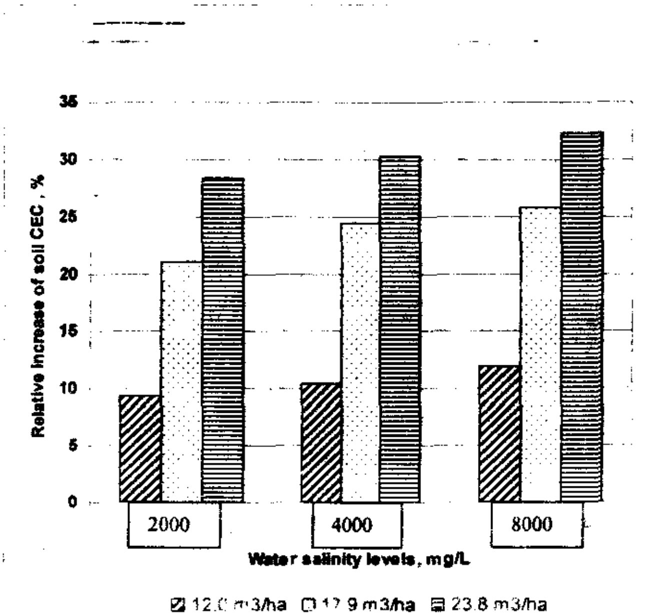

Table 8. Amounts of the available N, P and K of Lcaostarine soil cultivated with *Hibiscus sabdariffa*, L. cv., "Sabafia 17" in two seasons (2001 & 2002) after plant harvest.

Plant Parameters	Available N, ppm									
Seasons	2001					2002				
Treatments	Water Salinity, mg L^{-1}				Mean	Water Salinity, mg L^{-1}				Mean
Compost rate, $m^3\ ha^{-1}$	Control	2000	4000	8000		Control	2000	4000	8000	
0.0	21.00	18.40	16.30	14.20	17.48	22.00	19.70	17.60	15.30	18.65
12.0	30.40	29.60	28.30	27.11	28.85	33.30	32.10	30.40	29.50	31.33
17.9	42.60	40.80	39.70	38.70	40.45	44.40	43.20	41.30	39.70	42.15
23.8	54.40	53.60	52.70	51.60	53.08	56.60	55.30	53.80	52.20	54.48
Mean	37.10	35.60	34.25	32.90	34.96	39.08	37.58	35.78	34.18	36.65
LSD 0.05	Salinity	1.90				2.00				
	Compost	3.00				3.40				
	Interaction	3.50				3.70				
	Available P, ppm									
0.0	10.00	9.10	8.20	7.40	8.68	11.00	10.30	9.60	9.00	9.98
12.0	18.20	17.70	17.10	16.50	17.38	20.10	19.80	19.20	18.70	19.45
17.9	27.60	27.00	26.40	25.80	26.70	29.80	29.30	28.70	28.10	28.98
23.8	37.30	36.90	36.30	35.80	36.58	31.20	30.80	30.30	29.80	30.53
Mean	23.28	22.68	22.00	21.38	22.33	23.03	22.55	21.95	21.40	22.23
LSD 0.05	Salinity	0.70				0.72				
	Compost	4.70				4.90				
	Interaction	1.00				1.10				
	Available K, ppm									
0	76.50	81.20	87.30	94.40	84.85	77.20	83.40	91.20	99.80	87.90
12.0	80.60	87.30	93.20	101.60	90.68	82.30	88.20	96.30	103.40	92.55
17.9	84.00	94.10	102.40	111.80	98.08	87.60	92.40	104.60	107.80	98.10
23.8	87.40	102.40	109.30	120.60	104.93	91.40	95.30	102.80	113.60	100.78
Mean	82.13	91.25	98.05	107.10	94.63	84.63	89.83	98.73	106.15	94.83
LSD 0.05	Salinity	5.40				6.10				
	Compost	4.20				4.80				
	Interaction	4.10				4.20				

REFERENCES

Adel-Latif, I. A.(1973). Studies on the chemistry of chelating compounds and their reaction in soil. Ph. D. Thesis, Ain Shams Unniv., Cairo.

Afifi, M. Y. ,T. A. Ahmed, and N. M. Atyia (1998). Effect of some management practices on salinity regime of soil under irrigation with diluted sea water. *Egypt. J Soil Sci.* 38, No 1-4, pp: 413-423.

Awad, A. M. A. (1994). Crop residues effects on organic matter, wheat yield and nutrients dynamics. PH.D. Thesis Fac. of Agric. Alex. Univ. Egypt.

Beffa, T., M. Blanc, L. Marilley, J.L. Fischer, P.F. Lyon, and M. Aragno (1996). "Taxonomic and Metabolic Microbial Diversity During Composting." In The Science of Composting, by M. de Bertoldi, P. Bert, and P. Tiziano, 149-161. London: Blackie Academic and Professional.

Black, C. A., Evans, D. D., White , I. I. , Ensminger, L. E., and Clark, F. F. (1982). Methods of Soil Analysis. Am. Soc. Agron. Inc. Series No. 9 in Agron. Madison, Wisconsin.

Cole, M.A., L. Zhang, and X. Liu. (1995). "Remediation of Pesticide Contaminated Soil by Planting and Compost Addition." Compost Science and Utilization 3: 20-30.

Cole, M.A., X. Liu, and L. Zhang. (1994). "Plant and Microbial Establishment in Pesticide contaminated Soils Amended With Compost." In Bioremediation through Rhizosphere Technology, edited by T.A. Anderson and J.R. Coats, pp. 210-222. Washington, DC: American Chemical Society.

Dawh, K., Awad, A., and Salam, H. (1985). Effect of salinity, some growth regulators and light intensity on chrysanthemum leaf area and stomatal behavior Zagazic jour. Agric. Res. No. 12 91).

EL-Kouny, H. M. (1999). Evaluation of compost production and its properties with special reference to compost extract. Ph. D. thesis, Fac. Agric., Alex. Univ., Egypt.

El-Sayed, A. A., H. A. Mansour, Effat I. El-Maadawy, Mahassen M. A. Sidky, and E. A. El-Ghadban (2002). Effect of organic and in organic fertilization on herb and oil productivity of spearmint and marjoram.; Zagazig J. Agric. Res. Vol. 29, 6: 1859-1888.

EL-Sayed, S.G. (1991). Salt tolerance evaluation of some flower and ornamental plants. M. Sc. Thesis, Fac. Agric., Alex. Univ., Egypt.

Fahmy, R., (1970). Different quantitative estimation of some organic compounds in plant. Egypt. Soc. Hort., Vol. 155: 72-73. (in Arabic).

FAO (1970). International source book on irrigation and drainage of dry leands in relation to salinity and alkalinity. FAO Soil Bull. 22, (2).

Green way, H. (1973). Salinity, plant growth and metabolism. J. Aust. Inst. Agric. Sci. 39: 24 – 34.

Hewitt, J. and Cutting, C. (1979). Nitrogen assimilation of plants. Academic press, Inc. (London), LTD. 24/28 Oval Road, london, NWI.

Holcomb, J. (1984) Growing in sewage sludge compost. Hort. Abst., 45: 4638.

Hwang, S. and Yoom, H. (1995). The effect of salt concentration on the growth of chrysanthemum, carnation and gerbera in green house soil Hort, Abst., 58:10871.

Jackson, M. L. (1958). Soil Chemical Analysis. Prentices Hall, Englwood-Cliffs, New Jersey.

Jackson, M. L. (1967). Soil Chemical Analysis. Prentices Hall, India, Private Limited, New Delhi.

Kandeel and Naglaa Abou-Taleb (2002). Effect of some organic matter on the growth, yield and chemical composition of *Ocimum basilicum* L. plant. Zagazig J. Agric. Res., Vol. 29 No.(6):1839-1857.

Lindsay, W. L. and Norvell, W. A. (1978). Development of DTPA soil test for Zn, Fe Mn and Cu. Soil Sci. Am. J. 42,421.

Moore, K. A. (2000). Comparsion of Salvia growth in seaweed compost and biosolids compost. Sompost. Sci. and utilization, 8: 24 – 28.

Morsy, A. M. (2003). Effect of irrigation water quality on the soil physical and hydrological properties in western Delta region. Alex. Sci. Exch., Vol. 24, No 4, pp: 453-470.

Nieman, R. H. (1965). Expansion of bean leaves and its suppression by salinity. Plant physiology 40: 156 – 161.

Nishita, H. R. M and G. V. Alexander (1973). Influence of organic matter on the availability of certain elements to barley seedling grow by a modified Neubauer methods. Plant and Soil. 39, 161.

Osbrien, T. and Barker, A. (1996). Growth of Peppermimt in compost. J. Herbs Spices and Medicinal plants, 4: 19 – 27.

Page, A. L., Miller, R. H. and Keeney, D. R. (1982). Methods Soil Analysis. Part I and II. Amer, Soc. Agron. Madison, wisconsin, U.S.A.

Pinamonti, F., Stringari G., and Zorzi, G. (1997). Use of compost in soilless cultivation. Compost Sci. and Utilization, 5: 38 – 46.

Ponchia, G. and Zanin, G. (1998). Research on growing prunus Laurocerasus in containers. Colture protette, 27: 73-80.

Richards, L. A. (1954). Diagnosis and Improvement of Saline and Alkali oils. U.S.D.A. Handbook No. 60 Washington, D. C., U.S.A.

Sharaf, A. (1962). The pharmacological characteristics of *Hibiscus sabdariffa*. Plant Medica 10: 48 –52.

Snedecor, G.W. and Cochran, W. G. (1981). Statistical methods. 7th ed, Iowa State Univ. press, Amers. Iowa, U.S.A.

Wareing, P. F. and Phillips, I. D. (1974). The control of growth and differentiation in plants, pergamon Press Ltd Oxford.

Wasif, M. M., Shabuna, M. M. K., Sead, S. M., EL-Maghrby S.E., and Ashour, I. A. (1995). Influemce of some soil amendments on calcareous soil properties and its productivity of wheat under highly saline irrigation water. Egypt J. Soil Sci, 35.

Wilcox L. V. and Durum, W. H. (1967). Quality of irrigation water, pp. 104 – 122, In. Halen, R. M, (Ed.) Irrigation of Agric. Lands. Agronomy Monograph. No 11 SAS. Inc. Madison, Wisconsin, U.S.A.

Wright, C. H. (1954). Soil Analysis. Thomas, Murfy & Co., London.

الملخـــــــص العربى

تأثير إضافة الكمبوست والري بالماء المالح علي انتاج نبات الكركدية المنزرع في اراضي الترسيبات البحيرية

حامـد مبروك القونى[1] أحـمد إسماعيل شرف[2] على حسن النجار[٣]

[1] معهد الاراضى الملحية والقلوية- مركز البحوث الزراعية-الصـباحية-الإسكندرية.

[٢] قسم علوم الأراضي والميـاه - كليـة الزراعة - الشاطبى - جامعة الإسكندرية - الإسكندرية.

[٣] قسم الزهور ونباتات الزينة وتنسيق الحدائق- كليـة الزراعة - الشاطبى - جامعة الإسكندرية .

أقيمت تجربتان فى اصص تحت ظروف الحقل المفتوح، بمعمل بحوث الأراض الملحية والقلويه ــ الصباحيه، الإسكندرية. خلال موسمى 2001، 2002 لدراسة تأثير أضافه معدلات من الكومبست (صفر و ١٢ و ١٧,٩ و٢٣,٨ م٣/هكتار) والرى بمستويات مختلفه من المياه المالحة (ماء الصنبور ككنترول ، وماء الصنبور مخلوطاً بماء البحر لتكوين تركيزات ٢٠٠٠ و ٤٠٠٠ و ٨٠٠٠ مجم / لتر) على نمو وانتاج ونوعيه نبات الكركديه (*Hibiscus sabdariffa*, L.cv. Sbahia 17) وكذلك أثر ذلك على خصوبه الارض (أرض ترسيبات بحيريه Lacustrine) وعلى بعض خصائصها الكيماوية.

عند نهاية كل موسم تم قياس طول النبات وعدد الفروع لكل نبات وعدد الأوراق والوزن الطازج والجاف للاوراق، وعدد الثمار لكل نبات والوزن الطازج لها وايضاً الوزن الطازج والجاف للسبلات وتم تقدير صبغة الأنثوسيانين وفتيامين C في سبلات الثمار، وكذلك قياس كل من التوصيل الكهربى لمستخلص عجينه

الارض المشبعه وحساب نسبه الصوديوم المدمص SAR وتقدير كل من السعه التبادليه الكاتيونيه للأرض CEC ، وتقدير المتاح من النتروجين والفوسفور والبوتاسيوم فى الارض. وقد حللت النتائج أحصائيا وتحققت أفضل النتائج عند استخدام مياه ذات درجة ملوحة ٢٠٠٠ و ٤٠٠٠ مجم/ لتر وإضافة الكمبوست بمعدلى١٧,٩ و ٢٣,٨ متر مكعب فى الهكتار.

أشارت النتائج إلى ان استخدام معدل عالى من الكومبوست قد أدى الى تقليل ضرر ملوحه مياه الرى المستخدمه، حيث انخفض معنوياً قيم الـــ EC للارض ونسبة الصوديوم المدمص SAR وتجنب تمليح الارض حتى عند أستخدام مستوى عالى من ملوحه مياه الرى (٨٠٠٠ مجم/ لتر). كذلك تحسن خصوبة الارض حيث ازداد معنويا المتاح لكل من N و P و K ، وأرتفع معنوياً قيم الـــ CEC للارض نتيجه لاضافه الكومبوست وأستخدام مياه مالحه فى الرى مقارنة بمعاملة الكنترول.