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EFFECT OF SALINE IRRIGATION WATER TREATMENTS ON GROWTH, FRUITING, OIL YIELD AND SOME CHEMICAL CONSTITUENTS OF FENNEL PLANTS IN THE NEW RECLAMED SOILS

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ABSTRACT: This study was carried out during the two seasons of 1997/1998 and 1998/ 1999 at the Experimental Farm of Horticultural Research Institute, at El-Kassassin Station, Agriculture Research Center, to detect the tolerance of fennel plants to different saline irrigation water treatments (0, 1000, 2000, 3000 and 4000ppm) under sandy soil and drip irrigation system conditions. The results indicated that salinity treatment of 4000 ppm concentration, resulted in highly significant decrease in plant height, fresh and dry weights of leaves, stem as well as root / plant, no. of umbels / plant, no. of umbellates/ umbel and bisexual flowers / plant whereas, those of 2000, 3000 and 4000 ppm highly significantly increased male flowers no./ plant and sex expression. Moreover, weight of fruits as well as oil percentage and yield per plant or feddan were highly significantly decreased by using all salinity levels. Furthermore, the percentages and contents of total carbohydrates, nitrogen, protein, phosphorus and potassium as well as the fruits contents of zinc, manganese and iron were highly significantly decreased as a result of saline water irrigation at 3000 and 4000 ppm treatments.

Key words: Saline irrigation water, growth, yield, oil, fennel, and chemical constituents.

INTRODUCTION

Medicinal and aromatic plants are now, as one of the most important sources for national income. Fennel plant is one of those plants. Its volatile oil is principally used in many pharmaceutical and perfume industries. Also, Yasuda *et al.*, (1988) found that the essential oil of fennel had an inhibitory effects on some insects larvaes.

Most of promising lands in Egypt are situated either near the

mediterranean sea or in the western desert. In the former regions, it is mostly saline soils, whereas in the latter, salt water is generally used for irrigation.

Consulting the available review of literature, it is clear that the effects of saline irrigation water treatments on fennel parameters under sandy soil and drip irrigation system conditions were not studied.

However, growth and yield of many medicinal and aromatic plants were found to be adversely affected by saline conditions, (Fiad, 1997; Said-Al-Ahl, 1999; Khalil, 1999; Pathan *et al.*, 2000 and Attia, 2003). Furthermore, Hanafy *et al.* (1994), and Fiad (1997) on *Nigella sativa* as well as Said-El-Ahl (1999) on basil plants, found that oil yield was decreased as saline water concentrations increased. In the same time, Ali (1996) on Egyptian henbane and Attia (2003) on guar found that using sea water irrigation treatments up to 4000 ppm decreased percentages and contents of each of total carbohydrates, nitrogen, protein, phosphorus and potassium in leaves of the plants. Moreover, Fiad (1997) on *Nigella sativea* added that soil salinity levels at 500 or 5000 ppm treatments decreased percentages and contents of total carbohydrates, nitrogen, protein, phosphorus and potassium as well as zinc and iron contents .

Herein, the present work aimed to clarify to what extent *Foeniculum vulgare*, Mill plant will tolerate saline irrigation water. Besides studying the effects of these treatments on growth, flowering, fruit yield components, oil yield as well as some chemical constituents of fennel under sandy soil and drip irrigation system conditions.

MATERIALS AND METHODS

This work was carried out at the Experimental Farm of Horticultural Research Institute, at El-Kassassin Station, Agriculture Research Center, during the two successive seasons of 1997-1998 and 1998-1999 and the Laboratories of Fac. Agric., Zagazig University.

The fruits of fennel (*Foeniculum vulgare,* Mill) variety dulce were obtained from Research Center of Medicinal and Aromatic Plants, Dokky, Giza. The fruits were sown on October 15th for the two seasons of 1997 and 1998 in sandy soil. The mechanical and chemical properties of the used soil are shown in Table A.

The distance between rows was 100 cm and between plants

were 40 cm. apart. The irrigation system of the experiment was drip irrigation by using plastic tanks on the first of lateral side. The lateral sides were pipe lines from plastic material diameter 16 mm. The spaces between them were 100 cm and 40 cm between the plants on the row. The seedlings were thinned to be one plant gradually per hill after one month from sowing date.

The natural salt crust of sea water which was obtained from El-Nasr for Salines Co. and it was used to obtain saline irrigation water treatments. The concentrations used in the present work were 0, 1000, 2000, 3000 and 4000 ppm. The amount of natural salt for each treatment was dissolved in irrigation water by using drip irrigation system. The control plants were irrigated with tap water. Chemical analysis of the natural salt crust of sea water used is shown in Table B. The plants were irrigated when needed to maintain soil moisture at 65-70% of the field capacity.

Table A: Mechanical and chemical properties of the used soil

Characters			Value
Mechanical analysis			
	Sand %		89.92
	Silt %		6.08
	Clay %		4.00
Soil texture			sandy
Chemical analysis (mg/l)			
Cations	Ca^{++}		1.00
	Mg^{++}		0.40
	Na^{+}		0.76
	K^{+}		0.31
Anions	CO_3^{--}		-
	HCO_3^{-}		1.00
	Cl^{-}		0.50
	SO_4^{--}		0.97
	pH		8.10
	E.C. [mmhos/cm]		2.70
	Ca CO_3%		2.60
Macro elements (ppm)	-N		81.00
		- P	23.00
		- K	108.00
Micro elements (ppm)	- Fe		2.00
		- Cu	-
		- Zn	0.26
		- Mn	8.80

Table B: Chemical analysis of the natural salt crust of used sea water

Electrical conductivity (E.C.)	Cations, mg/l.				Anions, mg/l.			
mmhos/cm at 25°	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	CO^{--}	SO_4^{--}	Cl^{-}
171.3	9.28	8.54	3000	2.80	4.86	0.0	80.76	2935.0

The experimental design was simple experiment in complete randomized blocks design with three replicates. Each replicate contained 15 plants.

The following data were recorded

A random sample of three plants from each replicate was taken at 105 days after sowing and the following data were recorded:

A-Growth

1.Plant height (cm), after 45, 60, 75 and 90 days after planting,

2. Number of branches/ plant, after 45, 60, 75 and 90 days after planting, .

3.Fresh and dry weights of leaves / plant,

4.Fresh and dry weights of stem / plant, and

5.Fresh and dry weights of root / plant

B-Flowering Characters

At flowering stage, the following data were recorded:

1.Number of umbels /plant,

2.Number of umbellates / umbel,

3.Number of bisexual flowers/ plant,

4.Number of male flowers/plant, and

5.Sex expression (male/bisexual flowers ratio).

C-Fruit Yield Components

At harvesting stage (180 days after sowing) the following data were recorded; i.e., weight of fruits per plant (g) and per feddan (kg), weight of 100 fruits (g).

D-Oil Production Components

1. Volatile oil percentage

Oil percentage was determined in the air dried fruits [25g] in both seasons by distillation in Clevenger apparatus according to the method described by the British Pharmacopoeia (1963).

2.Oil yield

The oil yield per plant was calculated by multiplying the oil percentage by average plant yield of fruits and expressed as volume in CC per plant. Furthermore, the oil yield per feddan (kg) was calculated by multiplying the oil yield per plant by number of plants per feddan (10500 plants).

E- Chemical Analysis

The fruits at harvesting date were taken and dried in an electric oven at 70°C for 24 hours according to A.O.A.C.(1980), then were finally ground for chemical determination of total carbohyd-rates, macroelements (N, P and K) and microelements (Zn, Mn and Fe).

1.Determination of total carbohydrates percentage and content per plant

Total carbohydrates percentage in the fruits were determined according to Miller (1959). Whereas, total carbohydrates content per plant [g/plant fruits] was calculated by multiplying total carbohydrates percentage by weight of fruits per plant.

2.Determination of total nitrogen percentage and content per plant

Total nitrogen percentage was determined colorimetrically according to the method described by Kock and Mc. Meekin (1924). Whereas, total nitrogen content per plant [g/plant fruits] was calculated by multiplying total nitrogen percentage by weight of fruits per plant.

3.Determination of total protein percentage and content per plant

Total protein percentage was obtained by multiplying the total nitrogen percentage by 6.25. Whereas, total protein content per plant [g/plant fruits] was calculated by multiplying total protein percentage by weight of fruits per plant.

4.Determination of total phosphorus percentage and content / plant

Total phosphorus percentage was determined according to the method adapted by Troug and Mayer (1939). Whereas, total phosphorus content per plant [g/plant fruits] was calculated by multiplying total phosphorus percentage by weight of fruits per plant.

5.Determination of potassium percentage and content per plant

Potassium percentage was determined by using flame photometer, according to the method described by Brown and Lilleland (1946).Whereas, potassium content per plant [g/plant fruits] was calculated by multiplying potassium percentage by weight of fruits per plant

6.Determination of zinc, manganese and iron

Zinc, manganese and iron concentrations (mg/l) in the fruits were determined by using atomic absorption as described by Chapman and Pratt (1961).

Statistical Analysis

Data of the present study were statistically analyzed and the differences between the means of the treatments were considered significant when they were more than least significant differences (L.S.D.) at the 5% or 1% levels according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

1. Growth

Data in Tables 1 and 2 show that salinity treatments, generally, decreased growth characters of fennel; i.e., plant height and branches no./ plant, as well as fresh and dry weights of leaves, stem and root / plant compared to control. Such decrease mostly was highly significant, by using 3000 and 4000 ppm levels comparing to untreated plants in this respect. These results are in agreement with those found by Khalil (1999) on *Nigella sativa,* Said-Al-Ahl (1999) on basil varieties and Attia (2003) on guar.

Such decrement in plant height might be due to that salinity decreased cell division of plants as reported by Bolus *et al.*(1972) on castor bean. Also, the inhibition of both meristematic activity and elongation of cell by using salinity was mentioned by Ruf *et al.* (1963).

The decrease in fresh weight of leaves might be due to that salinity increased osmotic pressure which caused a drop in plant water content as found by Sanchesconde and Azura (1979) on tomato plant. High salinity levels could cause a depression in photosynthetic activities resulting in low CO_2 fixation. The absorption of mine-rals could be retarded leading to low plant metabolism.

The decrease in leaves dry weight due to salinity treatments might be attributed to that salinity reduced the synthesis of organic matter in leaves of the plants as mentioned by Kabanov *et al.* (1973) on pea. Also, this reduction in leaves dry weight might be attributed to the increase in the osmotic pressure of the irrigation water which led to a depression in water absorption by plants, consequently reduced plant photosynthesis, as reported by Mandour *et al.* (1979) on *Ammi majus.* Furthermore, Kohl and Gale (1966) on chrysanthemum, found that salinized plants were less efficient in metabolizing the dry matter in saline condition, they possessed lower rate of Co_2 fixation comparing to non- salinized plants.

Table 1: Effect of saline irrigation water treatments on plant height (cm) and number of branches / plant of fennel plants during two seasons

Saline irrigation water concentration (ppm)	Plant height (cm) Days after planting				Number of branches/ plant Days after planting			
	45	60	75	90	45	60	75	90
First season (1997 /1998)								
Control	29.55	51.64	62.50	80.53	5.30	10.72	16.90	30.32
1000	22.20	48.89	60.04	71.27	3.20	9.82	16.14	17.10
2000	21.80	32.87	56.33	67.32	2.50	9.03	15.50	16.83
3000	20.70	32.82	52.33	65.33	2.33	8.78	13.69	15.42
4000	19.90	28.68	50.72	62.72	1.70	6.95	11.71	13.98
L.S.D. at 5%	3.22	5.46	2.23	2.98	0.60	1.27	1.07	2.25
L.S.D. at 1%	4.69	7.95	3.25	4.34	0.88	1.85	1.56	3.28
Second season (1998/1999)								
Control	39.70	46.95	61.87	66.81	4.46	6.52	14.26	16.90
1000	34.70	45.95	56.11	65.86	3.85	6.40	13.95	16.17
2000	34.16	45.20	55.46	63.11	3.70	4.70	10.02	15.09
3000	30.95	41.10	49.45	64.54	3.70	4.60	9.46	12.76
4000	23.35	29.60	45.65	58.26	3.67	3.40	8.85	12.51
L.S.D. at 5%	2.63	3.54	5.08	4.79	0.30	1.33	1.20	2.47
L.S.D. at 1%	3.83	5.15	7.39	6.98	0.45	1.94	1.74	3.60

Table 2: Effect of saline irrigation water treatments on some vegetative growth and root system characters of fennel plants during the two seasons

Saline irrigation water concentration (ppm)	Fresh weight of leaves / plant (g)	Dry weight of leaves / plant (g)	Fresh weight of stem / plant (g)	Dry weight of stem / plant (g)	Fresh weight of root / plant (g)	Dry weight of root / plant (g)
First season (1997 /1998)						
Control	28.27	4.88	20.06	2.74	6.54	2.08
1000	21.30	4.38	18.80	2.25	4.31	1.43
2000	12.17	2.65	5.22	0.48	3.70	0.90
3000	11.71	1.68	3.07	0.46	2.85	0.71
4000	8.36	1.30	2.18	0.14	2.31	0.46
L.S.D. at 5%	3.02	0.93	2.21	0.18	0.94	0.67
L.S.D. at 1%	4.39	1.35	3.22	0.26	1.37	0.98
Second season (1998/1999)						
Control	22.62	1.70	8.29	2.40	6.71	2.30
1000	11.64	1.60	7.95	2.36	5.26	1.41
2000	11.22	1.40	4.21	2.20	3.50	1.18
3000	8.38	1.30	4.21	1.80	3.39	1.06
4000	7.72	0.85	3.31	1.66	2.50	0.81
L.S.D. at 5%	3.38	0.30	1.17	0.54	0.69	0.20
L.S.D. at 1%	4.92	0.44	1.71	0.78	1.01	0.30

Such decrease in stem fresh and dry weights might be due to the disturbance in anabolic activities, affected by the decrease in water absorption and/or disturbance of mineral balance or absorption and utilization caused by salinity treatment. Moreover, such decrease might be due to inhibition of water absorption and this greatly affected the metabolic processes.

In this regard, Hayward and Spurr (1943) stated that substrated of high osmotic pressure inhibited the meristematic activity and elongation of corn root. Also, a reduction of the new corn root and decreasing water uptake was mentioned by Eaton (1942) as a result of increasing osmotic pressure of media solution.

However, the decrease in root fresh and dry weights dut to salinity might be due to the reduction in water and minerals absorption and / or the reduction in upper ground growth, as found in the present study.

2. Flowering

The results of Table 3 indicate that salinity treatments at 2000, 3000 and 4000 ppm gave highly significant decrease in umbels no./plant and bisexual flowers no./plant compared to control in this respect. Moreover, the level of 4000 ppm was more effective in decreasing umbellates no./ umbel compared to untreated plants. While, male flowers no./ plant and sex expression highly significantly increased as salinity levels increased up to the concentration of 4000 ppm. These results hold true in both seasons.

3. Fruit Yield Components

As shown in Table 4, the yield of fruits per plant and per feddan as well as weight of 100 fruits recorded highly significant decrease as a result of using all levels of salinity treatments. Furthermore, the reduction was obvious as salinity levels increased up to that of 4000 ppm to be the lowest. Similar results were reported by Pascale and Barbieri (1995) on fennel, Boselah (1995) on *Coriandrum sativum,* Hamad (1996) on guar and Pathan *et al.* (2000) on cluster bean.

The reduction in fruits weight / plant under salinity treatments was predicted, since these treatments depressed all the vegetative growth parameters and decreased plant capability to produce fruits, as mentioned before in the present work.

4.Volatile Oil Percentage and Yield

Table 4 indicates that volatile oil percentage and yield /plant and/ feddan were highly significantly

Table 3: Effect of saline irrigation water treatments on flowering characters of fennel plants at flowering stage during two seasons

Saline irrigation water concentration (ppm)	Number of umbels / plant	Number of umbellates / umbel	Number of bisexual flowers / plant	Number of male flowers / plant	Sex expression male/ bisexual
		First season (1997/1998)			
Control	38.50	14.16	193.16	42.46	0.21
1000	25.00	13.91	181.77	52.18	0.28
2000	25.00	13.80	171.97	58.26	0.33
3000	19.00	13.05	156.76	62.81	0.41
4000	16.50	11.33	146.87	94.04	0.62
L.S.D. at 5%	2.84	0.79	12.92	6.44	0.02
L.S.D. at 1%	4.14	1.15	18.80	9.37	0.03
		Second season (1998/1999)			
Control	33.00	14.55	250.50	29.00	0.11
1000	25.50	13.90	228.50	60.50	0.28
2000	22.50	12.55	202.50	67.50	0.35
3000	19.50	12.50	197.00	88.00	0.50
4000	16.50	11.55	145.50	112.50	0.73
L.S.D. at 5%	3.09	0.93	14.05	25.45	0.05
L.S.D. at 1%	4.50	1.36	20.44	37.03	0.07

Table 4: Effect of saline irrigation water treatments on fruit and oil yield components of fennel plants during two seasons

Saline irrigation water concentration (ppm)	Weight of fruits / plant (g)	Weight of fruits / fed (kg)	Weight of 100 fruit (g)	Oil percentage	Oil yield / plant (ml)	Oil yield / feddan (L)
			First season (1997/1998)			
Control	54.2630	571.8970	1.5000	1.6633	0.9026	9.4776
1000	48.7333	511.3163	1.4400	1.1743	0.5722	6.0084
2000	40.2100	421.4390	1.2200	1.1643	0.4681	4.9154
3000	33.5666	349.6360	0.9650	1.1073	0.3716	3.9025
4000	24.7666	253.2003	0.8366	1.0563	0.2615	2.7464
L.S.D. at 5%	2.0179	3.9179	0.0260	0.0169	0.0003	0.3082
L.S.D. at 1%	2.9359	5.7002	0.0379	0.0246	0.0004	0.4484
			Second season 1998/1999)			
Control	50.6833	531.7210	1.5033	1.4633	0.7418	7.7896
1000	45.5466	475.1236	1.3966	1.3366	0.6084	6.3889
2000	35.1000	369.6773	1.5660	1.2433	0.4367	4.5857
3000	29.6366	312.7973	0.9233	1.2050	0.3571	3.7495
4000	19.7666	204.4250	0.8366	1.1433	0.2257	2.3702
L.S.D. at 5%	3.9746	4.5386	0.0478	0.0025	0.0595	0.6328
L.S.D. at 1%	5.7827	6.6033	0.0696	0.0036	0.0866	0.9207

decreased by using salinity treatments. The results were similar in both seasons. The inhibitory effect of high level of salinity was also found by Amer *et al.* (1994) on dill; Fiad (1997) on *Nigella sativa* and Said-El-Ahl (1999) on basil.

However, the reduction in oil content due to salinity treatments could be mainly due to the decrease in fruits yield and growth, as found in this study. In this regard, Penka (1978) showed that the formation and accumulation of essential oils in plants was explained as due to the action of environmental factors. It might be claimed that the formation and accumulation of essential oil was directly dependent upon perfect growth and development of the plants producing oils. Also, the decrease in oil production might be due to the decrease in plant anabolism.

5.Chemical Constituents

Data presented in Tables 5 and 6 show that the treatments of saline irrigation water (specially 4000 ppm) gave highly significant decrease in the percentages, and contents of each of total carbohydrates, nitrogen, protein and phosphorus as well as potassium, also, the fruits contents of zinc, manganese and iron in both seasons compared to control. Similar results were reported by Morales *et al.* (1993) on *Digitalis purpurea,* Rashad (1995) on *Tagetes erecta,* Ali (1996) on Egyptian henbane , Fiad (1997) on *Nigella sativa* and Garg *et al.* (1997) and Attia (2003) on guar plant. In addition, Baslavskaya (1936) attributed the decrease in the amount of carbohydrates in potato plant treated with chloride salinity to the hazard effect on photosynthetic activity due to a decrease in amount of chlorophyll per unit of fresh leaf surface. Also, Kabanov *et al.* (1973) on pea mentioned that high salinity levels caused a depression in photosynthetic activities, resulting in low CO_2 fixation. The absorption of minerals could be retarded leading to low plant metabolism.

The reduction in total nitrogen due to salinity treatments might be due to the depression in nitrogen uptake, as mentioned by Gauch and Wadleigh (1942) on beans. Furthermore, Suakjan and Petrosyan (1964) mentioned that the amount of total protein nitrogen sharply dropped in grape leaves under conditions of soda salinization. Cation balance was disturbed by salinity and caused disturbance in protein metabolism causing an inhibition of growth processes.

Table 5: Effect of saline irrigation water treatments on total carbohydrates percentage, carbohydrates content / plant (g), nitrogen percentage, nitrogen content/ plant (g), protein percentage and protein content /plant (g) of fennel plants during two seasons

Saline irrigation water concentration (ppm)	Total carbohydrates percentage	Total carbohydrates content / plant (g)	Total nitrogen percentage	Total nitrogen content / plant (g)	Total protein percentage	Total protein content / plant (g)
First season (1997/1998)						
Control	5.86	3.17	2.50	1.35	15.47	8.48
1000	5.76	2.80	2.29	1.11	14.36	6.99
2000	5.16	2.07	1.90	0.76	11.54	4.78
3000	4.83	1.62	1.62	0.54	10.43	3.40
4000	4.43	1.09	1.50	0.37	9.41	2.32
L.S.D. at 5%	0.17	0.14	0.12	0.05	0.38	0.34
L.S.D. at 1%	0.26	0.21	0.18	0.07	0.55	0.49
Second season (1998/1999)						
Control	6.31	3.19	3.07	1.55	19.96	9.73
1000	5.74	2.66	2.76	1.35	18.22	8.45
2000	5.42	1.89	2.34	0.77	15.05	4.86
3000	5.08	1.50	1.99	0.56	12.07	3.51
4000	4.81	0.94	1.37	0.27	8.58	1.69
L.S.D. at 5%	0.23	0.18	0.35	0.08	0.80	0.54
L.S.D. at 1%	0.33	0.27	0.51	0.12	1.17	0.78

Table 6: Effect of saline irrigation water treatments on phosphorus percentage, phosphorus content/ plant (g), potassium percentage, potassium content / plant (g) , Zn (g), Mn (g) and Fe (g) of fennel plants during two seasons

Saline irrigation water concentration (ppm)	Total phosphorus percentage	Total pho sphorus content / plant (g)	Potassium percentage	Potassium content /plant (g)	Zn content (g)	Mn content (g)	Fe content (g)
First season (1997/1998)							
Control	0.7213	0.3954	3.1018	1.6693	0.0194	0.0141	3.9636
1000	0.6802	0.3315	3.0654	1.4938	0.0132	0.0099	1.8630
2000	0.6587	0.2648	3.0350	1.2203	0.0088	0.0073	1.2991
3000	0.6311	0.2116	3.0108	1.0104	0.0045	0.0051	0.7992
4000	0.5233	0.1294	2.9516	0.7311	0.0017	0.0030	0.3378
L.S.D. at 5%	0.0135	0.0127	0.0145	0.0667	0.0026	0.0008	0.3378
L.S.D. at 1%	0.0197	0.0184	0.0211	0.0970	0.0038	0.0012	0.4915
Second season (1998/1999)							
Control	0.8312	0.4212	3.1544	1.5989	0.0130	0.0159	3.1870
1000	0.7723	0.3517	3.1139	1.4182	0.0133	0.0084	1.9596
2000	0.7258	0.2544	3.0492	1.0704	0.0144	0.0052	0.9699
3000	0.6789	0.2009	3.0249	0.8963	0.0059	0.0032	0.6218
4000	0.6556	0.1274	2.9845	0.5896	0.0026	0.0013	0.2283
L.S.D. at 5%	0.0223	0.0255	0.0293	0.1261	0.0020	0.0038	0.6887
L.S.D. at 1%	0.0325	0.0372	0.0426	0.1835	0.0029	0.0056	1.0020

Such decrease in phosphorus percentage or content under salinity conditions could be attributed to the decrease in phosphorus uptake under salinity treatments and/ or might be due to raising the pH of soil that lowered the availability of phosphorus, as stated by Ashour *et al.*(1970) on sunflower plants.

Such decrease in potassium percentage or content, could be attributed to the reduction in potassium uptake as mentioned by Mayers and Anderson (1954) on wheat, Paliwal and Moliwal (1972) on okra and Joshi and Naik, (1977) on sugar cane.

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تأثير معاملات ملوحة ماء الرى على النمو والإثمار ومحصول الزيت وبعض المكونات الكيميائية لنبات الشمر المنزرع فى الأراضى المستصلحة حديثاً

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أجريت هذه الدراسة خلال موسمى ١٩٩٨/١٩٩٧ ، ١٩٩٩/١٩٩٨ فى مزرعة محطة بحوث البساتين بالقصاصين التابعة لمركز البحوث الزراعية لتوضيح مقاومة نباتات الشمر لمعاملات من مستويات مختلفة من الرى بالماء المالح (بتركيزات صفر ، ١٠٠٠، ٢٠٠٠، ٣٠٠٠، ٤٠٠٠ جزء / مليون) تحت ظروف الأراضى الملحية ونظام الرى بالتنقيط ٠

وتشير النتائج إلى أن معاملة الملوحة عند تركيز (٤٠٠٠ جزء / مليون) قد أدت إلى نقص معنوى جداً فى أرتفاع النبات، والأوزان الطازجة، والجافة للأوراق والساق والجذر / نبات ، وعدد النورات / نبات، وعدد النويرات / نورة، والأزهار الخنثى / نبات، بينما أدى إستخدام معاملات ٢٠٠٠، ٣٠٠٠، ٤٠٠٠ جزء / مليون إلى زيادة معنوية جداً فى عدد الأزهار المذكرة / نبات والنسبة الجنسية ، وفى نفس الوقت أدى استخدام كل معاملات الملوحة إلى إنخفاض معنوى جداً فى وزن الثمار، والنسبة المئوية للزيت، ومحصول الزيت لكل من النبات والفدان، ولقد أدى استخدام معاملات ملوحة ماء الرى بتركيز ٣٠٠٠ ، ٤٠٠٠ جزء / مليون إلى نقص معنوى جداً فى النسب المئوية والمحتوى لكل من الكربوهيدرات الكلية والنيتروجين والبروتين والفوسفور والبوتاسيوم، وايضاً محتوى الثمار من الزنك والمنجنيز والحديد ٠