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Effect of Organic Manure and Different Levels of Saline Irrigation Water on Growth, Green Yield and Chemical Content of Sweet Fennel

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Abstract: Two pot experiments were conducted on sweet fennel variety "Dulce" during the two winter seasons of 2005/2006 and 2006/2007 at El-Kassasein, Ismailia Governorate, Egypt. Treatments were the combination of two levels of organic manure (with, without) and six saline irrigation water treatments, .i.e. well water (Control), 1000, 2000, 3000, 4000 and 5000 p.p.m. Results indicated that organic manure treatment increased all the vegetative growth parameters expressed as plant height, leaf number, fresh and dry weight of the total plant and its organs, green yield, nutrient contents of the leaves and bulbs (N, P and K). Also, K/Na ratio, calcium and proline content of bulbs were increased by organic manuring. Sodium content in bulbs was lowered by organic manure application. Growth and green yield parameters were adversely affected even at 1000 ppm which gave the standard characters of bulbs (mean bulb weight < 250 gm/ plant) and there was a proportionate effect with each increase in salinity to a maximum at 5000 ppm. On the contrary, increasing salinity of irrigation water decreased vegetative growth, green yield and nutrient contents in a descending order up to the highest level (5000 ppm). Also, under saline irrigation water conditions, fennel bulb length, width and thickness were significantly reduced. Interactions between organic manure and salinity levels of irrigation water gave positive results with respect to some of the abovementioned parameters and negative results with others. Thus, sweet fennel plant is sensitive to salt stress.

Key words: Sweet fennel, Salinity, Salt tolerance, Saline irrigation water, Organic manure, Chicken manure, Mineral fertilizer, Green yield, Free proline.

INTRODUCTION

Recently, the untraditional vegetable crops became of more importance for exportation and local consumption. Sweet fennel plants are used fresh for salad and in cooking. Dried leaves could be used as a hot drink. In addition, fennel oil infusion is used as aromatic carminative, stimulant and condiment. It is a new crop cultivated in scattered areas for exportation. So, it became of great importance to study its cultivars, fertilization and irrigation requirement.

Growing sweet fennel in the newly reclaimed soils is faced by various problems, such as salinity of irrigation water in many locations, low amounts of available nutrients and low organic matter content as well as poor hydrophilic, chemical and biological properties. The best means of maintaining soil fertility, productivity and salt tolerance could be through periodic addition of organic manures such as cattle, cheep, poultry manures and composts.

Other investigators studied the effect of saline irrigation water on sweet fennel plant (Pascale and Barbieri, 1995; Graifenberg *et al*., 1996; Yadav *et al*., 1996; Ahmad, 1999; Caliandro *et al*., 2000). Other investigators reported that organic fertilization increased salt tolerance of some vegetable crops under saline conditions (El-Missery, 2003 on cabbage and spinach; Saleh *et al*., 2003 on onion).

Therefore, this work was performed to evaluate vegetative growth and green yield of sweet fennel plants under saline irrigation water and the role of organic manure in increasing their salt tolerance.

MATERIALS AND METHODS

Two pot experiments were carried out on sweet fennel (*Foeniculum vulgare Mill*.var. *Dulce*) Fam. *Apiaceae* (*Umbelliferae*) in an area of newly reclaimed land at El-Kassasin,Ismailia Governorate , Egypt, during the two successive winter seasons of 2005/2006 and 2006/2007.

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Soil analysis is presented in Table (1). Soil physical properties were analyzed using the procedures described by Black *et al.* (1981). While soil chemical analysis was measured according to the procedures described by Jackson (1973). Analysis of irrigation water is presented in Table (2). On the other hand, organic manure contents of N, P and K and available Fe, Mn, Zn, Cu, Pb, Ni and Co as well as C/N ratio, D.M. %, O.C. % and humidity are presented in Table (3) and their analysis followed the procedures of Black *et al.* (1981).

Table 1: Physical and chemical properties of the experimental soil during the two seasons of 2005/2006 and 2006/2007.

A. Physical properties:-			
Characters		2005/2006	2006/2007
Soil texture		Loamy sand	Loamy sand
Clay %		11.38	13.54
Silt %		0.66	1.25
Sand %		87.96	85.21
A. Chemical properties:			
pH	8.40	8.37	
E.C(mmhos)	2.10	1.06	
CaCo3 %	1.00	1.25	
Cations	Ca^{++} (Milliequivalent/L)	23.00	22.00
	Mg^{+2} (Milliequivalent/L)	12.00	11.00
	Na^{+1} (Milliequivalent/L)	14.00	17.35
	K^{+1} (Milliequivalent/L)	2.79	2.62
Anions	Co_3^{-} (Milliequivalent/L)	-	-
	HCO_3^{-}(Milliequivalent/L)	7.10	4.55
	Cl^{-1} (Milliequivalent/L)	26.00	25.00
	$So_4^{=}$ (Milliequivalent/L)	18.69	23.42

Table 2: Chemical analysis of irrigation well water during two seasons of 2005/2006 and 2006/2007.

A. Chemical analysis:		2005/2006	2006/2007
PH		7.10	7.51
E.C(mmhos)		1.29	1.17
Cations	Ca^{++} (Milliequivalent/L)	5.0	4.0
	Mg^{+2} (Milliequivalent/L)	3.1	2.1
	Na^{+1} (Milliequivalent/L)	4.82	6.73
	K^{+1} (Milliequivalent/L)	0.44	0.53
Anions	$Co3^{-}$ (Milliequivalent/L)	-	-
	$HCO3^{-}$(Milliequivalent/L)	4.2	3.4
	Cl^{-1} (Milliequivalent/L)	4.32	5.80
	$So_4^{=}$ (Milliequivalent/L)	4.84	4.16

Table 3: Chemical analysis of poultry manure during the two seasons of 2005/2006 and 2006/2007.

Mineral contents	2005/2006 season	2006/2007 season
N %	2.2	2.46
P %	0.91	1.8
K %	1.4	2.37
Fe ppm	2400	230
Mn ppm	342	266
Zn ppm	140	18
Cu ppm	97	36
Pb ppm	1.01	1.2
Cd ppm	1.1	0.9
Ni ppm	2.1	3.6
Co ppm	8	6
C/N	4.29	7.4
D.M %	28.1	46.5
O.C %	16.3	27
Humidity%	17.2	17.48

Sweet fennel seeds cultivar Dulce were sown in the nursery in foam trays filled with a mixture of peat moss and vermiculite (1:1 volume) on 15 th of August in 2004 season and 17 th of August in 2005 season. Trays were then kept under unheated plastic house conditions. All required agricultural managements for transplant production were carried out .Transplant were then set up in the pots on the first and third of October in 2004 and 2005, respectively.

Pots of 40 cm diameter were filled each with 20 kg sandy soil of the location. Five hundred grams of poultry manure were mixed carefully with the soil of every pot of the organic manure treatments. Transplant of sweet fennel were then transplanted in all the pots. Plants were equally irrigated with well water for four

weeks. Before salinization, plants were thinned to leave three plants well distributed in every pot. Sea water was analyzed for determining its total salinity. The concentration of the stock of sea water used was 34000 ppm total salts which contained Ca 4000 ppm, Mg 1272.0 ppm, Na 9430.1 ppm, K 380.0 ppm, Co_3 12.0 ppm, HCO_3 97.9 ppm, SO_4 2496.0 and Cl 16312.0 ppm. Irrigation was carried out with saline water using one liter/pot/day to maintain soil water content at the range 60-65% of water holding capacity (WHC). All plants received the same agricultural practices. The untreated pots were irrigated with well water. Constant level of soil moisture (Field capacity + 25%) was maintained by using the diluted saline sea water treatments for irrigation when the plants reached near the wilting point.

Treatments of the Experiment Were as Follows:

Organic Manure Treatments:

Two treatments of poultry manure, .i.e. control (without organic manure) and with organic manure. All the control plants received mineral fertilization without organic manure [4.0 gm ammonium nitrate (33.5% N), 4.0 gm calcium super phosphate (15.5% P_2O_5) were added one time with soil before transplanting and 2.0 gm potassium sulphate (48% K_2O) was applied at monthly into three equal doses one month after transplanting 30 days from the first one, 30 days after the second one] beside plants. Whereas, the plants which received organic manure only took the same level of calcium super phosphate and potassium sulphate and the same times of adding fertilizers.

Salinity Concentrations:

Sea water was analyzed for determining its total salinity. Six irrigation water treatments were used. Control (irrigation water of the location) and five dilutions of sea water were adjusted carefully at 1000,2000,3000,4000 and 5000 ppm.

Experimental Design:

Each replicate included 12 treatments which were the combinations of two organic manure treatments and six saline water irrigation treatments. Every treatment was replicated in five pots. The split plot design with five replicates was used. The main plots were organic manure, whereas the sub plots were assigned for the salinity concentrations. Data were subjected to proper statistical analysis according to Snedecor and Cochran, 1980.

Data recorded:

Vegetative Growth Characteristics:

A random sample of three plants was taken from three pots at 120 days after transplanting and the following data were recorded during the two seasons.

Vegetative Growth:

Plant height, leaf number per plant, bulb thickness, bulb width, bulb length, fresh and dry weight of leaves, bulbs and total plant.

Total Green Yield:

All the plants of every pot of the experiment were harvested at 120 days from transplanting and total green yield (kg/pot) was weighed.

Chemical Content:

Mineral Nutrients:

The percentages of nitrogen, phosphorus and potassium in the acid digested samples of dry leaves and bulbs, were determined as follows:-

- Total nitrogen was determined according to the procedure described by Koch and McMeekin (1924).
- Phosphorus was determined colorimetrically according to the method described by Trough and Meyer (1939).
- Potassium was determined using Flame Photometer according to Brown and Lilleland (1946).
- Sodium and calcium were determined in bulbs of sweet fennel using the methods suggested by A.O.A.C. (1995).

Free Proline:

The proline content was determined on fresh weight basis according to Bates *et al*. (1973) using the following equation:

$$\mu \text{ moles proline /g F.W} = \frac{\text{Mg proline} \times \text{ml Toluene}}{11.5 \times \text{gm sample} \times 5}$$

RESULTS AND DISCUSSION

Vegetative Growth and Total Green Yield:

Effect of Organic Manure:

Data presented in Table (4) showed that organic manure led to statistical increases in the vegetative growth of sweet fennel plants expressed as plant height, leaf number, bulb dimensions (thickness, width and length) as well as fresh and dry weight of total plant and its organs, i. e. leaves and bulbs. Total green yield of sweet fennel followed the same trend of vegetative growth. The increase in the green yield due to organic manuring amounted to 46 and 44 % in the first and second seasons, respectively. These increases were statistical and similar in the two seasons. Similar results were obtained on sweet fennel by El-Kassas (1999), El-Desuki *et al.* (2001), Ali (2002); El-Ghawwas *et al*. (2002), Kandil (2002), El-Shakry (2005) and Badawi *et al.* (2005). The increase in vegetative growth might be due to improvement of the structure of the soil by increasing the soil water holding capacity which gave rise to good aeration and drainage that encourage better root growth and nutrient absorption as shown in Table (7). Saleh *et al*. (2003) on onion revealed also that organic manure enhanced the availability of certain elements and their supply to the plant during growth period. However, poultry manure increased the presence of P, K and Mg in the soil beside the solubility of Ca, Mg and NO_3 as a result of the continuous lowering of pH by manure application and to the increase of electrical conductivity. In addition, organic matter may affect plant growth as a source of growth promoters, axins, vitamins, amino acids which act on the vegetative growth, yield and quality of the plant product (Melo and De- Oliveira, 1999).

Table 4: Effect of organic manure on vegetative growth and total green yield of sweet fennel at 120 days from transplanting during two seasons (2005/2006 and 2006/2007).

Organic manure	Plant height (cm)	Leaf No.	Bulb dimensions			Fresh weight (gm/plant)			Dry weight (gm/plant)			Total green yield (kg/pot)
			Thickness (cm)	width (cm)	lenght (cm)	Leaves	Bulbs	Total	Leaves	Bulbs	Total	
	First season (2005/2006)											
Without	45.91	7.70	5.61	6.25	7.50	163.05	160.88	323.93	21.49	11.71	33.20	0.972
With	53.91	9.42	7.61	8.16	8.93	250.99	265.13	516.12	31.24	30.60	61.84	1.548
L.S.D. at 0.05	4.97	0.65	0.37	0.48	0.39	28.14	43.50	70.38	2.34	0.78	2.84	0.211
Second season (2006/2007)												
Without	44.22	9.80	5.76	7.15	7.57	131.43	159.41	290.84	18.58	12.13	30.71	0.873
With	50.44	10.70	6.88	8.06	8.62	207.72	254.32	462.04	27.92	23.29	51.21	1.386
L.S.D. at 0.05	1.11	0.60	0.22	0.19	0.49	6.15	24.46	30.19	2.06	1.35	2.25	0.091

B

Table 5: Effect of salinity treatments on vegetative growth and total green yield of sweet fennel at 120 days from transplanting during two seasons (2005/2006 and 2006/2007).

Salinity conc.	Plant height (cm)	Leaf No.	Bulb dimensions			Fresh weight (gm/plant)			Dry weight (gm/plant)			Total green yield (kg/pot)
			Thickness (cm)	width (cm)	lenght (cm)	Leaves	Bulbs	Total	Leaves	Bulbs	Total	
						First season (2005/2006)						
Control	64.39	9.89	8.28	8.47	10.15	399.89	365.19	765.08	54.72	40.38	95.09	2.295
1000	56.00	9.22	7.88	8.08	9.49	346.33	308.00	654.33	39.56	32.89	72.45	1.963
2000	48.33	8.86	6.91	7.72	8.45	225.83	208.67	434.50	29.81	19.84	49.65	1.304
3000	45.94	8.44	6.32	7.43	7.71	144.74	155.67	300.41	16.12	15.48	31.61	0.901
4000	43.72	7.83	5.48	5.93	7.30	79.17	124.83	204.00	11.24	9.96	21.20	0.612
5000	41.06	7.11	4.79	5.62	6.19	46.17	115.67	161.83	6.72	8.38	15.10	0.486
L.S.D. at 0.05	2.12	0.28	0.40	0.29	0.41	17.70	10.91	21.20	2.59	0.77	2.61	0.064
						Second season (2006/2007)						
Control	72.78	11.72	7.76	10.49	11.51	346.56	308.22	654.78	48.20	30.27	78.47	1.964
1000	65.19	11.39	7.22	9.29	10.23	240.39	279.12	519.51	31.44	25.27	56.71	1.559
2000	52.67	10.67	6.65	8.71	8.81	210.71	265.69	476.40	28.67	21.52	50.19	1.429
3000	42.56	10.50	5.97	7.03	7.58	106.43	155.85	262.28	14.12	11.94	26.06	0.787
4000	27.97	9.11	5.47	5.69	5.93	63.73	123.63	187.36	9.42	9.62	19.04	0.562
5000	22.79	8.11	4.84	4.42	4.53	49.64	108.68	158.32	7.68	7.63	15.31	0.475
L.S.D. at 0.05	0.67	0.27	0.09	0.13	0.21	3.17	16.89	16.02	1.37	0.91	1.62	0.048

Effect of Irrigation Water Salinity:

Data presented in Table (5) show that vegetative growth of sweet fennel plants was statistically decreased by increasing irrigation water salinity. As salinity of irrigation water increased vegetative growth characteristics were decreased. Linear decrement was recorded in plant height, bulb dimensions (thickness, width and length) as well as fresh and dry weight of total plant and its organs, i. e. leaves and bulbs, by increasing salinity of

irrigation water up to the highest level (5000 ppm). Total green yield followed the same trend of vegetative growth as affected by salinity. Increasing salinity of irrigation water decreased the total yield up to the highest concentration (5000 ppm). These results were similar and statistical in the two seasons of the experiment. Irrigation by control well water (749 – 826 ppm) and 1000 ppm treatment produced the tallest plant, good quality of bulb dimensions (thickness, width and length) and the heaviest fresh and dry weight of total plant and its organs, i. e. leaves and bulbs. While, the shortest plants resulted from the highest salinity level (5000 ppm) in both seasons. Similar results were obtained by Mangal *et al.* (1986); Singh *et al*., 1986; Amin (1994); Pascal and Barbieri (1995); Ravender-Sing *et al. (1995)*; (Ahmad, 1999); Salem (1974) and Loescher *et al*. (1994). Similar results were reported on fennel plants (Amin, 1994; Graifenberg *et al*., 1996 and Ahmad, 1999). The reduction in the vegetative growth and green yield of sweet fennel as a result of increasing salinity levels might be due to the increase in osmotic pressure that affects the ability of the plant to absorb water for its growth processes from the soil solution and (or) the toxicity of specific ions to various plant physiological processes. It might be also due to the secondary specific-ions effects of sodium as the excess of exchangeable sodium can lead to soil swelling and /or dispersion causing water infiltration, aeration and root penetration problems (Ayers, 1952). The harmful effects of irrigation with saline water on sweet fennel might be related to the injurious effect of specific ions such as NaCl, $CaCl_2$ and $NaSO_4$ which inhibited the production of chlorophyll and carotene in leaves, high sodium concentration that induced calcium and magnesium nutritional deficiencies and influenced the respiratory pathways in roots (Abel and Mackenzie, 1964).However, long term exposure of roots to high salt concentration make the plants suffer from drought (Bernstein, 1975), reduced water and nutrient availability, make direct toxic effect of different ions because of emplaces of mineral nutrition (Bower, 1976), minimized photosynthesis due to reduction in stomatal conduction and increasing stomatal limitations to CO_2 uptake (Pascale and Barbieri, 1995) and changed enzymatic activities in the plant (Abd el-Razaek,1997).

Many investigators reported that salinity caused decreases in the yield of fennel plant. Pascale and Barbieri, 1995; Graifenberg *et al*., 1996; Francois, 1994 on garlic and Saleh *et al*., 2003 on onion**.**

Effect of the Interactions:

The recorded data in Table (6) show that the highest vegetative growth and green yield was obtained by the combined effect of organic manure and irrigation of well water. It is clear from the data that application of organic manure decreased the adverse effect of salinity on the vegetative growth and green yield of sweet fennel plants. The lowest vegetative growth and green yield was recorded when the plants received mineral fertilization with irrigation by the highest concentration of diluted sea water. These results were similar and true in the two seasons of the experiments. These results are in agreement with those obtained by Saleh *et al*. (2003) who revealed that the use of saline water to irrigation decreased the yield of onion plants and the application of organic manure significantly increased onion yield. Similar results were also obtained on spinach plants irrigated with saline well water (4200 ppm), when chicken manure was applied, significant increases were obtained in plant height, leaf number and plant fresh weight (El-Missery,2003).

Table 6: Effect of interaction between organic manure and salinity concentration on vegetative growth and total green yield of sweet fennel at 120 days from transplanting during two seasons (2005/2006 and 2006/2007).

Organic manure	Salinity conc.	Plant height (cm)	Leaf No.	Bulb dimensions			Fresh weight (gm/plant)			Dry weight (gm/plant)			Total green yield (kg/pot)
				Thickness (cm)	width (cm)	lenght (cm)	Leaves	Bulbs	Total	Leaves	Bulbs	Total	
						First season (2005/2006)							
Without	Control	61.44	9.11	6.27	7.19	9.31	282.30	276.59	558.90	36.27	21.39	57.66	1.677
	1000	51.44	8.44	6.71	7.23	8.40	256.67	213.67	470.33	34.14	17.33	51.47	1.411
	2000	44.33	7.89	6.42	6.84	7.68	241.67	181.00	422.67	28.65	12.93	41.58	1.268
	3000	42.56	7.56	5.64	6.49	7.18	99.67	120.67	220.33	14.76	10.74	25.50	0.661
	4000	39.00	7.00	4.56	5.01	6.63	79.67	90.00	169.67	11.25	4.65	15.90	0.509
	5000	36.67	6.22	4.07	4.74	5.81	18.33	83.33	101.67	3.88	3.19	7.07	0.305
With	Control	67.33	10.67	10.29	9.74	10.99	517.47	453.79	971.27	73.17	59.36	132.53	2.914
	1000	60.56	10.00	9.04	8.93	10.59	436.00	402.33	838.33	44.99	48.44	93.43	2.515
	2000	52.33	9.83	7.40	8.60	9.22	210.00	236.33	446.33	30.97	26.75	57.72	1.339
	3000	49.33	9.33	7.00	8.37	8.23	189.82	190.66	380.48	17.49	20.23	37.71	1.141
	4000	48.44	8.67	6.40	6.86	7.97	78.67	159.67	238.33	11.22	15.27	26.50	0.715
	5000	45.44	8.00	5.51	6.49	6.57	74.00	148.00	222.00	9.57	13.57	23.14	0.666
L.S.D. at 0.05		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	29.99	N.S.	1.09	3.69	0.090
						Second season (2006/2007)							
Without	Control	67.11	11.44	6.97	10.14	11.18	258.44	234.52	492.97	36.87	20.41	57.28	1.479
	1000	61.39	11.00	6.71	9.31	10.18	194.66	220.34	415.00	27.85	15.92	43.77	1.245
	2000	50.56	10.22	5.77	8.31	8.17	172.11	182.87	354.98	24.48	14.11	38.60	1.065
	3000	41.67	10.22	5.64	6.77	7.36	84.72	132.73	217.45	10.54	11.30	21.83	0.652
	4000	24.28	8.44	5.02	4.78	4.88	45.90	97.55	143.45	6.53	6.09	12.61	0.430
	5000	20.30	7.44	4.44	3.58	3.68	32.75	88.41	121.17	5.23	4.94	10.17	0.364
With	Control	78.44	12.00	8.54	10.84	11.84	434.67	381.92	816.58	59.53	40.13	99.66	2.450
	1000	69.00	11.78	7.73	9.28	10.28	286.11	337.90	624.01	35.02	34.62	69.65	1.872
	2000	54.78	11.11	7.53	9.10	9.44	249.30	348.51	597.81	32.85	28.93	61.78	1.793
	3000	43.44	10.78	6.30	7.29	7.81	128.13	178.97	307.10	17.69	12.59	30.28	0.921
	4000	31.67	9.78	5.92	6.61	6.99	81.55	149.71	231.27	12.32	13.15	25.47	0.694
	5000	25.29	8.78	5.23	5.26	5.38	66.53	128.95	195.48	10.13	10.32	20.45	0.586
L.S.D. at 0.05		N.S.	N.S.	N.S.	N.S.	N.S.	4.48	N.S.	22.65	N.S.	1.29	2.29	0.068

Chemical Content (Mineral Nutrients):

Effect of Organic Manure:

The results in Table (7) revealed that application of organic manure increased nitrogen, phosphorus and potassium content of sweet fennel plants (leaves and bulbs) compared with mineral fertilizer. Results were true and similar in the two seasons of the experiment. Organic manure enhanced the availability of certain elements and their supply to the plant during growth period (Saleh *et al*., 2003). In addition, poultry manure increased the presence of P, K and Mg in the soil beside the solubility of Ca and Mg and NO_3 as a result of the continuous lowering of the pH by manure applications and to the increase of electrical conductivity (Ohallorans *et al*., 1993). The obtained results showed also that K/Na ratio and calcium content of sweet fennel bulbs were slightly higher with organic manure compared with mineral fertilization in the two seasons of the experiment. On the contrary, Na content was lowered when organic manure was used compared with mineral fertilization.

Table 7: Effect of organic manure on N, P, K,Na, Ca, K:Na and free proline content in leaves and bulbs of sweet fennel at 120 days from transplanting during two seasons (2005/2006 and 2006/2007).

Organic manure	Nitrogen (%)		Phosphours (%)		Potassium (%)		Ca (%)	Na (%)	K : Na (%)	Free proline (µ mole/g F.w)
	Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs	Bulbs	Bulbs	Bulbs	Bulbs
First season (2005/2006)										
Without	3.56	2.96	0.29	0.29	2.62	2.90	0.48	1.40	2.40	26.83
With	3.76	4.10	0.44	0.43	2.91	3.14	0.50	1.34	2.75	32.67
L.S.D. at 0.05	0.09	0.40	0.07	0.01	0.08	0.09	0.01	0.02	0.12	2.14
Second season (2006/2007)										
Without	3.33	3.13	0.34	0.32	2.86	2.92	0.45	1.28	3.02	27.41
With	4.13	4.02	0.53	0.42	3.34	3.37	0.52	1.22	3.52	36.29
L.S.D. at 0.05	0.16	0.22	0.07	0.05	0.07	0.16	0.02	0.02	0.34	5.22

Effect of Irrigation Water Salinity:

Nitrogen and potassium content of sweet fennel leaves and bulbs as well as phosphorus in bulbs were decreased by increasing salinity of irrigation water up to 5000ppm concentration (Table 8). But Phosphorus content in sweet fennel leaves was not significantly affected by the increase of the different salinity levels. These results were similar and true in the two seasons of the experiment. Nitrogen content in umbellifera plants may or may not change due to the irrigation with saline water. This depends on plant age, saline concentration and the employed crop. Many investigators reported that, increasing salt concentrations in irrigation water decreased N concentration of the plant tissues (Ahmad, 1999 on sweet fennel; Stoop and Mason, 1994; Pardossi *et al*., 1999 on celery). Ahmad (1999) working on sweet fennel found that bulb N content was significantly increased with the increase in saline water concentrations till 2000 ppm, then a reduction happened in this content from the use of 3000 ppm.

The obtained results showed also that sodium and calcium content were affected by salinity. Calcium percentage was gradually decreased by increasing irrigation water salinity up to its highest level. On the contrary, Sodium percentage increased linearly and significantly by the increase in irrigation water salinity up to its highest level. Similar results were obtained by Graifenberg *et al*. (1996) working on fennel; Francois and West (1982) and Pardossi *et al*. (1999) working on celery.

Effect of the Interactions:

The results in Table (9) revealed that nitrogen, phosphorus and potassium content of sweet fennel leaves and bulbs were not statistically affected by the interaction of organic manure and salinity. These results were true and similar in the two seasons indicating that the organic manure application and salinity acted independently.

Proline Content:

Effect of Organic Manure:

The results in Table (7) revealed that plants grown in soil under organic manure contained more proline content than the control (mineral fertilization) which might mean that organic manure reduced the stress of saline water by proving good water relation and improving cations and anions exchange and solubility. Organic manure increased free proline content under saline conditions which was reflected on producing better growth parameters, photosynthesis apparatus and sugar content in the two seasons. This free amino acid accumulates in plant tissues in response to several types of stresses as salt, drought or temperature. The accumulation of proline might result from increasing of protein turnover (Singh *et al*., 1972), and (or) might be due to enzyme stabilization and (or) osmoregulation (Madan *et al*., 1994).

Effect of Irrigation Water Salinity:

It appears from data Table (8) that proline content under salinity conditions was raised more than the control plants. However, it gradually increased as salt concentrations in irrigation water increased. The accumulation of free proline in plant tissues might be due to other soluble compounds, because of the reduction of the oxidation enzymes (Stewart *et al.*, 1977).

Effect of the Interactions:

The results in Table (9) revealed that proline content of sweet fennel bulbs was not statistically affected by the interaction of organic manure and salinity. These results were true and similar in the two seasons. In other words, the tested factors acted indepently on praline content.

Table 8: Effect of salinity treatments on N, P, K,Na, Ca, K:Na and free proline content in leaves and bulbs of sweet fennel at120 days from transplanting during two seasons (2005/2006 and 2006/2007).

Salinity conc.	Nitrogen (%)		Phosphours (%)		Potassium (%)		Ca (%)	Na (%)	K : Na (%)	Free proline (µ mole/g F.w)
	Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs	Bulbs	Bulbs	Bulbs	Bulbs
					First season (2005/2006)					
Control	4.30	4.89	0.20	0.49	3.18	3.56	0.49	0.66	5.38	11.34
1000	3.97	4.24	0.27	0.46	2.99	3.27	0.53	1.17	2.79	16.40
2000	3.84	4.09	0.32	0.44	2.84	2.97	0.49	1.42	2.10	28.07
3000	3.53	3.62	0.35	0.34	2.62	2.92	0.50	1.51	1.98	35.06
4000	3.30	2.25	0.51	0.28	2.51	2.86	0.48	1.95	1.48	40.89
5000	3.04	2.12	0.53	0.17	2.44	2.56	0.46	1.51	1.71	46.73
L.S.D. at 0.05	0.14	0.18	N.S.	0.03	0.08	0.06	N.S.	0.05	0.11	1.05
					Second season (2006/2007)					
Control	4.66	4.90	0.35	0.49	3.58	3.52	0.48	0.53	6.76	13.17
1000	4.34	4.19	0.39	0.45	3.29	3.28	0.52	0.74	4.46	20.16
2000	4.08	3.63	0.42	0.41	3.18	3.23	0.48	1.09	2.97	30.82
3000	3.32	3.18	0.46	0.36	3.07	3.20	0.48	1.32	2.42	37.57
4000	3.08	2.79	0.49	0.31	2.88	3.16	0.47	2.15	1.54	43.60
5000	2.89	2.73	0.49	0.23	2.59	2.47	0.47	1.67	1.48	45.78
L.S.D. at 0.05	0.23	0.27	N.S.	0.03	0.05	0.08	N.S.	0.05	0.19	2.70

Table 9: Effect of interaction between organic manure and salinity concentration on N, P, K,Na, Ca, K:Na and free proline content in leaves and bulbs of sweet fennel at120 days from transplanting during two seasons (2005/2006 and 2006/2007).

Organic manure	Salinity conc.	Nitrogen (%)		Phosphours (%)		Potassium (%)		Ca (%)	Na (%)	K : Na (%)	Free proline (µ mole/g F.w)
		Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs	Bulbs	Bulbs	Bulbs	Bulbs
						First season (2005/2006)					
Without	Control	4.22	4.41	0.14	0.43	2.90	3.38	0.47	0.67	5.06	12.64
	1000	3.84	3.35	0.21	0.37	2.88	3.20	0.53	1.21	2.65	14.35
	2000	3.76	3.23	0.27	0.34	2.69	2.92	0.47	1.49	1.96	24.88
	3000	3.35	2.84	0.25	0.30	2.51	2.86	0.49	1.70	1.69	30.62
	4000	3.33	2.07	0.48	0.19	2.37	2.77	0.45	1.78	1.55	36.36
	5000	2.87	1.88	0.39	0.14	2.36	2.28	0.49	1.55	1.47	42.12
With	Control	4.38	5.36	0.26	0.55	3.46	3.73	0.50	0.66	5.70	10.04
	1000	4.10	5.12	0.33	0.54	3.10	3.35	0.53	1.14	2.94	18.45
	2000	3.92	4.95	0.38	0.53	2.99	3.02	0.52	1.35	2.24	31.26
	3000	3.70	4.41	0.46	0.39	2.72	2.97	0.52	1.31	2.27	39.50
	4000	3.27	2.43	0.54	0.37	2.64	2.94	0.52	2.11	1.40	45.42
	5000	3.22	2.36	0.66	0.21	2.52	2.83	0.43	1.46	1.94	51.33
L.S.D. at 0.05		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
						Second season (2006/2007)					
Without	Control	3.97	4.17	0.27	0.40	3.02	3.43	0.44	0.59	5.88	12.36
	1000	3.91	3.62	0.31	0.38	2.92	2.96	0.49	0.66	4.54	14.33
	2000	3.72	3.20	0.31	0.36	2.99	2.92	0.44	1.06	2.76	29.80
	3000	3.13	2.87	0.35	0.32	2.85	2.90	0.44	1.27	2.29	33.94
	4000	2.78	2.51	0.37	0.30	2.74	2.86	0.42	2.54	1.13	36.25
	5000	2.45	2.40	0.40	0.19	2.61	2.42	0.45	1.59	1.53	37.79
With	Control	5.35	5.64	0.44	0.57	4.14	3.62	0.52	0.47	7.65	13.97
	1000	4.77	4.76	0.48	0.52	3.66	3.60	0.54	0.82	4.38	26.00
	2000	4.45	4.06	0.53	0.46	3.36	3.53	0.53	1.12	3.18	31.83
	3000	3.51	3.49	0.58	0.39	3.29	3.50	0.52	1.38	2.54	41.20
	4000	3.38	3.08	0.60	0.31	3.03	3.46	0.53	1.77	1.95	50.96
	5000	3.33	3.06	0.58	0.27	2.57	2.53	0.48	1.76	1.44	53.77
L.S.D. at 0.05		N.S.	N.S.	N.S.	N.S.	0.07	N.S.	N.S.	0.07	N.S.	N.S.

Conclusions:

From the results of the present investigation it might be recommended to add organic manure at the rate of (5.0 ton / fed.) to sweet fennel plants, when water irrigation contains salinity levels up to 1000 ppm, in order to overcome or reduce the toxic effect of salinity and to obtain relatively good plant growth, good quality and yield, as well as good chemical composition.

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