J. Plant Production, Mansoura Univ., Vol. 10 (7): 523 - 528, 2019

Effects of Irrigation Water Salinity and Humic Acid Treatments on Caraway Plants

Hassan, A. A.
Hort. Dept., Fac. of Agric., Minia Univ.

ABSTRACT

The present study was carried out during two successive seasons of 2016/2017 and 2017/2018 at the Nursery of Ornamental plants, Fac. of Agric., Minia University, to study effects of saline water irrigation (250, 1000, 1750 and 2500 ppm) as the main plot and humic acid (control, 100, 200 and 400 mg/l.) as the sub plot and the interaction between them on vegetative growth traits (plant height, number of branches and herb dry weight/plant), fruit and essential oil productivity, as well as, some chemical composition (photosynthetic pigments, nitrogen, phosphorus, potassium, sodium, calcium and proline percentages) of caraway. Under irrigation with saline water ranged from 1000 and 1750 ppm, all studied vegetative growth characters were significantly increased such as fruit yield/plant, oil % and oil yield/plant and some chemical composition (photosynthetic pigments, N, P and K %). Also, humic acid treatments increased all studied parameters but decreased proline %. From results of this research it could be concluded that, caraway plants are moderately tolerant to salinity stress and can be vigorously grown under irrigation with saline water ranged from 1000 to 2500 ppm when sprayed with humic acid at 400 mg/l.

INTRODUCTION

Caraway (*Carum carvi*, L.) plant belongs to family Apiaceae (Umbelliferae). It considered one of the most important aromatic plants grown in Upper Egypt. The drug obtained from caraway fruits for both food and pharmaceutical industries requires the same treatment and storage. This drug is used in various forms as carminative and antispasmodic, as a tonic and in the treatment of digestive disorders (Stary and Jirasck, 1975 and Muhammad *et al.*, 2014).

Salinity is one of the major abiotic stresses limiting growth and productivity of medicinal plants (Shafi *et al.*, 2009). Salinity is an environmental pressure that hinders crop production and quality. Plant responses to extra salts are complex and involve variations in their morphology, physiology and metabolism (Hilal *et al*., 1998). Movements of salts from roots to shoots is a result of transpiration fluidity prerequisite to maintain water content of plant and changeability of transpiration may cause toxic levels of ion increase in plants (Takase *et al*., 2011).

Humic substances are one of the main soil organic matter components and the most biochemical active soil organic matter fraction as well (Tan, 2003; Cwielag-Piasecka *et al*., 2018). Literature specified humic substances could be applied as organic fertilizers or soil amendments. Humic substances rise soil organic matter, chiefly for sandy soils in Egypt, and hence improve soil physicochemical and biological characteristics. Accordingly, soil nutrient availability for plants as well as microorganisms could be enhanced (El-Ghozoli, 2003; El-Ghanam and El-Ghozoli 2006; Sayed *et al*., 2007; El-Sharkawy, 2007) Humic acid usage in agriculture has led to substantial rise in soil fertility and increased plant quality and crop productivity (Selim *et al*., 2009, Selim and Mosa, 2012 and Arif *et al*., 2013).

Therefore, the purposes of this research were to investigate effects of water salinity and some humic acid treatments, as well as, their interaction on vegetative growth, yield of fruits, oil production and chemical constituents of *Carum carvi*, L. plants.

MATERIALS AND METHODS

Current research was carried out during two successive seasons of 2016/2017 and 2017/2018 in the Nursery and Laboratory of Ornamental plants Division, Horticulture Department, Faculty of Agriculture, Minia University on caraway (*Carum carvi*, L.) plants. The scientific aim of this experiment was to study the influence of water salinity and humic acid treatments, as well as, their interaction on vegetative growth, yield of fruits, oil production and some chemical constituents of caraway plants.

Caraway seeds were sown on September, 15th in the first and second seasons in plastic pots (45 cm diameter) containing 27 kg of sandy soil/pot. The sandy soil brought from Eastern Bank of River Nile in the front of El-Minia city. Soil physicochemical properties presented in Table (1), were analyzed using standard methods according to Jackson (1975).

Table 1. Some soil physicochemical properties of the investigated soil.

Soil property	Value	Soil property		Value
Sand %	90.0	Available P (mg kg^{-1})		3.00
Silt %	6.7	Exch. Ca^{++} (mg/100gm soil)		3.80
Clay %	3.3	Exch. Mg^{++} (mg/100gm soil)		1.60
Soil texture	Sand	Exch. Na^{+} (mg/100gm soil)		2.00
Organic matter (g kg^{-1})	0.9	Exch. K^{+} (mg/100gm soil)		0.60
$CaCO_3$ (g kg^{-1})	131		Fe	1.20
pH (1:2.5 suspension)	7.89	DTPA	Cu	0.41
E.C. dS m^{-1}	1.03	Ext. ppm	Zn	0.31
Total N %	0.004		Mn	0.63

This trial was settled in a split plot design (randomized complete block design) with three replicates, each replicate contained 9 pots. The main plots (A) included four levels of water salinity (250, 1000, 1750 and 2500 ppm), while four treatments of humic acid (0, 100, 200 and 400 mg/l.) occupied in the sub plots (B). Therefore, the interaction treatments (48 replicate=432 plots). Plants were thinned twice, the first one after one month from planting date and the second one after two weeks from the first one living two plants/plot.

Plants were irrigated with different levels of water salinity (NaCl + $CaCl_2$, 1:1 by weight) to reach 100 % percentages of the field capacities according to El-Tomi *et al*., (1984), where each pot irrigated twice every week using two liters. In both experimental seasons, humic acid obtained from Sigma Company. Humic acid was applied 4 times at one-month interval by hand sprayer, starting 1st of November. Plants were sprayed till run off. All other agricultural practices were carried out as usual.

Plants were harvested on first week of May in both experimental seasons and the following data were recorded: vegetative growth characters (plant height, number of branches and herb dry weight/plant), fruits (g/plant) and essential oil productivity (essential oil percentage and essential oil ml/plant of fruits), as well as chemical composition (N, P, K, Na, Ca and proline percentages). Also, photosynthetic pigments (chl. a, b and carotenoids) were estimated.

Essential oil percentage in the fruits of caraway was determined according to British pharmacopoeia (1963). Satisfactory results were obtained by distillation of 25 g of fruits for three hours. Then the essential oil percentage and essential oil yield /plant were calculated.

Determination of N, P and K % in the dry herb was carried out according to Wilde *et al*. (1985), Chapman and Pratt (1975) and Cottenie *et al*. (1982). Determination of sodium and calcium percentages were measured using Flame spectrophotometer (Kalra, 1998) and free proline was determined according to Bates *et al.* (1973). Chlorophyll a, b and carotenoids contents were determined in fresh leaves (first week of March) according to Moran (1982).

Statistical analysis: data of both seasons were subjected to the statistical analysis of variance using MSTAT-C (1986). L.S.D. test at 0.05 was used to compare the means of treatments.

RESULTS AND DISCUSSION

1- Vegetative growth characters:

Data obtained in Table (2) clearly shown that plant height, number of branches/plant and herb dry weight/plant were significantly increased by the gradual increase in irrigation water salinity level up to 1750 ppm in both experimental seasons as compared with control. It was obvious that caraway plants grown under the highest salinity stress (2500 ppm) were the shortest plants (87.17 and 89.79 cm in both seasons), minimizing number of branches (6.69 and 6.75) and lightest weight (27.02 and 29.60 g/plant)

Zhu, (2001) concluded that under salt stress photosynthesis owing to stomata closure and consequently limited carbon dioxide uptake. Similar results were obtained by Kandil and Elewa (2008) on *Ammi majus*, Okkaoglu *et al.* (2015) on coriander and Saliani and Bahraminejad (2015) on cumin. Concerning humic acid, all treatments resulted in significantly increased vegetative growth taller plants (96.47 and 99.36 cm in both first and second seasons, respectively), highest number of branches (8.33 and 8.42) and heaviest herb dry weights (31.52 and 33.40 g/plant) were obtained with high concentration of humic 400 mg/l. Jamali *et al.* (2015) showed that humic acid enhanced the vegetative growth of plants. The same effect was found by Beyzi *et al.* (2017) on coriander plants.

The interaction between salinity and humic acid treatments was significant for plant height, number of branches/plant and herb dry weight/plant. The highest values of plant height, number of branches/plant and herb dry weight/plant were obtained by interaction treatments of salinity water at 1750 ppm with humic acid at 400 mg/l. The interaction effect between salinity and humic acid was highly significant on growth parameters. This means that humic acid could alleviate salinity stress (Paksoy *et al*., 2010).

Table 2. Effect of experimental treatments interaction on plant growth parameters of caraway plants during 2016/2017 and 2017/2018 seasons

Salinity stress and /or humic acid treatments	Water salinity stress (A)									
	1st season (2016/2017)					2nd season (2017/2018)				
	250ppm	1000ppm	1750ppm	2500ppm	Mean (B)	250ppm	1000ppm	1750ppm	2500ppm	Mean (B)
Plant height (cm)										
Control	84.78	90.13	93.15	83.92	88.00	87.33	92.83	95.95	86.44	90.64
100 mg/l. humic acid	87.68	93.68	96.30	84.35	90.50	90.31	96.49	99.19	86.88	93.22
200 mg/l. humic acid	91.62	96.73	100.23	88.95	94.38	94.37	99.63	103.24	91.62	97.22
400 mg/l. humic acid	94.28	98.23	101.89	91.47	96.47	97.11	101.18	104.95	94.21	99.36
Mean (A)	89.59	94.69	97.89	87.17		92.28	97.53	100.83	89.79	
L.S.D. at 5 %	A : 2.40		B : 1.81	AB : 3.68		A : 2.45		B : 1.90	AB : 3.80	
Number of branches/plant										
Control	6.47	7.18	7.55	6.30	6.88	6.53	7.26	7.63	6.36	6.94
100 mg/l. humic acid	6.55	7.67	8.03	6.41	7.17	6.62	7.75	8.11	6.48	7.24
200 mg/l. humic acid	7.27	8.70	9.40	6.83	8.05	7.34	8.79	9.49	6.90	8.13
400 mg/l. humic acid	7.73	8.83	9.57	7.20	8.33	7.81	8.92	9.67	7.27	8.42
Mean (A)	7.01	8.10	8.64	6.69		7.07	8.18	8.72	6.75	
L.S.D. at 5 %	A : 0.38		B : 0.38	AB : 0.76		A : 0.31		B : 0.39	AB : 0.78	
Herb dry weight/plant (g/plant)										
Control	26.23	28.27	30.16	25.00	27.41	28.57	30.99	31.91	28.31	29.95
100 mg/l. humic acid	26.73	30.26	31.07	25.63	28.42	29.59	32.07	33.11	28.34	30.78
200 mg/l. humic acid	29.32	31.14	33.00	28.20	30.42	31.23	33.55	34.20	30.67	32.41
400 mg/l. humic acid	30.73	31.57	34.55	29.24	31.52	32.68	33.94	35.90	31.06	33.40
Mean (A)	28.25	30.31	32.20	27.02		30.52	32.64	33.78	29.60	
L.S.D. at 5 %	A : 1.54		B : 1.49	AB:2.98		A : 1.10		B : 0.99	AB : 1.98	

2-Fruits and essential oil productivity:

Data presented in Table (3) cleared that treatments of 1000 and 1750 ppm salinity water significantly increased fruit yield/plant essential oil percentages and essential oil yield/plant than the control. On the other side, the treatment of 2500 ppm water salinity decreased the previous characters in both seasons. Our results mean that caraway plant tolerate salinity stress till 1750 ppm, also 2500 ppm had negative effect on caraway plants, such an adverse effects of salt stress on fruit and essential oil production has been observed by Semiz *et al*. (2012) on fennel and Okkaoglu *et al.* (2015) and Asaad (2018) on coriander.

Regarding the effect of humic acid treatments, data presented in Table (3) indicated that all used humic acid treatments led to a significant increase in fruit yield/plant, essential oil % and oil yield/plant in both seasons over control. The highest values were obtained by humic acid at 400 mg/l. similar in agreement with our results were those obtained by Beyzi *et al.* (2017) and Asaad (2018) on coriander.

The interaction treatments were significant for fruit yield, essential oil % and yield/plant in both seasons. The highest values were obtained by plants irrigated with 1750 ppm saline water and sprayed with humic acid at 400 mg/l. Many authors have confirmed that humic acid can indirectly and directly affect the physiological processes of plant growth and enhance stress tolerances (Yang *et al*., 2004 and Rady, 2012).

Table 3. Effect of Salinity stress and humic acid treatments, as well as, their interaction on fruit yield/plant (g), oil % & oil yield/plant (ml) of caraway plants during 2016/2017 and 2017/2018 seasons

Salinity stress and /or humic acid treatments	Water salinity stress (A)									
	1st season (2016/2017)					2nd season (2017/2018)				
	250ppm	1000ppm	1750ppm	2500ppm	Mean (B)	250ppm	1000ppm	1750ppm	2500ppm	Mean (B)
Fruit yield/plant (g)										
Control	22.30	23.73	25.57	21.07	23.17	22.52	23.97	25.83	21.28	23.40
100 mg/l. humic acid	22.50	25.67	26.60	21.70	24.12	22.73	25.93	26.87	21.92	24.36
200 mg/l. humic acid	24.07	27.03	27.97	23.30	25.59	24.31	27.30	28.25	23.53	25.85
400 mg/l. humic acid	25.90	27.07	28.70	24.00	26.42	26.16	27.34	28.99	24.24	26.68
Mean (A)	23.69	25.88	27.21	22.52		23.93	26.14	27.49	22.74	
L.S.D. at 5 %	A: 1.29		B: 0.31		AB :0.62	A: 1.33		B: 0.35		AB: 0.70
Oil %										
Control	2.34	2.53	2.74	2.31	2.48	2.38	2.58	2.79	2.24	2.50
100 mg/l. humic acid	2.34	2.78	2.95	2.33	2.60	2.39	2.84	3.01	2.36	2.65
200 mg/l. humic acid	2.71	3.09	3.18	2.46	2.86	2.76	3.15	3.22	2.52	2.91
400 mg/l. humic acid	2.78	3.16	3.29	2.68	2.98	2.84	3.19	3.36	2.74	3.03
Mean (A)	2.54	2.89	3.04	2.45		2.59	2.94	3.10	2.46	
L.S.D. at 5 %	A : 0.13		B : 0.05		AB: 0.10	A : 0.15		B : 0.06		AB: 0.12
Oil yield/plant (ml)										
Control	0.522	0.600	0.701	0.487	0.577	0.536	0.618	0.721	0.477	0.588
100 mg/l. humic acid	0.527	0.714	0.785	0.506	0.633	0.543	0.736	0.809	0.517	0.651
200 mg/l. humic acid	0.652	0.835	0.889	0.573	0.738	0.671	0.860	0.910	0.593	0.758
400 mg/l. humic acid	0.720	0.855	0.944	0.643	0.791	0.743	0.872	0.974	0.664	0.813
Mean (A)	0.605	0.751	0.830	0.552		0.623	0.772	0.853	0.563	
L.S.D. at 5 %	A : 0.064		B:0.020		AB :0.040	A :0.072		B:0.023		AB :0.046

3- Chemical composition:

1- Photosynthetic pigments:

Data presented in Table (4) showed that all saline water treatments increased the contents of chlorophyll a, b and carotenoids as compared with the control treatments, except at high level salinity stress during both seasons. Similar results were obtained with Kaur and Kumar (2017) and Asaad (2018) on coriander and Sardar *et al*. (2018) on anise.

Regarding the effect of humic acid, all used treatments of humic acid significantly increased chlorophyll a, b and carotenoids, in both seasons, comparing with control. By increasing humic acid levels, chlorophyll a, b and carotenoids were increased as clearly shown in Table (4). Similar results were obtained by Vafa *et al.* (2015) on savory and Asaad (2018) on coriander.

Table 4. Effect of Salinity stress and humic acid treatments, as well as, their interaction on photosynthetic pigments (mg/g F.W.) of caraway L. plants during 2016/2017 and 2017/2018 seasons

Salinity stress and /or humic acid treatments	Salinity stress (A)									
	1st season (2016/2017)					2nd season (2017/2018)				
	250ppm	1000ppm	1750ppm	2500ppm	Mean (B)	250ppm	1000ppm	1750ppm	2500ppm	Mean (B)
Chlorophyll a										
Control	2.080	2.160	2.220	1.990	2.113	2.103	2.184	2.244	2.012	2.136
100 mg/l. humic acid	2.100	2.235	2.313	2.050	2.175	2.123	2.260	2.338	2.073	2.198
200 mg/l. humic acid	2.210	2.320	2.440	2.120	2.273	2.234	2.346	2.467	2.143	2.297
400 mg/l. humic acid	2.260	2.434	2.591	2.190	2.369	2.285	2.461	2.620	2.214	2.395
Mean (A)	2.163	2.287	2.391	2.088		2.186	2.312	2.417	2.110	
L.S.D. at 5 %	A : 0.024		B : 0.011		AB : 0.022	A : 0.030		B : 0.028		AB : 0.056
Chlorophyll b										
Control	1.190	1.230	1.300	1.150	1.218	1.203	1.244	1.314	1.163	1.231
100 mg/l. humic acid	1.200	1.310	1.360	1.180	1.263	1.213	1.324	1.375	1.193	1.276
200 mg/l. humic acid	1.290	1.390	1.410	1.220	1.328	1.304	1.405	1.426	1.233	1.342
400 mg/l. humic acid	1.320	1.400	1.470	1.270	1.365	1.335	1.415	1.486	1.284	1.380
Mean (A)	1.250	1.333	1.385	1.205		1.264	1.347	1.400	1.218	
L.S.D. at 5 %	A : 0.052		B : 0.010		AB : 0.020	A : 0.053		B : 0.014		AB : 0.028
Carotenoids										
Control	1.280	1.320	1.350	1.240	1.298	1.294	1.335	1.365	1.254	1.312
100 mg/l. humic acid	1.290	1.360	1.400	1.270	1.330	1.304	1.375	1.415	1.284	1.345
200 mg/l. humic acid	1.340	1.410	1.441	1.300	1.373	1.355	1.426	1.457	1.314	1.388
400 mg/l. humic acid	1.370	1.420	1.470	1.330	1.398	1.385	1.436	1.486	1.345	1.413
Mean (A)	1.320	1.378	1.415	1.285		1.335	1.393	1.431	1.299	
L.S.D. at 5 %	A : 0.037		B : 0.004		AB : 0.008	A : 0.038		B : 0.005		AB : 0.010

The interaction between main and sub plot (A×B) treatments was significant for chl. a, b and carotenoids in both seasons as shown in Table (4).

The highest values of three pigments were procedure from plants irrigated with 1750 ppm and sprayed with humic acid at 400 mg/l.

2- N, P & K %:

Data presented in Table (5) indicated that all treatments of water salinity decreased NPK % in both seasons, the lowest values N % (2.037 and 2.057), P % (0.174 and 0.175) and K % (0.761 and 0.769) were obtained with 2500 ppm saline water. Similar results were obtained by Khalid and Shedeed (2014) on black cumin, and Askari-Khorasgani *et al.* (2017) on *Matricaria recutita*.

Concerning the effect of humic acid, data showed that all used treatments significantly increased N, P and K % in both seasons. Humic acid at 400 mg/l. was more effective than other used treatments. In agreement with our results were those given by Shahin *et al.* (2014) on *Merremia dissecta* and Asaad (2018) on coriander. It is obvious that spraying caraway plants, irrigated with 1000 ppm water salinity, could procedure equal values of herb N, P and K % to those of control/sprayed with humic acid (400 mg/l.) (Table, 4).

Table 5. Effect of Salinity stress and humic acid treatments, as well as, their interaction on nitrogen, phosphorus and potassium percentages of caraway plants during 2016/2017 and 2017/2018 seasons

Salinity stress and /or humic acid treatments	Salinity stress (A)									
	1st season (2016/2017)					2nd season (2017/2018)				
	250ppm	1000ppm	1750ppm	2500ppm	Mean (B)	250ppm	1000ppm	1750ppm	2500ppm	Mean(B)
					N %					
Control	2.185	2.091	1.946	1.730	1.988	2.207	2.112	1.965	1.747	2.008
100 mg/l. humic acid	2.401	2.310	2.212	1.929	2.213	2.425	2.333	2.234	1.948	2.235
200 mg/l. humic acid	2.684	2.798	2.441	2.128	2.513	2.711	2.826	2.465	2.149	2.538
400 mg/l. humic acid	3.040	2.855	2.785	2.360	2.760	3.070	2.884	2.813	2.384	2.788
Mean (A)	2.578	2.514	2.346	2.037		2.603	2.538	2.369	2.057	
L.S.D. at 5 %	A : 0.061		B : 0.093		AB : 0.186	A : 0.062		B : 0.094		AB : 0.188
					P %					
Control	0.240	0.209	0.162	0.136	0.187	0.242	0.211	0.164	0.137	0.188
100 mg/l. humic acid	0.256	0.236	0.190	0.161	0.211	0.259	0.238	0.192	0.163	0.213
200 mg/l. humic acid	0.286	0.273	0.204	0.187	0.238	0.289	0.276	0.206	0.189	0.240
400 mg/l. humic acid	0.310	0.287	0.235	0.211	0.260	0.313	0.290	0.237	0.213	0.263
Mean (A)	0.273	0.251	0.198	0.174		0.276	0.253	0.200	0.175	
L.S.D. at 5 %	A : 0.020		B : 0.012		AB : 0.024	A : 0.021		B : 0.013		AB : 0.026
					K %					
Control	1.017	0.796	0.737	0.700	0.813	1.027	0.804	0.744	0.707	0.821
100 mg/l. humic acid	1.038	0.871	0.779	0.744	0.859	1.048	0.880	0.787	0.751	0.867
200 mg/l. humic acid	1.099	0.981	0.866	0.780	0.931	1.110	0.991	0.875	0.788	0.940
400 mg/l. humic acid	1.119	1.007	0.992	0.818	0.984	1.130	1.017	1.002	0.826	0.994
Mean (A)	1.069	0.914	0.843	0.761		1.079	0.923	0.851	0.769	
L.S.D. at 5 %	A : 0.152		B : 0.040		AB : 0.080	A : 0.157		B : 0.041		AB : 0.082

3- Plant sodium and calcium %:

Data presented in Table (6) indicated that Na and Ca % were gradually increased as water salinity was raised upward. These results were in agreement with those of Semiz *et al.* (2012) on fennel and Asaad (2018) on coriander.

Table 6. Effect of water salinity stress and humic acid treatments, as well as, their interaction on sodium, calcium and proline percentages of caraway plants during 2016/2017 and 2017/2018 seasons

Salinity stress and /or humic acid treatments	Salinity stress (A)									
	1st season (2016/2017)					2nd season (2017/2018)				
	250ppm	1000ppm	1750ppm	2500ppm	Mean(B)	250ppm	1000ppm	1750ppm	2500ppm	Mean (B)
					Na %					
Control	1.517	1.786	1.981	2.074	1.839	1.532	1.804	2.001	2.095	1.857
100 mg/l. humic acid	1.500	1.690	1.951	2.051	1.798	1.515	1.707	1.971	2.072	1.816
200 mg/l. humic acid	1.491	1.658	1.857	2.035	1.760	1.506	1.675	1.876	2.055	1.778
400 mg/l. humic acid	1.476	1.623	1.831	2.013	1.736	1.491	1.639	1.849	2.033	1.753
Mean (A)	1.496	1.690	1.905	2.043		1.511	1.706	1.924	2.063	
L.S.D. at 5 %	A : 0.182		B : 0.042		AB : N.S.	A : 0.187		B : 0.043		AB : N.S.
					Ca %					
Control	0.097	0.209	0.237	0.299	0.211	0.254	0.202	0.117	0.032	0.152
100 mg/l. humic acid	0.076	0.193	0.221	0.282	0.193	0.271	0.213	0.146	0.048	0.170
200 mg/l. humic acid	0.048	0.146	0.213	0.271	0.170	0.282	0.221	0.193	0.076	0.193
400 mg/l. humic acid	0.032	0.117	0.202	0.254	0.152	0.299	0.237	0.209	0.097	0.211
Mean (A)	0.064	0.167	0.218	0.277		0.277	0.218	0.167	0.064	
L.S.D. at 5 %	A : 0.096		B : 0.020		AB : N.S.	A : 0.099		B : 0.021		AB : N.S.
					Proline %					
Control	0.693	0.855	0.887	1.052	0.872	0.700	0.864	0.896	1.063	0.881
100 mg/l. humic acid	0.681	0.840	0.868	1.038	0.856	0.688	0.847	0.877	1.047	0.865
200 mg/l. humic acid	0.657	0.801	0.828	1.016	0.826	0.664	0.809	0.836	1.026	0.834
400 mg/l. humic acid	0.468	0.794	0.820	0.988	0.767	0.473	0.802	0.828	0.998	0.775
Mean (A)	0.625	0.823	0.850	1.024		0.632	0.831	0.859	1.034	
L.S.D. at 5 %	A : 0.088		B : 0.032		AB : 0.064	A : 0.091		B : 0.033		AB : 0.066

All treatments of humic acid decreased Na and Ca % with significant differences compared to control. The interaction was not significant. The role of humic acid in relief the adverse of salinity on Na and Ca % was also given by Aydin *et al.* (2012) on *Phaseolus vulgaris*, Mostafa (2015) on fennel and Asaad (2018) on coriander.

4- Plant Proline %:

Water salinity at 1000, 1750 and 2500 ppm were very effective in promoting proline % in the herb of caraway. In agreement with our results were those of Ali and Attia (2015) on rosemary, Haddadi *et al*. (2016) on *Mentha aquatic* and Asaad (2018) on coriander.

All used humic acid application rates caused reduction, in both seasons, in proline % in comparison to that untreated plants (Table, 6). The highest values of proline % were obtained (1.052 %) from plants grown under 2500 ppm saline water and non-sprayed with humic acid (control), while, the least value (0.988 %) was obtained with 2500 ppm and sprayed 400 mg/l. Such two combined treatments gave equal significant.

CONCLUSION

Obtained results from this experiment showed that humic acid at all application rates enhanced significantly vegetative growth, fruit yield and chemical composition of caraway plants and fruits under gradual increase in irrigation water salinity leveled up to 2500 ppm in both experimental seasons as compared with control. The interaction effect between salinity and humic acid was significant on theses growth, yield and quality parameters. The highest values of these plant parameters were obtained by interaction treatments of salinity water at 1750 ppm with humic acid at 400 mg/l, indicating that humic acid could alleviate salinity stress. By contrast, all used humic acid application rates caused reduction, in both seasons, in proline, Ca and Na (%) in comparison to that untreated plants, where the highest values of proline %, Ca% and Na% were obtained from plants grown under 2500 ppm saline water and non-sprayed with humic acid (control).

REFERENCES

Ali, H.M.H. and Attia, M.G. (2015): Response of salt stressed rosemary plants to anti-stress agents. Scientific J. Flowers & Ornamental Plants, 2 (3):249-264.

Arif, S., K. Tahsin and T. Muhammet, (2013): Effects of leonardite applications on yield and some quality parameters of potatoes (Solanum tuberosum L.). Turkish Journal of Field Crops, 18(1): 20-26.

Asaad, S.G.Y. (2018): Water desalinated by solar energy and its impact on cultivation and production of some medicinal plants. M.Sc. Thesis, Fac. of Agric. Minia Univ.

Askari-Khorasgani, O.; Mortaazaeinezhad, F. and Rafiee, P. (2017): Variations in the growth, oil quantity and quality and mineral nutrients of chamomile genotypes under salinity stress. Journal of Central European Agriculture, 18(1), p.150-169.

Aydin, A.; Kant, C. and Turan, M. (2012): Humic acid applications alleviate salinity stress of bean (*Phaseolus vulgaris* L.) plants decreasing membrane leakage. African Journal of Agricultural Research Vol. 7(7), pp. 1073-1086.

Bates, L.S.; Waldern, R.P. and Teare, I.D. (1973): Rapid determination of free proline for water-stress studies. Plant Soil 39:205-207.

Beyzi, E.; Gunes, A. and Gurbuz, B. (2017): Effects of humic acid treatments of yield, morphological characteristics and essential oil components of coriander (*Coriandrum sativum*, L.). Research Journal of Soil Biology, 9 (1):1-8.

British pharmacopoeia (1963): Determination of volatile oil drugs. The Pharmaceutical Press, London.

Chapman, H.D. and Pratt, P.F. (1975): Methods of Analysis for Soil, Plant and Water Calif. Univ. Division of Agric. Sci., 172-174.

Cottenie, A.; Verloo, M.; Velghe, M. and Camerlynck, R. (1982): Chemical Analysis of Plant and Soil. Laboratory of Analytical and Agro Chemistry. State Univ., Ghent, Belgium.

Cwielag-Piasecka, I., Agnieszka, M. J., Maria, J., Magdalena, D., Jakub, B., Elzbieta, J. and Dorota, K. (2018): Humic substances in the environment. Journal of Soil and Sediments, Vol 18,: 2692-2702.

El-Ghanam, M.M.M. and El-Ghozoli, M.A. (2006): Behavior of selenium in calcareous soil treated with humic acid. Annals of Agric. Sci., Moshtohor, Vol. 44 (1): 407-424.

El-Ghozoli, M.A. (2003): Influence of humic acid on faba bean plants grown in cadmium polluted soil. Annals of Agric. Sci., Moshtohor, Vol. 41 (4): 1787-1800.

El-Sharkawy, Sh. M. M. (2007): Response of guava trees to organic fertilization. The Third Conf. of Sustain. Agric. Develop. Fac. Of Agric., Fayoum Univ., 12-14 Nov., 2007, 179-196.

El-Tomi, A.L.; Montasser, H.S.; Behairy, Z.H.; Bondok, A.Z. and El-Nahaas, M.A. (1984): Effect of irrigation on mineral content of jojoba plants. Annals of Agric. Sci, Ain Shams Univ., 29: 2, 1055-1067.

Haddadi, B.S.; Hassanpour, H. and Vahid Niknam (2016): Effect of salinity and waterlogging on growth, anatomical and antioxidative responses in *Mentha aquatica*, L. Acta Physiol Plant 38:119, 1-11.

Hilal, M., A. M. Zenoff, G. Ponessa, H. Moreno, E. D. Massa, (1998): Saline Stress Alters The Temporal Patterns of Xylem Differentiation and Alternative Oxidative Expression in Developing Soybean Roots. Plant Physiol., 117, 695–701.

Jackson, M. L. (1975): Soil chemical analysis- Advanced course. M. L. Jackson, Madison, W. L.

Jamali, Z.S.; A.R. Astaraei and Emami, H. (2015): Effects of humic acid, compost and phosphorus on growth characteristics of basil herb and concentration of microelements in plant and soil. J. Sci. & Technol. Greenhouse Culture, Vol. 6, No. 22, Summer 2015, Isfahan Univ. Technol., Isf., Iran.

Kalra, Y.P. (1998): Handbook of Reference Methods for Plant Analysis. Soil and Plant Analysis Council, Inc. CRC Press, Taylor & Francis Group, USA.

Kandil, H.K. and Elewa, M.E. (2008): Effect of the growth regulator uniconazole and salt stress on growth, yield and nutrients content of *Ammi majus*, L. plant. Aust. J. Basic & Appl. Sci., 2(3): 458-465.

Kaur, G. and Kumar, A. (2017): Effect of salinity stress on plant growth, chlorophyll content and carotenoids of coriander (*Coriandrum sativum*, L.) cultivars. International Journal of Current Research, Vol. 9, Issue, 09, pp.: 57536-57544.

Khalid, K. and Shedeed, M. (2014): The effects of saline irrigation water and cobalt on growth and chemical composition in *Nigella sativa.* Nusantara Bioscience, Vol. 6, No. 2, pp. 146-151.

Moran, R. (1982): Formula determination of chlorophylls Pigments extracted with N-N dimethyl-formamide. Plant Physiological., 69: 1376-1381.

Mostafa, G.G. (2015): Improving the growth of fennel plant grown under Salinity Stress using some biostimulants. Am. J. Plant Physiol., 10 (2): 77-83.

MSTAT-C (1986) : A Microcomputer Program for the Design, Management and Analysis of Agronomic Research Experiments (Version 4.0), Michigan Stat Univ., U.S.A.

Muhammad, T.S.; Masood, S.B.; Saeed A.; Atif, N.A.; Mubasher, R.; Muhammad, S.S. and Ambreen, N. (2014): Antioxidant and antimicrobial of potential of dried cumin (*Cuminum cyminum*, L.), caraway (*Carum carvi*, L.) and tumeric powder (*Curcuma longa*, L.). Food J., Agric. & Environ. 12 (3 & 4): 71-76.

Okkaoglu, H.; Sonmez, C.; Şimsek, A.Ö. and Bayram, E. (2015): Effect of salt stress on some agronomical characteristics and essential oil content of coriander (*Coriandrum sativum*, L.) cultivars. Journal of Applied Biological Sciences, 9 (3): 21-24.

Paksoy, M.; Türkmen, Ö. and Dursun, A. (2010): Effects of potassium and humic acid on emergence, growth and nutrient contents of okra (*Abelmoschus esculentus*, L.) seedlings under saline soil conditions. Afr. J. Biotechnol. 9, 5343-5346.

Rady, A.A. (2012): A novel organo-mineral fertilizer can mitigate salinity stress effects for tomato production on reclaimed saline soil. South Afr. J. Bot. 81, 8-14.

Saliani, M.S. and Bahraminejad, A. (2015): Evaluation of the salinity stress Effect on cumin (*Cuminum cyminum*, L.) ecotypes in Kerman, Iran. ARRB., 6(3): 166-175.

Sardar A. ; Javeed, Z.; Riaz, H.; Saleem, A.; Ehsan, M.; Naveed, M.; Zulqadar, S.A.; Kharal, M.A. (2018): Effect of Salinity Stress on Anise (*Pimpinella anisum,* L.) seedling characteristics under hydroponic conditions. Journal of Environmental and Agricultural Sciences, 14: 39-45.

Sayed, R.A.; Ibrahim, M.A. and Solaiman, B.M. (2007): Response of valencia orange trees to foliar and soil application of humic acids under new reclaimed land conditions. The Third Conf. of Sustain. Agric. Develop. Fac. Of Agric., Fayoum Univ., 12-14 Nov., 2007, 259-274.

Selim, E.M. and A.A. Mosa, (2012): Fertigation of humic substances improves yield and quality of broccoli and nutrient retention in a sandy soil J. Plant Nutr. Soil Sci., 175: 273-281.

Selim, E.M., A.A. Mosa and A.M. El-Ghamry, (2009): Evaluation of humic substances fertigation through surface and subsurface drip irrigation systems on potato grown under Egyptian sandy soil conditions. Agricultural Water Management, 96: 1218-1222.

Semiz, G.D.;Ünlukara, A.; Yurtseven, E. and Suarez, D.C. (2012): Salinity impact on yield, water use, mineral and essential oil content of fennel (*Foeniculum vulgare*, Mill.). Journal of Agricultural Sciences, 18: 177-186.

Shafi, M., Bakht, J., Raziuddin, A. and Zhang, G. (2009): Effect of cadmium and salinity stresses on growth and antioxidant enzymes activity of wheat genotypes Bull. Environ. Contain. Toxicol., 82 (6): 772-776.

Shahin, S.M; Boshra, A.; El-Sayed, A. and El-Tayeb, H.F. (2014): Improving growth and quality of *Merremia dissecta* (Jacq.) H. G. Hallier twiner by some fertilization Treatments. Alex. J. Agric. Res., Vol. 59, No.1, pp.43-49.

Stary, F. and Jirasck, V. (1975): A concise Guide in colour Herbs Hamlyn, London, New york, Sydney and Toronto.

Takase, M., Sam-Amoah, L. K. and Owusu-Sekyere. (2011): The effects of four sources of irrigation water on soil chemical and physical properties Asian J. Plant Sci., 10: 92-96.

Tan, K.H.T. (2003): Humic Matter in Soil and Environment Principles and Controversies. Marcel Dekker Inc., New York, USA

Vafa, Z.N.; Sirousmehr1, A.R.; Ghanbari, A.; Khammari, I.; and Falahi, N. (2015): Effects of nano zinc and humic acid on quantitative and qualitative characteristics of savory (*Satureja hortensis*, L.). Int. J. Biosci., Vol. 6, No. 3, p. 124-136.

Wilde, S.A.; Covey, R.P.; Lyer, J.C. and Voigt, G.K. (1985): Soil and Plant Analysis for Tree Culture. Oxford, IBH. Publishing Co., New Delhi, India.

Yang, H.L.; Hseu, Y.C.; Hseu, Y.T.; Lu, F.J.; Lin, E. and Lai, J.S. (2004): Humic acid induces apoptosis in human premyelocytic leukemia HL-60 cells. Life Sci. 75, 1817-1831.

Zhu, J.K. (2001): Plant salt tolerance. Trends in Plant Science, 6, 66-71.

تأثير معاملات ملوحة المياه وحمض الهيوميك على نباتات الكراوية

أحمد علي حسن
قسم البساتين – كلية الزراعة - جامعة المنيا

لقد تم اجراء هذه الدراسة خلال موسمين متتاليين هما 2017/2016 و 2018/2017 في مشتل نباتات الزينة بكلية الزراعة - جامعة المنيا بهدف دراسة تأثير الري بالماء المملح بتركيزات (250 ، 1000 ، 1750 ، 2500 جزء في المليون) كعامل رئيسي ومعاملات حمض الهيومك بتركيزات (كنترول ، 100 ، 200 ، 400 ملجم/لتر) كعامل ثانوي ومعاملات التداخل بينهم على صفات النمو الخضري (طول النبات وعدد الافرع والوزن الجاف للنبات) والمحصول وانتاجية الزيت الطيار بالاضافة الى بعض الصفات الكيميائية (صبغات البناء الضوئي والنسبة المئوية لكل من النتروجين والفوسفور والبوتاسيوم والصوديوم والكالسيوم والبرولين) لنبات الكراوية.تحت ظروف الري بالماء المملح من 1000 الى 1750 جزء في المليون حدثت زيادة لكل صفات النمو الخضري ومحصول الثمار للنبات والنسبة المئوية للزيت ومحصول الزيت للنبات وبعض الصفات الكيميائية مثل صبغات البناء الضوئي والنسبة المئوية للنتروجين والفوسفور والبوتاسيوم ، ايضا معاملات حمض الهيومك احدثت زيادة في كل الصفات المدروسة مع نقص في البرولين %.تحت ظروف الاجهاد الملحي تم الحصول على نتائج ملخصها ان نباتات الكراوية تعتبر من النباتات متوسطة التحمل للاجهاد الملحي وتستطيع النمو ويمكن ان تروى بماء مملح تصل الملوحة فيه من 1000 الى 2500 جزء في المليون مع رش النباتات بحمض الهيومك عند 400 ملجم/لتر.