ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 45(4): 1619-1633,.(2007).

EFFECT OF SALINE WATER IRRIGATION ON GROWTH, YIELD AND CHEMICAL COMPOSITION OF JERUSALEM ARTICKOKE

BY

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ABSTRACT

Pot experiment was carried out at the experimental farm of vegetable Research Department of Horticulture Research Institute, Dokki, Giza governorate, on sandy soil during 2004 and 2005 to study the effect of saline water on growth, tubers yield, as well as some chemical constituents, of the local and Fuseau cultivars of Jerusalem artichoke (*Helianthus tuberosus* L.).

Three saline water levels (1.5, 3, 4.5 d S/m and the control as plants received only fresh water (0.4 d S/m) were studied. Results showed that all growth characteristic in this investigation were gradually decreased when the Jerusalem artichoke plants were irrigated with saline water content up to 4.5 d S/m.

The results indicated that plants of local cultivar were more salt tolerant than those of Fuseau cultivar. Growth and yield were reduced in both cultivars. The relative vegetative growth was unaffected up to 1.5 d S/m for local cultivar (plant height and No. stems/plant), whereas number of tubers/plant, fresh weight of tubers/plant and total yield per plot were higher for Fuseau cultivar compared with local cultivar. Increasing saline water reduced phosphorus, potassium and inulin content, while, increased nitrogen and protein content in tubers up to EC_e of 1.5 d s/m. higher accumulation of Na, Ca and proline content in leaf and tuber for Fuseau and local cultivars but local cultivar was more severely affected.

Key words: Jerusalem artichoke, salinity, saline water, tubers, yield, chemical composition.

INTRODUCTION

Jerusalem artichoke has a great potential as livestock forage and for production of ethanol and fructose, a polysaccharide that stimulates the growth of beneficial gut bacteria and is marketed as a fat replacement in the production of low-fat health foods.

Salinity is considered one of the main elements of mineral stresses. Adverse growing conditions such as, salinity and water stress occur naturally in Egypt.

Salinity in the arid lands is a common problem. Areas dependent on irrigation frequently suffer from high salinity. Salinity has negative effects on plants growth and yields. Salt stress influences plant growth in three major ways: firstly, there is an effect of plant water deficit to the reduction in soil water potential, and secondly, the presence of salt can affect the up take of other essential nutrients and thirdly, the sodium and chloride ions themselves may by phototoxic (Levitt, 1980). Bernstein and Hayward (1958) found that salinity reduced growth in plant parts and dry weight of plants. Several workers have been attracted by the effect of water salinity on plant growth and yields. Jerusalem artichoke was rated as moderately salt tolerant, according to the classification of Mass and Hoffman (1977), with 50% yield reduction when ECe was 7.5 d Sm^{-1}.

Jerusalem artichoke has been rated as moderately salt tolerant with a threshold ECe of 8.3 d Sm^{-1}, slope of 1.2% and a C_{50} yield decline at an ECe of 7.5 d Sm^{-1} the crop was rated as sensitive to moderately sensitive because salinity treatments significantly reduced plant density when tuber yield was expressed in terms of land area. On this basis, the salt tolerance threshold ECe was 0.4 d Sm^{-1}, slope was 9.62% and an expected C_{50} yield reduction was 5.8 d Sm^{-1} (Newton *et al.*, 1991). Soil salinity causes great losses to agriculture by lowering the yields of various crops, and hence excessive salt accumulation presents or limits the production of economic crops in million hectars (Hassan and EL-Sannoudi, 1993). Malach *et al.* (1996) reported that artichoke yield declined by 60% due to salinity when ECe increased from 1.5 to 6.2 d Sm^{-1}.

Long-XiaoHua *et al.* (2005) found that when Helianthus tuberosus was irrigated with seawater different in concentration, the results show that when irrigation water W_1 (fresh water) and W_2 (25% seawater), no significant difference in yield of tuber and aerial parts the plant between W_2 and W_1. The yields for treatment W_2 and W1 declined significantly, from 32 to 25% and from 76 to 60% respectively, when the irrigation water contained higher percentage of seawater 50% in treatment W_3 and 75% in treatment W_4. Liu-Zhaopu *et al.* (2005) reported that, in Helianthus tuberosus were irrigated with seawater and diluted with fresh water at the following ratios 0:1 (pure water), 1:9, 1:4 and 1:3. The results showed that at the end of the growing period, the yield of fresh tuber in the 1:3 treatment was much higher than in the other treatments.

The objective of the work reported here was to compare two cultivar of Jerusalem artichoke and the effect of different concentrations of saline water on vegetative growth, yield and chemical constituents in order to evaluate the productivity of this crop in Egypt under these conditions.

MATERIALS AND METHODS

The present investigation was carried out at the Experimental farm of vegetable Research Department of the Horticulture Research Institute, Dokki, Giza governorate, on sandy soil during 2004 and 2005 years.

The chemical characteristics of the experimental soil are given in Table (1).

Preparation methods for standard stock solution.

N (Total) 11%, P (P_2O_5) 6%, Fe (0.15%), Zn (0.15%), Mn (0.14%), Mg (0.05%), Ca (0.02%), Cu (0.02%), So (0.02%), Bo (0.01%) and Mo (0.01%).

Table (1): Chemical characteristics of the experimental soil.

Characteristic	pH	EC (ds/m)	Exchangeable ($CmolKg^{-1}$)				Anions ($CmolKg^{-1}$)			Mineral nutrients ($mg\ Kg^{-1}$)		
			Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO^{3-}	Cl^{-}	So_4^{2-}	N	P	K
Value	7.78	1.35	11.22	6.45	7.5	3.1	12.4	6.8	8.11	12.2	14	66

Tubers of local and Fuseau cultivars of Jerusalem artichoke (*Helianthus tuberosus* L.) were used. The Department of vegetable crops, Faculty of Agriculture, Cairo University, Egypt, supplied the local cultivar. While, Fuseau cultivar was imported from the United Kingdom.

Tubers (60-80g) of Jerusalem artichoke were irrigated with nutrient solution and fresh water for one month before salt treatments, then irrigated with saline water two times weekly at different concentrations. NaCl and $CaCl_2$ were mixed together with ratio 1:1 and obtained levels of both salts namely 1.5, 3, 4 d Sm^{-1} and the control plants received only fresh water (0.4 d Sm^{-1}). Every three irrigation with saline water the plants received fresh water to prevent the accumulation of salinity. Three replicates were carried out in each treatment and each treatment was represented by 9 plants. In this experiment 216 plastic pots of 40 cm diameter were used. The obtained data analyzed statistically by using a General Linear Model procedure of SAS Institute (1989). Fishers protected least significant difference (LSD) at $P \leq 0.05$ was employed to separate the treatment means. The experimental design, which used was complete randomized block in factorial arrangement. Three samples, each four plants from four different pots were randomly taken 150 and 180 days after planting for measuring the plant development. The following characteristics were determined in each sample:-

I. Vegetative growth:

1- Plant height (cm).
2- No. of stems.
3- Leaf content of chlorophyll.
4- Fresh weight (kg/plant).

II. Tuber development:

1- No. of tubers.
2- Tuber fresh weight per plant (Kg/plant).
3- Tuber dry weight percentage.
4- Total yield/plot (kg/plot).

III. Chemical content:

Inulin concentration was determined according to (Winton and Winton, 1958), nitrogen (Koch and McMeckin, 1924), protein content was determined as nitrogen content and converted to its equivalent protein content by multiplying by 6.25 as described by (Pregi, 1945), phosphorus (Troug and Meyer, 1939), calcium , potassium and sodium were determined by using the flamephotometer method (Jackson 1973). Proline content was determined according to Bates *et al.* (1973). Dry weight was determined following oven-dry at 65-70°C for 48 h in an air-forced ventilated oven.

RESULTS

Effect of salinity on vegetative growth:

1- Plant height:

Data presented in Table 2 show that Fuseau cultivar produced longer plants compared with local cultivar. The increment in the plant height was estimated by 17.20 and 14.2 % for the two growing seasons, respectively. A wide range of variation due cultivars was reported by many authors, (Khereba. 1979; Kiehin *et al.*, 1993; and El-Sharkawy. 1998). Concerning the effect of salinity it could be also noticed that the different high saline concentrations, over 1.5 d Sm^{-1} led to a negative significant effect on plant height in both seasons. Concerning the interaction effect between cultivars and salinity treatments, it could be noticed that in 2004 and 2005 Fuseau cultivar produced the longest stem compared to the local cultivar when using 1.5 d Sm^{-1} and a reduction in the same character at salinity levels of 3.0 or 4.5 d Sm^{-1}. Greenway (1961, 1963) suggested that salinity reduced plant height either by making osmotic cell enlargement dependent on soluble ion accumulation or by drastic changes in cellular ionic relationships.

2- No. of stems:

Table (2) show that local cultivar surpassed Fuseau cultivar on number of main stems in the two growing seasons. It is also evident from data in Table (2) that number of main stems tended to be reduced when the higher salinity levels 3 and 4.5 d Sm^{-1} compared with 0.4 and 1.5 d Sm^{-1}. However, the difference did not reach to the significant level in the first season.

During the first season number of stems of Fuseau and local cultivars did not reach the significant level by using low and high saline levels.

3- Leaf content of chlorophyll:

Regardless of salinity effect, plants of the Fuseau cultivar produced 32.6 and 33.90 % more chlorophyll content compared to these of local cultivar during 2004 and 2005 studies, respectively (Table 2).

The concentrations of salinity, i.e. 1.5, 3 and 4.5 d Sm^{-1} led to a significant decrease in leaf content of chlorophyll under study in both seasons.

Concerning the effect of the interaction between cultivars and salinity level on leaf content chlorophyll, results in the same table showed that the maximum chlorophyll content of the two cultivars was obtained by applying 0.4 d S/m (fresh water). El-Sherif *et al.* (1990) reported that the reduction in leaf chlorophyll content by increasing salinity levels in the nutrient medium could be attributed to the effect of salinity on decreasing Mg uptake which is the main component of chlorophyll. Ali and Malash (1998) revealed that the depression in pigments may be due to the depressive effect of salinity on absorption of mineral elements such as Fe, K, Zn and Mg.

4- Foliage fresh weight (Kg/plant):

Table (2) clearly indicate that the Fuseau cultivar produced greater foliage fresh weight as it showed 1.32 and 1.18 kg /plant during 2003 and 2004 seasons, respectively. Whereas, Local cultivar produced 1.06 and 0.918 kg/plant.

Table (2): Effect of cultivars and different concentrations of saline water on vegetative growth of Jerusalem artichoke at 120 days after planting during the two seasons 2004 and 2005.

Characters / Treatments	Plant height (cm)		No. of stems		Chlorophyll (mg/g)		Fresh weight (kg/plant)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Cultivars								
Fuseau	143.62	132.27	4.87	5.30	37.13	31.69	1.32	1.18
Local	122.51	115.77	6.05	6.23	28.00	23.66	1.06	0.91
L.S.D. at 0.05	**1.95**	**3.87**	**0.42**	**0.47**	**3.25**	**2.68**	**0.12**	**0.05**
Saline water (Ece, ds/m):								
0.4	146.11	132.31	5.70	6.23	39.02	31.40	1.37	1.25
1.5	140.25	129.48	5.54	6.16	34.68	28.82	1.28	1.05
3	127.65	123.76	5.36	5.47	29.45	27.03	1.12	0.99
4.5	118.24	110.53	5.24	5.26	27.12	23.45	0.99	0.87
L.S.D. at 0.05	**6.59**	**3.97**	**0.43**	**0.26**	**2.05**	**2.15**	**0.09**	**0.11**
Interactions:								
Fuseau:								
0.4	152.87	138.57	4.94	6.02	41.70	37.07	1.40	1.26
1.5	153.73	138.61	4.88	5.70	41.07	32.87	1.41	1.12
3	137.44	132.00	4.79	4.80	33.63	30.40	1.31	1.20
4.5	130.45	119.90	4.85	4.68	32.13	26.43	1.16	1.12
Local :								
0.4	139.35	126.05	6.46	6.44	36.33	25.73	1.33	1.24
1.5	126.78	120.34	6.20	6.62	28.30	24.77	1.14	0.98
3	117.87	115.52	5.93	6.52	25.27	23.67	0.92	0.78
4.5	106.03	101.17	5.63	5.73	22.10	20.47	0.82	0.62
L.S.D. at 0.05	**9.32**	**5.62**	**0.61**	**0.37**	**2.90**	**3.03**	**0.13**	**0.16**

Regarding to salinity, the concentration of saline water significantly decreased foliage fresh weight/plant.

Results did not reflect any significant differences between the four salinity concentrations by combination of Fuseau cultivar in respect to foliage fresh weight/plant in the second season. However, in the first season, the highest concentration of saline water significantly decreased foliage fresh weight/plant.

While the local cultivar produced the highest fresh weight /plant was obtained by applying fresh water .

Tuber development:

1- Number of tubers/plant:

The Fuseau cultivar produced the higher number of tubers/plant compared with local cultivar in the two growing seasons (Table 3).

Table (3): Effect of cultivars and different concentrations of saline water on No. of tubers, tuber fresh weight (kg/plant), total yield (Kg/plot) and dry matter (%) of Jerusalem artichoke at 180 days after planting during the two seasons 2004 and 2005.

Characters / Treatments	No. of tubers		Tubers fresh weight (kg/plant)		Total yield/plot (kg)		Dry matter (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Cultivars								
Fuseau	54.75	45.58	2.39	2.21	21.24	20.26	26.27	26.14
Local	47.77	35.51	2.25	1.76	19.94	16.76	25.12	24.75
L.S.D. at 0.05	**2.20**	**2.98**	**N.S.**	**0.14**	**N.S.**	**1.29**	**0.80**	**0.94**
Saline water								
(Ece, ds/m):	59.17	46.49	2.88	2.32	25.23	21.37	27.35	26.93
0.4	53.24	43.90	2.87	2.07	25.73	20.00	26.00	26.42
1.5	48.90	35.98	1.80	1.95	16.38	18.11	25.35	24.79
3	43.73	35.81	1.68	1.59	15.03	14.56	24.08	24.24
4.5	**3.18**	**1.16**	**0.28**	**0.16**	**2.59**	**1.81**	**0.65**	**0.50**
Interactions:								
Fuseau :								
0.4	67.82	52.06	2.89	2.45	25.06	22.74	27.83	26.94
1.5	56.16	51.06	2.91	2.48	26.02	22.23	26.55	27.22
3	52.67	39.71	2.06	2.17	18.84	20.34	26.07	25.65
4.5	42.35	39.48	1.70	1.73	15.05	15.65	24.63	24.72
Local :								
0.4	50.31	40.91	2.86	2.18	25.40	20.00	26.87	25.83
1.5	50.13	36.74	2.83	1.66	25.44	17.68	25.45	25.62
3	45.13	32.24	1.55	1.73	13.92	15.88	24.62	23.93
4.5	45.11	32.15	1.67	1.45	15.02	13.48	23.52	23.75
L.S.D. at 0.05	**4.50**	**1.65**	**0.39**	**0.23**	**3.67**	**2.56**	**0.92**	**0.71**

Regard to salinity, the same table indicates number of tubers/plant gradually decreased as salinity concentration from 0.4 up to 4.5 ds/m increased.

Also, the interaction between cultivar and salinity concentration on the number of tubers/plant it is evident that all salinity levels significantly decreased the number of tubers/plant, with the two cultivars in the two seasons under study. Barakat (1996) and Abd El-Al (2001) reported that salinity reduced the number of tubers per plant.

2- Tubers fresh weight /plant:

Table (3) show that the Fuseau cultivar surpassed local cultivar on tubers fresh weight (kg/plant) but the difference was only significant during the second season and reached 25.6%.

With regard to the effect of salinity level, the highest levels of saline water led to a significant reduction in tubers fresh weight. On the other hand, no significant differences on tubers fresh weight/plant was detected between the lowest salinity level of salinity, i.e. 1.5 d S/m and the fresh water. This was in agreement with the findings of Barakat (1996), El-Khatib (1996) and Abd El-Al (2001) on potato, who indicated that salinity reduced tuber fresh weight per plant. Also, the interaction between cultivar and salinity concentration was significant in the two seasons, indicating that the two cultivars (Fuseau and local) produced higher yield when using the lowest concentration of salinity (1.5 d S/m) whereas the highest concentrations (3, 4.5 d S/m) inhibited accumulation of fresh weight in tubers.

Also, Abd El-AL (2001) indicated that irrigation of potato plants with high saline water (Ec 4.5 d S/m) caused a dramatic reduction in the numbers of tubers, tuber fresh and dry weight per plant.

3- Total yield/plot:

Table (3) show that the Fuseau cultivar surpassed local cultivar on total yield/plot but these differences were only significant during the second season.

Regardless of cultivars, it was obvious that total yield/plot was decreased gradually with the increase in saline water concentration during the two growing seasons. So, the lowest values were recorded when the highest level of saline water was used. Similar results were reported by (Newton *et al.*, 1991) who indicated that Jerusalem artichoke crop was rated as sensitive to moderately sensitive because salinity treatments significantly reduced total yield. Also, Phoades and Loveday (1990) showed that total yield was reduced 40 to 50% of its maximum as irrigation water salinity increased from 1.5 to 6.2 d S/m.

4- Tuber dry weight:

Regarding the effect of cultivar on dry matter, data in Table (3) indicate that there were significant differences between the tested cultivars in both seasons of study. Fuseau cultivars produced tubers that contained higher dry matter compared with that local cultivar. The percentage of dry matter content of the tubers of Fuseau cv. were 26.27 and 26.14 compared with 25.12 and 24.75 for local cv. in the first and second seasons, respectively. Significant differences between the dry matter of Jerusalem artichoke tubers were reported by El-Sharkawy (1998).

Data presented in Table (3) indicate that the high saline concentrations, over 1.5 d Sm^{-1} led to negative significant effect on dry matter percentage. Also concerning the interaction between the cultivars and saline water, it could be noticed that Fuseau cultivar produced higher dry matter % compared with local cultivar when using 1.5 d Sm^{-1}. Levy *et al.* (1988) and Abd El-Al (2001) found that salinity reduced the tuber dry matter.

Effect of salinity on tuber inulin content:

The results presented in Table (4) indicate that Fuseau cultivar tubers contained higher inulin level than that of local cultivar. However, the difference did not reach to the significant level in the first season. Genetic differences were recorded for concentration of inulin of Jerusalem artichoke tubers (Bobrovnik *et al.*, 1991 and Zuber *et al.*, 1993).

Data in table (4) reveal that there was clear negative effect for the excess of salinity concentrations on the reduction of inulin contents where the highest value of Ec 4.5 caused the lowest accumulation of inulin in tubers at the end of both seasons. Newton *et al.* (1991) showed that percentage fermentable sugar decreased by 15 to 20% at the highest salinities compared with the control treatment. Also, for tubers percentage fermentable sugars was affected by applied salinities when that of the 10 d S/m treatment was 7% lower than that of the channel water treatment

Table (4): Effect of cultivars and different concentrations of saline water on Inulin, Nitrogen, Phosphorus, Potassium and Protein (g/100 g DM) of Jerusalem artichoke at 180 days after planting during the two seasons 2004 and 2005.

Characters / Treatments	Inulin		Nitrogen		Phosphorus		Potassium		Protein	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Cultivars										
Fuseau	15.56	14.10	1.77	1.42	0.36	0.35	3.30	3.55	11.06	8.85
Local	14.21	11.44	1.86	1.59	0.33	0.32	3.34	3.77	11.59	9.88
L.S.D. at 0.05	**N.S.**	**1.59**	**N.S.**	**0.065**	**0.072**	**N.S.**	**N.S.**	**0.021**	**N.S.**	**0.47**
Saline water (Ece, ds/m):										
0.4	16.96	15.17	1.96	1.65	0.37	0.39	3.79	3.82	12.22	10.29
1.5	16.29	13.54	1.87	1.54	0.36	0.35	3.44	3.75	11.70	9.56
3	15.04	11.83	1.73	1.44	0.33	0.32	3.19	3.64	10.81	9.01
4.5	11.25	10.54	1.69	1.38	0.30	0.28	2.88	3.42	10.56	8.59
L.S.D. at 0.05	**1.30**	**0.79**	**0.14**	**0.041**	**0.013**	**0.044**	**0.33**	**0.023**	**0.83**	**0.24**
Interactions:										
Fuseau :										
0.4	17.50	16.50	1.91	1.51	0.39	0.40	3.73	3.76	11.96	9.46
1.5	16.67	14.33	1.83	1.45	0.38	0.37	3.39	3.66	11.44	9.04
3	15.50	13.50	1.69	1.35	0.34	0.35	3.27	3.52	10.54	8.46
4.5	12.58	12.08	1.65	1.35	0.31	0.29	2.82	3.24	10.29	8.44
Local :										
0.4	16.42	13.83	1.99	1.78	0.35	0.38	3.84	3.89	12.48	11.13
1.5	15.92	12.75	1.92	1.63	0.35	0.32	3.49	3.83	11.96	10.09
3	14.58	10.17	1.77	1.53	0.31	0.29	3.10	3.76	11.08	9.57
4.5	9.92	9.00	1.733	1.40	0.29	0.27	2.93	3.59	10.83	8.75
L.S.D. at 0.05	**2.4**	**1.76**	**0.27**	**0.078**	**0.018**	**0.062**	**0.57**	**0.032**	**1.55**	**0.52**

Nitrogen, Phosphorus and Potassium contents in tubers:

The effects of cultivar and salinity level on NPK content in tubers are recorded in Table (4). Concerning the nitrogen content in the tubers, the data in the table show that tubers of local cultivar contained higher level compared with that of Fuseau cultivar while, the difference did not reach to the significant level in the first season. Moreover, the results revealed a negative relationship between the salinity treatments and nitrogen content in the tubers. However, the lower reduction in nitrogen content in Fuseau tubers was recorded at the third and fourth concentrations.

The data in Table (4) show that Fuseau cultivar tubers contained higher level of phosphorus compared with that of local cultivar. The results also indicated a negative relationship between salinity treatments and phosphorus tubers content. However, the interaction of salinity treatment and cultivar showed that Fuseau cultivar responded significantly to the lowest salinity treatments.

Regarding the effect of cultivar and salinity treatments on potassium content, the data in Table (4) show that higher level of potassium was found in local cultivar tubers compared with that of Fuseau cultivar. The results indicate a sharp decrease in potassium concentration at Ec 3 and 4.5 d S/m. Hassan *et al.* (1999) and Ab El-Al (2001) reported that increasing salinity led to a decrease in potassium content.

Effect of salinity on protein content in tubers:

The data in Table (4) show that a significant difference was observed between the two tested cultivars in the two seasons. Local cultivar tubers contained higher percent of protein than Fuseau cultivar.

The highest levels of saline water led to a significant reduction in tuber protein. On the other hand, no significant differences on tuber protein were detected between the lowest salinity level of salinity, i.e. 1.5 d S/m and the tap water. Farahat (1990) Shehata (1992), and Younis *et al.* (1993) reported that salinity caused a significant decrease in total carbohydrates and protein content.

Effect of salinity on leaf and tuber content of free proline:

Data illustrated in Fig. (1) show that local cultivar produced higher free proline compared with Fuseau cultivar. It was also noticed that the different salinity levels significantly increased proline accumulation in Jerusalem artichoke leaves over the control. The accumulations were more pronounced at the highest salinity level. Meanwhile, the increase in salinity concentration led to a remarkable increase in proline in Jerusalem artichoke tubers, such increase were more pronounced at Ec 1.5 d S/m. This was clear in both seasons. The effect of salinity on proline content in potato was investigated by Nadler and Heuer (1995) when irrigated potato plants with saline water of Ec; 1.5, 3 and 6 d S/m and they showed that all treatments increased the accumulation of proline in plants.

Potluri and Pasad (1993) maintained that increasing proline accumulation with increasing salinity level due to new synthesis rather than breakdown of existing proteins.

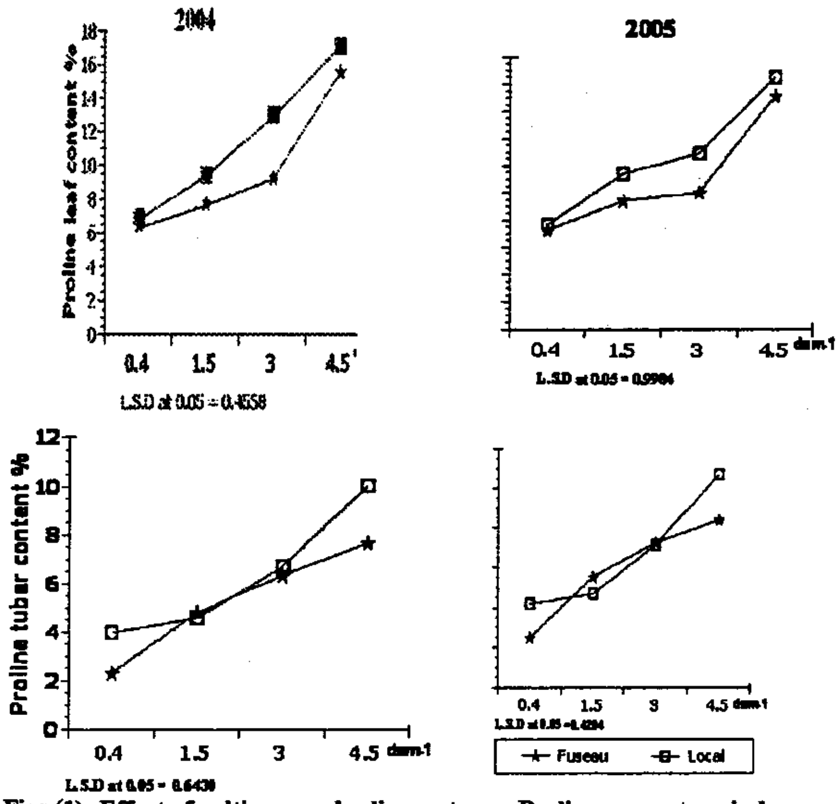
Effect of salinity on sodium content:

Data presented in Fig. (2) showed that leaf and tuber of local cultivar surpassed Fuseau cultivar in sodium content in the two growing seasons regarding saline concentration of irrigation water, using saline water for irrigation increased leaf and tuber content of sodium; the highest saline level led to the highest accumulation of sodium in plant leaves. Moreover, increasing water salinity enhanced higher accumulation of sodium concentration in tubers Moreover, sodium content was more sharply pronounced under the conditions of using high level of salinity, i.e. at 3 and 4.5 d S/m. Xia-Tianxiang *et al.* (2004) reported that when *H. tuberoses* seedlings were treated with concentration of Na Cl and water stresses, the content of Na^+, Cl^- in stem and leaf increased but the content of K^+ showed no significant changes. The content of Na^+ for stem and leaf gradually increased as the concentration of NaCl increased

(Fig. 2). This increment of sodium content in leaves with increasing salinity might be due to the increase of this cation in root medium since there was a relationship between the cations content in both leaves and soil solution as mentioned by Lunin and Gallatin (1965). Chhoura *et al.* (1979) mentioned that there did not appear to be a critical leaf Na in artichoke because, when Ec was 5.5 d S/m, leaf Na was low (6 m M/kg) and similar to that of the control treatment but yield was reduced by 40%. Newton *et al.* (1991) reported that the concentrations of sodium remained low in leaf tissues except in the highest salinity treatment.

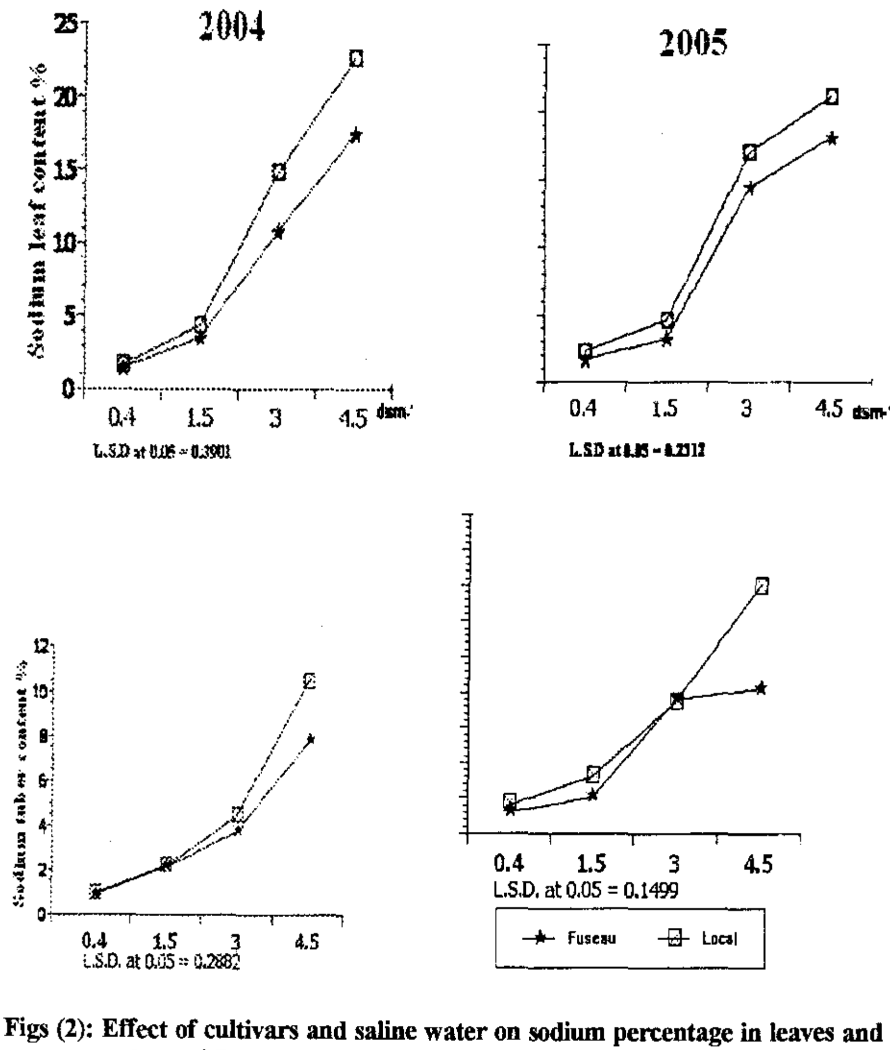
Effect of salinity on calcium content:

It is clear from Fig. (3) that local cultivar produced the higher calcium in leaves compared with Fuseau cultivar in both years of study. It could be also noticed that different high saline levels, led to a positive significant effect on calcium content in leaves. Data presented in Fig. (3) show that the tubers of local cultivar produced higher calcium content than those of Fuseau cultivar in both seasons while, the difference between the two cultivars did not reach to the significant level, in the first season.

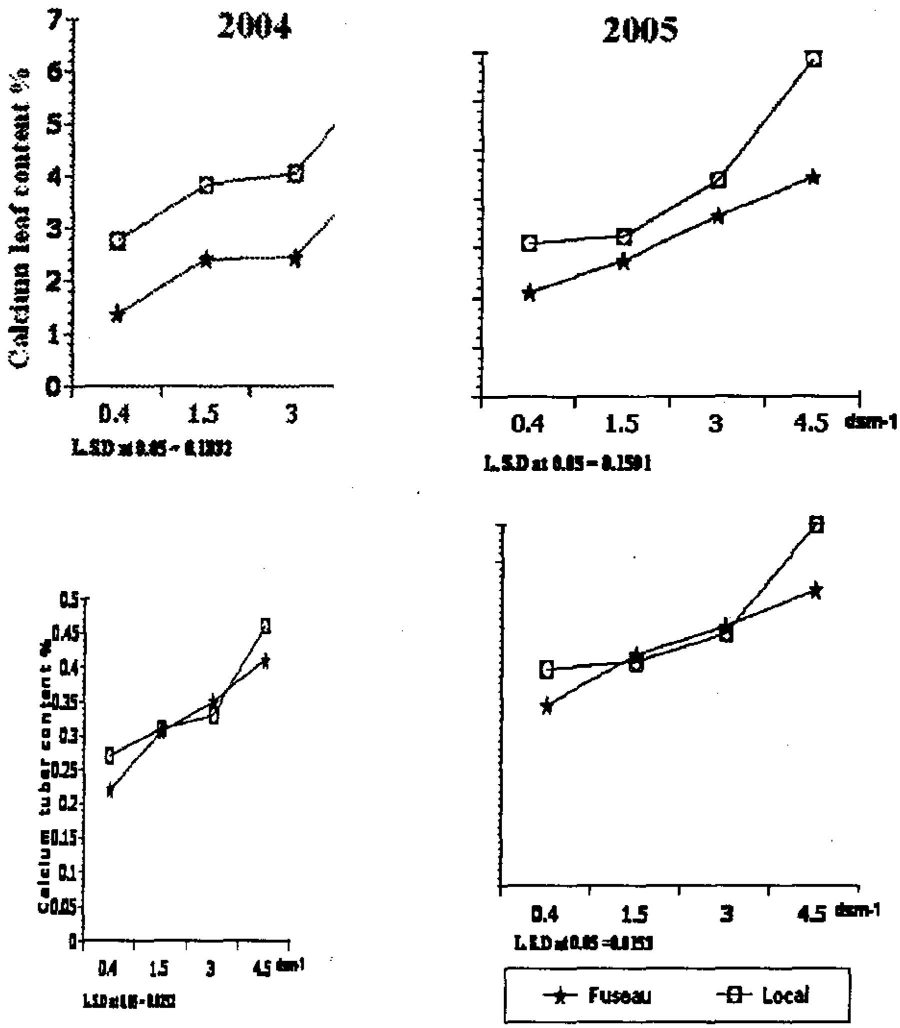


Figs (1): Effect of cultivars and saline water on Proline percentage in leaves and tubers of Jerusalem artichoke during 2004 and 2005 seasons.

Regarding saline concentration of irrigation water, the results indicate a sharp increase in calcium concentration at 4.5 d S/m, while no significant differences were detected in calcium content between the control and the treatment of 1.5 d S/m. Calcium concentrations increased significantly in leaves (from 500 to 700 m M/Kg for Ec of 0.2 to 10 d S/m) but not in stem and tubers (Newton *et al.*, 1991).



Figs (2): Effect of cultivars and saline water on sodium percentage in leaves and tubers of Jerusalem artichoke during 2004 and 2005 seasons.



Figs (3): Effect of cultivars and saline water on calcium percentage in leaves and tubers of Jerusalem artichoke during 2004 and 2005 seasons.

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تأثير الرى بالماء المالح على النمو والمحصول والمحتوى الكيميائى على الطرطوفة

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من خلال تجربة أصص أجريت هذه الدراسة فى معهد بحوث البساتين بالدقى- جيزة فى تربة رملية لموسمين زراعيين ٢٠٠٤ - ٢٠٠٥ لدراسة تأثير الماء المالح بتركيزات ١,٥-٣-٤,٥ ديسمتر/م (d S/m) مقارنة بالماء العادى على صنفى الطرطوفة البلدى والفيوزا وتم دراسة صفات النمو والمحصول وبعض المحتويات الكيمياتية .

أوضحت النتائج أن صنف الفيوزا أكثر تحملا للملوحة بينما الصنف البلدى أكثر حساسية للملوحة . النمو والمحصول أنخفض تدريجيا لكلا الصنفين مع زيادة تركيز ملوحة الرى حتى ٤,٥ ديسمتر/م .

أن بعض صفات النمو الخضرى لم يتأثر بزيادة ملوحة مياه الرى حتى ١,٥ ديسمتر/م للصنف البلدى (أرتفاع النبات - عدد السيقان الرئيسية للنبات) زيادة ملوحة مياه الرى أدت إلى نقص فى عدد درنات النبات والمحصول الدرنى للنبات ومحصول القطعة التجريبية لكلا الصنفين. أظهرت النتائج أن زيادة ملوحة مياه الرى أدت إلى انخفاض تركيز الفوسفور والبوتاسيوم والأنيولين بينما زاد تركيز النتروجين والبروتين.

كذلك زيادة ملوحة مياه الرى أدت إلى زيادة تراكم كلا من الصوديوم والكالسيوم والبرولين فى الأوراق والدرنات لكلا الصنفين وبنسبة أعلى فى الصنف البلدى .