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Influence of Compost on *Calendula Officinalis* Plants as Affected by Different Agricultural Drainage Levels of Irrigation Water

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A POT EXPERIMENT was conducted to identify the influence of compost mixed with the soil at three different rates (0, 50 and 100 g/pot) before cultivation and application of agricultural drainage saline water (DW) alone (DW, ECw = 4.93 dS/m) or mixed with fresh water (FW) (FW, ECw = 0.31 dS/m) in different mixtures (FW:DW =2:1, 1:1 and 1:2, corresponding ECw values of 1.68, 2.27 and 3.62 dS/m, respectively) for irrigating *Calendula officinalis* L. plants during two successive growing seasons of 2013/2014 and 2014/2015.

The results obtained showed that all vegetative growth, flowers parameters and chemical constituents were significantly decreased except of proline. Na, Mg, Ca and B were significantly increased by applying the drainage water directly or as a mixture with fresh water at any ratio. On the other hand, these parameters and chemical constituents were significantly increased with increasing compost application rates under irrigation with fresh or drainage water, while prompted a noteworthy decrease in proline, Na and B. The interaction effect between compost and drainage water levels was almost positive for all vegetative growth, flower parameters and chemical constituents. The most favorable interaction treatment was the highest level of compost (100g/pot) combined with drainage water at rates 2:1 and 1:1. It can be concluded that compost application overcome the harmful effect of drainage water and had a favorable effect on vegetative growth, flowering and chemical constituents of *Calendula officinalis* L. plants.

Keywords: *Calendula officinalis*, Compost, Agricultural drainage saline water, Growth, Yield.

Marigold (*Calendula officinalis* L.) belongs to Asteraceae family, is a medicinal-ornamental herbaceous annual plant which is originated from Mediterranean and West Asia. The active substance of this plant is made and stored in its yellow and orange flowers, the most important ones are: flavonoids, carotenoids, essential oils, mucilage substances and vitamin A. This plant is used to treat diseases of the stomach, intestines, and also, the flowers extract is used to dye some types of foods and fats (Ehsan *et al.*, 2012). The herb also astrogenic the capillaries, an action that explains its effectiveness for cuts, wounds, varicose, veins and various inflammatory conditions (Mahmoud, 1998). Also, Chevallier

(1996) reported that calendula has a mild estrogenic action and is often used to reduce menstrual bleeding. Its infusion makes an effective + douche for yeast infections.

Salinity is a major limiting factor in agricultural production and exerts unfavorable influence on various physiological and biochemical processes associated with plant growth and development (Greenway and Munns, 1980, Pitman and Lauchli, 2002). The negative impact of salinity on plant growth and metabolism has been attributed, principally, to enhanced Na^+ ion uptake, which causes an excess of Na^+ ions in plant tissues (Abbas *et al*., 1991). One of the primary effects of increasing the salinity of the growth medium is the inhibition of K^+, Ca^{2+} and NO^-_3 ion uptake by plant roots (Mass, 1986). In addition, it is well-established that salinity stress damages plant cells through the production of active oxygen species, including superoxide radicals, hydrogen peroxide, hydroxyl anions and singlet oxygen (Scandalios, 1997).

In the arid and semi-arid regions water resources of good quality are becoming more and scarcer and are allocated with priority to urban water supply. For this reason, there is an increase in needs to irrigate with water of certain salt content, like groundwater, drainage water and treated wastewater.

Organic material improve soil physical properties (structure and aggregation) and soil chemical properties (decrease soil pH, increase cation exchange capacity and enhance the most nutrient) that important for plant growth (Snyman *et al*., 1998). Application of organic fertilizer increased the biomass yield of the main crop and total essential oil yield of davana (*Artemisia pallens* Wall) plant (Parakasa Rao *et al*., 1997). Khalid *et al*. (2006b) reported that organic fertilization increase the vegetative growth and essential oil content of marigold (*Calendula officinalis* L.) plants. Lakhdar *et al.* (2009) found that compost application could be a promising alternative to alleviate the adverse effects caused by soil salinization. With high organic matter content and low concentrations of inorganic and organic pollutants allow an improvement of physical, chemical and biochemical characteristics and constitute low cost soil recovery. Abd El Aziz *et al*. (2011) on *Matthiola incana,* reported that all vegetative growth and flowers parameters were significantly increased with increasing compost rates under irrigation with normal or saline water up to 3000 ppm.

The present work was undertaken to study the effect of compost and drainage water on vegetative growth and chemical composition of *Calendula officinalis* L.

Material and Methods

A pot trail of *Calendula officinalis* L. plants was conducted during two successive growing seasons of 2013/2014 and 2014/2015 at the Experimental Farm, Faculty of Agriculture, Fayoum University.

Clay pots 30 cm diameter and 50 cm height were filled with an air dried sandy loam soil. Seeds of calendula plants were obtained from Res. Dept. Hort. Res. Inst. ARC, Ministry of Agriculture, Egypt. Seeds were sown in the nursery on 1th September in both seasons, then, one plant/pot (45 days old and 15 cm in height) was transplanted on the 15th of October, in the two successive seasons. Compost was mixed with the soil at three rates (0, 50 and 100 g/pot) (0 , 5 and 10g/kg soil) before cultivation. The agricultural drainage saline water (DW) (DW, ECw= 4.93 ds/m) was directly used for irrigating calendula or its dilutions (Fw : Dw = 2:1, 1:1 and 1:2, (V:V) corresponding (electrical conductivity of water) ECw values of 1.68, 2.27 and 3.62 ds/m, respectively). Thus, the applied compost and irrigation water were included 15 treatments.

Black polyethelyne was placed under the soil pots in order to prevent penetration of roots to the ground. Some mechanical and chemical analysis of both soil and water used were carried out according to Black (1982), Jackson (1973) and Olsen and Sommers (1982) and also the compost. Results of these analyses are shown in Tables 1, 2 and 3.

TABLE 1. Some physical and chemical characteristics of the tested soil.

Physical properties				
Coarse sand (%)	**Fine sand (%)**	**Silt (%)**	**Clay (%)**	**Soil texture**
7.34	63.62	16.5	12.54	Sandy loam

Chemical properties												
O. matter %	EC dsm^{-1}	pH	N %	P %	$CaCO_3$ %	Ca^{++}	Mg^{++}	N^{a+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
0.67	4.5	7.5	0.06	0.07	10	0.50	0.12	0.14	0.02	0.05	0.18	0.55

TABLE 2. Chemical analysis of fres, drainage water and their different mixtures.

Irrigation water Treatment	pH	ECw (ds/m)	Soluble ions (meq/L)								B(ppm)
			CO_3^{-}	HCO_3^{-}	Cl^{-}	SO_4^{--}	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	
1(FW)	7.35	0.31	--	2.08	0.86	0.29	1.37	0.79	0.85	0.19	0.11
2(2:1)	7.27	1.68	--	3.19	11.71	3.50	4.68	2.70	10.75	0.27	0.12
3(1:1)	7.22	2.27	--	3.90	14.15	4.18	5.84	4.86	10.98	0.35	0.16
4(1:2)	7.11	3.62	--	4.39	23.31	7.95	7.79	5.65	22.59	0.62	0.20
5(DW)	7.04	4.93	--	4.92	32.50	12.05	9.10	7.19	32.61	0.71	0.25

FW and DW: fresh water and agricultural drainage saline water, respectively.

TABLE 3. Chemical analysis of compost.

Characters	pH	O.C %	C/N ratio	Macro elements %			Micro elements (ppm)			
				N	P	K	Fe	Mn	Zn	Cu
Value	6.7	26.1	19/1	1.45	0.58	0.78	547.3	38.7	53.1	26.8

The experimental layout was a factorial experiment in a completely randomized blocks design with three replications. Each experimental unit contained five pots. The plants were irrigated every four days with 300 cm^3 of water (either fresh or saline). The following data were recorded as follows:

- Morphological characters, *i.e.*, plant height (cm), number of branches plant^{-1} and fresh and dry weights/plant (g).
- *Yield and its components:* The inflorescences were collected weekly started from the 1st week of December until the end of experiment to determine yield data, *i.e.*, number of inflorescences plant^{-1}, diameter of inflorescences (cm) and fresh and dry weights/inflorescences (g) (air dried).

Chemical compositions

Total chlorophylls (mgg^{-}1) were determined in fresh leaves samples according to Welburn and Lichtenthaler (1984). Total carbohydrates content in dry matter of herb (stems + leaves) were determined colormetrically according to Herbert *et al.* (1971). Free proline in dry herb was detected by an acid-ninhydrin method as outlined by Bates *et al.* (1973). Nitrogen, phosphorus, potassium and sodium elements were determined according to the method described by Cottenie *et al.* (1982). Leaf Ca, Mg and B were determined as outlined by Jackson (1973) and Black (1982). Beta-carotene and xanthophyll (mg/g) were determined in dry ray flowers samples according to A.O.A.C. (1995) and Bacot (1954).

Statistical analysis

The obtained data of plant parameters were subjected to the statistical analysis, where the least significant difference test (L.S.D.) at 0.05 level was used to verify the differences between treatments as mentioned by Snedecor and Cochran (1980).

Results and Discussion

Vegetative growth characters

Data presented in Table 4 revealed that irrigation of calendula either with mixture of fresh-drainage water or drainage water alone significantly decreased plant height, number of branches plant^{-1}, fresh and dry weights of plant as compared to irrigation with fresh water alone.

It was interest to note that there was a negative relationship between drainage of irrigation water and plant height and number of branches. Also, increasing drainage water level decreased growth of calendula which was reflected in the fresh and dry weights. These results are in accordance with the findings of many investigators as Zidan and Newmann (1990) on maize, found that salt stress may directly or indirectly inhibit cell division and/or cell elongation in growing tissues of roots, stems and leaves and Hang and Cox (1998) stated that salinity reduce plant height of *Catharanthus rosus* and *Tagets erecta*, Ezz El-Din *et al.* (2009) on *Thymus vulgaris*, Abd El-Aziz *et al.* (2011) on *Matthiola incana*, found that application of saline water led to a significant decrease in all vegetative growth and D'souza1 and Devaraj (2015) on hyacinth bean found that application of saline water significantly decrease fresh and dry weights of plant.

On the other hand, application of compost at any level overcome the harmful effect of drainage water. Whereas, all levels of compost significantly increased plant height, number of branches, fresh and dry weight of calendula plants (Table 4). Compost at level 100g/pot was more effective and significantly increased all vegetative growth. The increase percentage were 17.48, 96.83, 22.33 and 17.39% to plant height, number of branches, fresh and dry weights over control in the first season, respectively. The same trend was seen in the second season. Compost encouraged all the plant growth parameters through the stimulation effect on the meristematics tissues, where these organic manures are in N,P,K and other minerals which required propellant growth (Adams *et al.*, 2001). Many investigators indicated that the application of organic manures tended to increase the total count of bacteria as well as improving soil biological and chemical properties. Moreover, the supplied organic manures amended the microorganisms with necessary nutrients and increased microbial respiration and CO_2 output. These organisms consume carbon and nitrogen in a ratio of approximately 30:1 producing the proteins necessary for the growth and reproduction organisms. Furthermore, there were a fairly close relationship exists between the rates of organic matter decompositions in soils and CO_2 production and the number of bacteria (Abo-Hussein, 1995). As a result of these prospects, it may be concluded that compost improved the structure of sandy soil and consequently encourage the plant to have a good growth. Moreover, the slow released nutrients from compost permit the plants to benefits. All these responses resulted in improving plant growth. These results are in line with those obtained by Vendrame *et al*. (2005), Atif *et al.* (2008) on *Zinnia elegans* plants, Hendawy (2008) on *Plantago arenaria* plants and El- Sayed *et al.* (2015) on canola.

Data presented in Table 4 show that the interaction between drainage water at the rate 2:1 or 1:1 and compost at the rate 100 g/pot significantly increased all vegetative growth characters in the first season as compared with the control. Similar trend was observed in the second season. This may be due to salt stress inactivated nitrate in organic matter reductive activity due to decreased NO_3 uptake. Moreover, Albassam (2001) found that high nitrate percentage in irrigation solution is necessary to decrease salt concentration and convert inactive reductase to active form. Also, Abd El Aziz *et al*. (2011) on *Matthiola incana*, found that fertilizing with Nile compost rates under salinity stress significantly increased all growth characters.

TABLE 4. Effect of compost and drainage water on vegetative growth characters of calendula plants during 2013/2014 and 2014/2015 seasons.

Compost (g/pot) A	2013/2014						2014/2015					
	Drainage water B											
	0	1	2	3	4	Mean	0	1	2	3	4	Mean
Plant height (cm)												
0	31.6	29.2	26.7	24.4	20.6	26.5	35.0	30.9	29.5	25.8	23.1	28.9
50	36.9	34.5	29.6	25.8	23.7	30.1	43.4	42.3	36.9	34.9	28.0	37.1
100	43.7	40.9	35.2	31.6	24.2	35.1	45.5	42.4	41.3	36.1	33.5	39.8
Mean	37.4	34.9	30.5	27.3	22.8		41.3	38.5	35.9	32.3	28.2	
L.S.D 0.05	A = 1.3 B = 1.7 AXB = 2.9						A = 1.5 B = 1.9 AXB = 3.3					
Number of branches plant^{-1}												
0	14.8	11.7	10.3	7.0	6.4	10.1	14.5	12.2	10.6	8.6	6.7	10.5
50	17.8	17.4	14.4	14.3	8.4	14.5	17.2	16.7	15.5	14.2	12.0	15.1
100	19.8	18.4	17.5	15.2	12.6	16.7	19.6	18.1	18.5	16.1	14.6	17.4
Mean	17.5	15.9	14.1	12.2	9.1		17.1	15.7	14.9	13.0	11.1	
L.S.D 0.05	A = 1.0 B = 1.3 AXB = 2.2						A = 1.6 B = 2.1 AXB =3.5					
Fresh weight (g) plant^{-1}												
0	279	255	234	225	206	240	287	254	229	223	206	240
50	301	292	259	257	230	268	301	290	261	246	227	265
100	311	291	272	268	252	279	308	283	276	267	256	278
Mean	297	280	255	250	229		299	276	255	245	230	
L.S.D 0.05	A = 10 B = 12 AXB = 18						A = 11 B = 13 AXB = 21					
Dry weight (g) plant^{-1}												
0	60.2	58.2	56.6	55.0	50.6	56.1	60.4	59.6	56.5	54.9	50.6	56.4
50	72.0	69.2	67.6	60.0	54.9	64.7	71.0	67.5	64.8	59.8	55.6	63.7
100	74.9	70.5	68.3	63.8	59.4	67.4	72.7	70.0	67.9	64.5	58.5	66.7
Mean	69.0	65.9	64.2	59.6	55.0		68.0	65.7	63.1	59.7	54.9	
L.S.D 0.05	A = 0.4 B = 0.6 AXB =1.0						A = 1.1 B = 1.4 AXB = 2.4					

Flowering characters

Data presented in Table 5 indicated a significant suppressing effect of salinity on number, diameter, fresh and dry weights of inflorescences as compared with control treatment in both studied seasons. Nevertheless, irrigation with a mixtures of fresh-drainage water at a ratio 1:2 consecutively or irrigation with drainage water alone significantly produced lower number of inflorescences, diameter, fresh and dry weights of inflorescences plant^{-1}than the control in both seasons. Greenway and Munns (1980) suggested that this reduction in flowering parameters may ensue from the plants inability to adjust osmotically, counteraction toxicities or related disruptive phenomena or from the excessive energy demand placed upon the metabolic machinery required by such homeostatic systems.

Concerning the role of compost on elevated the negative effect of drainage water on calendula plants, the data presented in Table 5 show that addition of compost at the two rates increased number, diameter, fresh and dry weights of inflorescences as compared with control in both studied seasons. In this respect, it can be assumed that the depressive effects of salinity on flowering characters and other relevant physiological activities can be alleviated and/or modified to some extent by addition compost to the soil. Similar result was obtained by Abd El-Aziz *et al.* (2011) on *Matthiola incana*, who found that addition Nile compost significantly increased all flowering characters.

Results showed that addition compost to soil and irrigation of calendula with fresh-drainage water at different ratios insignificantly affected on number and diameter of inflorescences, while, was significant on fresh and dry weights of inflorescences in the second season as compared with the control. The same trend was in the second season.

TABLE 5. Effect of compost and drainage water on flowering characters of calendula plants during 2013/2014 and 2014/2015 seasons.

Compost (g/pot) A	**2013/2014**						**2014/2015**					
	Drainage water (B)											
	0	**1**	**2**	**3**	**4**	**Mean**	**0**	**1**	**2**	**3**	**4**	**Mean**
Number of inflorescences												
0	30.4	26.6	23.8	19.5	18.0	23.7	32.2	27.7	25.3	21.3	19.9	25.3
50	34.6	32.6	29.0	27.7	21.3	29.0	33.3	33.9	31.0	28.3	21.9	29.7
100	36.4	34.9	31.3	28.7	23.9	31.0	40.7	38.5	31.2	30.1	24.2	32.9
Mean	33.8	31.4	28.0	19.5	18.0		35.4	33.4	29.2	26.6	22.0	
L.S.D 0.05	A = 1.8 B = 2.3 AXB = n.s						A = 1.8 B = 2.3 AXB =n.s.					
Diameter of inflorescences (cm)												
0	5.33	5.02	4.85	4.62	4.30	4.82	5.30	5.02	4.66	4.57	4.24	4.76
50	5.52	5.44	5.27	4.76	4.63	5.12	5.58	5.50	5.32	4.80	4.62	5.16
100	5.65	5.53	5.47	5.25	5.05	5.39	5.73	5.58	5.52	5.33	4.95	5.42
Mean	5.50	5.33	5.20	4.88	4.66		5.53	5.37	5.16	4.90	4.60	
L.S.D 0.05	A = 0.15 B = 0.19 AXB = n.s						A = 0.18 B = 0.23 AXB = n.s.					
Fresh weight of inflorescences (g)												
0	1.36	1.35	1.27	1.26	1.23	1.29	1.33	1.32	1.26	1.25	1.21	1.28
50	1.68	1.58	1.55	1.48	1.30	1.52	1.63	1.55	1.53	1.45	1.28	1.49
100	1.66	1.63	1.57	1.53	1.40	1.56	1.65	1.61	1.55	1.52	1.38	1.54
Mean	1.56	1.52	1.46	1.43	1.31		1.53	1.49	1.45	1.41	1.29	
L.S.D 0.05	A = 0.03 B = 0.04 AXB = 0.07						A = 0.03 B = 0.04 AXB = 0.06					
Dry weight of inflorescences (g)												
0	0.21	0.20	0.19	0.22	0.24	0.21	0.22	0.20	0.19	0.19	0.17	0.19
50	0.26	0.24	0.24	0.23	0.19	0.23	0.27	0.24	0.24	0.23	0.19	0.23
100	0.28	0.27	0.25	0.23	0.23	0.25	0.28	0.27	0.26	0.24	0.21	0.25
Mean	0.25	0.24	0.23	0.23	0.22		0.26	0.24	0.23	0.22	0.19	
L.S.D 0.05	A = 0.01 B = 0.02 AXB = 0.03						A = 0.01 B = 0.01 AXB= n.s.					

Chemical composition

Total chlorophyll, total carbohydrates and free proline

The influence of irrigation with different combinations of fresh-drainage water and drainage water alone on total chlorophyll and total carbohydrates were significantly decreased in both studied seasons as compared to the control (Table 6). However, the reduction in total chlorophyll linked with increasing levels of salinity might be attributed to: (i) the suppress of the specific enzyme, which is responsible for the synthesis of photosynthetic pigments (Strognova *et al*., 1970). (ii) the destruction of chlorophyll (Afria *et al*., 1998) or (iii) the decrease in the absorption of minerals needed for chlorophyll biosynthesis, *i.e.* iron and manganese (Salama *et al*., 1992). The depression in the content of total carbohydrates was suggested to be due to the production of relatively high energy by increasing respiration to overcome the relatively low availability of water and nutritional elements in saline medium (Moursi *et al*., 1979). While, the reverse was true for free proline. The free proline concentration was increased with increasing the drainage water levels. The accumulation of free proline in salt stressed plants may be attributed to an adaptive mechanism for osmoregulation in plants cells to cope with salinity problems (Wated *et al*., 1983 and Heuer & Nadler, 1998). The obtained results are in agreement with those of Gadallah *et al.* (2001) on wild mint.

Results in Table 6 show effect of the compost treatments on chlorophyll, carbohydrates and proline. The recorded data revealed the positive and active effect of the compost on chlorophyll and carbohydrates content in calendula plants while, the reverse was true for free proline as compared to control in both seasons. Similar trend was obtained by Hendawy (2008) on *Plantago arenaria* plants, found that compost at 100m/L caused highest significant increment in total carbohydrates content, Abd El-Aziz *et al.* (2011) on *Matthiola incana* and El-Sherbeny *et al*. (2012) on *Brassica rapa* plant.

Regarding the effect of interaction, compost application (100 g.) was more effective on chlorophyll and carbohydrates while, significantly decreased proline content under drainage water as compared to control in both seasons.

TABLE 6. Effect of compost and drainage water on total chlorophyll, total carbohydrates and free proline of calendula plants during 2013/2014 and 2014/2015 seasons.

Compost (g/pot) A	2013/2014						2014/2015					
	Drainage water (B)											
	0	1	2	3	4	Mean	0	1	2	3	4	Mean
Total chlorophyll (mg/g)												
0	1.54	1.48	1.37	1.36	1.12	1.38	1.46	1.37	1.28	1.24	1.03	1.28
50	1.73	1.60	1.49	1.46	1.19	1.49	1.86	1.64	1.49	1.44	1.24	1.53
100	1.89	1.80	1.57	1.53	1.22	1.60	1.90	1.66	1.49	1.46	1.29	1.56
Mean	1.72	1.63	1.48	1.45	1.18		1.74	1.56	1.42	1.38	1.19	
L.S.D 0.05	A = 0.06 B = 0.08 AXB = n.s						A = 0.01 B = 0.01 AXB = 0.02					
Total carbohydrates %												
0	15.47	12.86	11.26	10.13	8.99	11.74	15.49	12.25	10.46	9.18	8.57	11.19
50	16.22	14.45	12.89	12.43	10.83	13.36	16.14	14.48	12.37	11.69	10.39	13.01
100	18.12	15.58	14.33	12.81	12.98	14.77	18.47	15.78	14.43	12.72	12.31	14.74
Mean	16.60	14.30	12.83	11.79	10.93		16.70	14.17	12.42	11.20	10.42	
L.S.D 0.05	A = 0.89 B = 1.15 AXB = n.s						A = 0.71 B = 0.91 AXB = n.s.					
Free proline (µ mole g^{-1} dry weight)												
0	3.81	5.33	5.73	8.95	11.23	7.01	2.59	5.71	6.48	8.15	10.48	6.68
50	3.53	5.22	5.35	8.66	10.24	6.60	2.52	4.15	5.33	6.42	7.49	5.04
100	2.73	5.06	5.35	7.41	10.14	6.14	2.14	3.75	4.33	5.63	7.09	4.73
Mean	3.36	5.20	5.48	8.34	10.54		2.42	4.54	5.38	6.73	8.35	
L.S.D 0.05	A = 0.13 B = 0.17 AXB = 0.29						A = 0.11 B = 0.14 AXB = 0.24					

Nutrient content

Nitrogen, potassium and phosphorus contents

Regarding the effect of fresh-drainage dilutions or drainage water alone on N, P and K content, it is clear from data (Table 7) that increasing salinity levels reduced the percentage of N and K while increased the percentage of P. Whereas, drainage water alone gave the lowest values of N and K percentage while gave the highest value of P as compared with control. The same trend was observed in results of both seasons. The obtained results are in agreement with those Gadallah *et al.* (2001) on wild mint, Hassanain and Matter (2002) on *Theveitia nerefolia*, Abdel -Mawgoud *et al.* (2010) on green bean and Abd El-Aziz *et al.* (2011) on *Matthiola incana* plant.

Results in Table 7 Show that application of compost at 50 or 100 g/pot stimulate the concentration and content of N, P and K in plants as compared to control in both seasons. The increment of these nutrients could be attributed to their availability in compost. Also, this may be due to the ability of organic matter in rendering soil nutrients more available and chelating of these elements. This helps to increase the respiration rate, metabolism and growth of plant that causing the plant required to more nutrients from soil and fertilizers. In this respect, Khalil and El-Sherbeny (2003) on three *Mentha sp* found that the highest compost level resulted in maximum micro and macronutrients content except Zn content. Similar trend was obtained by Khalid *et al.* (2006a) on *Ocimum basilicum*, Hendawy (2008) on *Plantago arenaria*, Abd El-Aziz *et al.* (2011) on *Matthiola incana* and El-Sherbeny *et al*. (2012) on *Brassica rapa* plant.

TABLE 7. Effect of compost and drainage water on nutrient content of calendula plants during 2013/2014 and 2014/2015 seasons.

Compost (g/pot) A	**2013/2014**						**2014/2015**					
	Drainage water (B)											
	0	**1**	**2**	**3**	**4**	**Mean**	**0**	**1**	**2**	**3**	**4**	**Mean**
Nitrogen %												
0	2.79	2.76	2.55	2.45	2.40	2.59	2.94	2.92	2.81	2.59	2.26	2.70
50	3.14	3.05	3.00	2.86	2.48	2.91	4.01	3.42	3.37	3.16	2.67	3.32
100	3.35	3.25	3.10	2.94	2.79	3.09	4.14	3.70	3.50	3.35	2.88	3.51
Mean	3.09	3.02	2.88	2.75	2.56		3.70	3.34	3.23	3.03	2.61	
L.S.D 0.05	A = 0.16 B = 0.20 AXB = n.s						A = 0.16 B = 0.21 AXB = n.s.					
Phosphorus %												
0	0.11	0.13	0.15	0.15	0.18	0.14	0.08	0.09	0.11	0.12	0.14	0.11
50	0.15	0.16	0.19	0.21	0.22	0.19	0.12	0.13	0.15	0.16	0.17	0.15
100	0.17	0.21	0.23	0.22	0.26	0.22	0.14	0.18	0.20	0.21	0.22	0.19
Mean	0.14	0.17	0.19	0.19	0.22		0.11	0.13	0.15	0.17	0.18	
L.S.D 0.05	A = 0.02 B = 0.03 AXB = n.s						A = 0.02 B = 0.03 AXB = n.s.					
Potassium %												
0	2.83	2.62	2.43	2.25	2.09	2.44	2.76	2.61	2.35	2.20	2.03	2.39
50	2.95	2.72	2.66	2.51	2.32	2.63	2.92	2.71	2.64	2.50	2.30	2.61
100	3.18	3.01	2.92	2.72	2.64	2.89	2.76	2.96	2.88	2.67	2.58	2.77
Mean	2.98	2.78	2.67	2.49	2.35		2.81	2.76	2.62	2.46	2.31	
L.S.D 0.05	A = 0.07 B = 0.10 AXB = n.s						A = 0.11 B = 0.14 AXB = n.s					

Sodium, magnesium, calcium and boron contents

Furthermore, the combination between compost and drainage water levels had almost positive effect for the percentage and content of N, P and K. The protection of plant against drainage water by a nutrient supply of compost is believed to be caused indirectly as a result of its effect on N, P and K uptake which plays an essential role in many metabolic processes such as photosynthesis process and hence the formation of starch. Similar trend was obtained by Abd El Aziz *et al.* (2011) on *Matthiola incana* plant.

The effect of fresh-drainage dilutions or drainage water alone on Na, Mg, Ca and B content of calendula herb were presented in Table 8. The results showed significant increments of Na, Mg, Ca and B in treated plants as compared to untreated ones in both seasons. In this concern, Glenn (1987) on grasses and sledge, found that the increase in Na concentration in plant with salinity may be a result of the ability of plants to use Na to maintain an adequate osmotic potential gradient between the plant tissues and the external solution. Also, The obtained results are in agreement with those Hassanain and Matter (2002) on *Theveitia nerefolia* and Abd El Aziz *et al.* (2011) on *Matthiola incana* plant.

TABLE 8. Effect of compost and drainage water on sodium, magnesium, calcium and boron percentage of calendula plants. (Mean values of two seasons).

Compost (g) A	**Drainage water (B)**											
	0	**1**	**2**	**3**	**4**	**Mean**	**0**	**1**	**2**	**3**	**4**	**Mean**
	Sodium %						Magnesium %					
0	0.80	1.45	1.50	1.94	2.34	1.61	0.21	0.31	0.31	0.41	0.42	0.33
50	0.80	1.32	1.32	1.85	2.15	1.49	0.21	0.32	0.35	0.43	0.46	0.35
100	0.70	1.33	1.34	1.65	1.95	1.39	0.22	0.36	0.36	0.43	0.48	0.37
Mean	0.77	1.37	1.39	1.82	2.14		0.21	0.33	0.34	0.42	0.45	
L.S.D 0.05	A = 0.05 B = 0.06 AXB = 0.11						A = 0.02 B = 0.03 AXB =n.s.					
	Calcium %						Boron ppm					
0	1.31	1.41	1.52	1.53	1.62	1.48	10.12	15.37	18.03	20.06	25.02	17.72
50	1.32	1.43	1.51	1.59	1.62	1.49	9.97	13.96	15.64	17.55	21.35	15.69
100	1.35	1.46	1.53	1.58	1.61	1.50	8.62	11.31	13.54	17.24	19.22	13.98
Mean	1.33	1.43	1.52	1.57	1.62		9.57	13.55	15.74	18.28	21.86	
L.S.D 0.05	A = n.s B = 0.04 AXB = n.s						A = 0.21 B = 0.27 AXB = 0.47					

From the data in Table 8 it can be noticed that raising compost from 50 to 100 g/pot significantly decreased sodium and boron in plant while increased magnesium and calcium. Similar results was obtained with Herrera *et al.* (1997) who indicated that N, P, K, Ca and Mg of thyme seedlings were increased with increasing compost ratio in growth media.

Regarding the effect of interaction, compost application and drainage water led to significantly different on sodium and boron contents while were insignificant on magnesium and calcium contents as compared to control.

Beta- carotene and xanthophyll contents

Results of this study showed that all levels of drainage water significantly decreased beta-carotene and xanthophyll contents as compared to the control. The same trend was observed in both seasons. The depression in the content of beta-carotene and xanthophyll was suggested to be due to decreased of total carbohydrates under drainage water.

Data in Table 9 revealed that application of compost at 50 or 100 g/pot significantly increased beta-carotene and xanthophylls content in dry ray flowers and the highest increase was obtained by the treatment 100 g/pot 18.90 and 20.94% for beta-carotene and xanthophylls, respectively, as compared with the control at the first season. Similar trend was observed in the second season.

Combination between drainage water with compost significantly increased beta-carotene and xanthophylls content except when the plants were irrigated with fresh and drainage water at ratio of 1: 2 or drainage water alone with application of compost at 50 or 100 g/pot led to significant decrease in beta-carotene and xanthophylls content as compared with control in the first season. Similar trend was observed in the second season.

TABLE 9. Effect of compost and drainage water on beta- carotene and xanthophylls content of calendula plants during 2013/2014 and 2014/2015 seasons.

Compost (g) A	2013/2014						2014/2015					
	Drainage water (B)											
	0	1	2	3	4	Mean	0	1	2	3	4	Mean
Beta – carotene (mg/g dry ray flowers)												
0	0.489	0.471	0.465	0.443	0.409	0.455	0.480	0.454	0.443	0.441	0.403	0.444
50	0.580	0.568	0.541	0.486	0.446	0.524	0.584	0.571	0.561	0.493	0.443	0.531
100	0.601	0.578	0.552	0.499	0.476	0.541	0.595	0.582	0.562	0.499	0.472	0.542
Mean	0.557	0.539	0.519	0.476	0.444		0.553	0.536	0.522	0.478	0.440	
L.S.D 0.05	A = 0.010 B = 0.013 AXB = 0.023						A = 0.006 B = 0.008 AXB = 0.014					
Xanthophyll (mg/g dry ray flowers)												
0	0.324	0.297	0.289	0.264	0.211	0.277	0.320	0.300	0.285	0.264	0.216	0.277
50	0.364	0.355	0.331	0.298	0.249	0.320	0.371	0.356	0.348	0.310	0.270	0.331
100	0.373	0.364	0.333	0.311	0.293	0.335	0.386	0.361	0.347	0.344	0.314	0.350
Mean	0.354	0.339	0.318	0.291	0.251		0.359	0.339	0.327	0.306	0.266	
L.S.D 0.05	A = 0.006 B =0.008 AXB= 0.013						A = 0.007 B = 0.009 AXB =0.015					

Thus, it could be recommended to add compost as a promising alternative to *Calendula officinalis* L. plants grown in regions irrigated with drainage water, to alleviate the adverse effects caused by soil salinization.

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تأثير الكمبوست على نباتات الأقحوان المتأثرة بمستويات رى مختلفة من مياه الصرف الزراعى

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أجريت تجربة أصص لدراسة مدى تأثير الكمبوست المضاف للتربه بمعدلات ٠ و٥٠ و ١٠٠ جرام للأصيص قبل الزراعه على نباتات الأقحوان التى تم ريها بأستعمال مياه الصرف الزراعى (DW) المالحه (DW, ECw = 4.93 dS/m) أو مياه الرى العادية (FW) (FW, ECw= 0.31 dS/m) منفردة أو مخاليط منهما بنسب مختلفه خلال موسمي ٢٠١٤/٢٠١٣ و٢٠١٥/٢٠١٤ كما يلى:

a) 2:1of FW:DW, with a ECw value of 1.68 dS/m.
b) 1:1of FW:DW, with a ECw value of 2.27 dS/m.
c) 1:2of FW:DW, with a ECw value of 3.62 dS/m.

تشير النتائج المتحصل عليها إلى أن قياسات النمو الخضرى والزهرى والمكونات الكيماويه قد تأثرت معنويا بالسلب بينما أدت إلى زياده معنويه فى نسبة البرولين والصوديوم والماغنسيوم والكالسيوم نتيجة ري النباتات بمياه الصرف المباشره أو بعد خلطها بالمياه العادية عند أى نسبه' على العكس أدت اضافة الكمبوست للتربه إلى زيادة معنويه فى النمو الخضرى والزهرى والمكونات الكيماويه بينما أدت إلى نقص نسبه البرولين والصوديوم والبورون'بينما كان تأثير التفاعل بين الكمبوست ومياه الصرف الزراعى أو مستوياته معظمه كان ايجابيا على القياسات السابقه وكان افضل المعاملات هى المعدل ١٠٠جرام كمبوست للأصيص مع المستوى ٢:١ و١:١ لذا يمكن القول أن أضافة الكمبوست للتربه كان مناسبا لنمو الأقحوان تحت تأثير الرى بمياه الصرف الزراعى.