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A Study on the Tolerance of Some Selected Jojoba Clones to Salinity of Irrigation Water

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Abstract: The present study was undertaken in two successive seasons of 2014 and 2015 on jojoba "*Simmondsia chinensis* Link) transplants at the experimental farm of the Horticultural Research Institute, Agricultural Research Center (ARC), Giza Governorate, Egypt. The aim was to compare between three clones and different salts "$CaCl_2$; $MgSO_4$; KCl; K_2SO_4; Na_2SO_4 and NaCl" concentrations (0.00 "Control", 3000, 6000 and 9000 ppm) at sodium adsorption ratio (SAR 12). The results showed the ability of the three jojoba clones under study [namely (Fg10, Fg22 and Fg24) which were previously evaluated] to tolerate irrigation with saline water. Data showed that, the maximum values of vegetative growth measurements were recorded with control treatment for Fg24 clone, while the lowest values were detected with clone Fg22 under saline water 9000 ppm. There was a negative relationship between leaf pigments contents and salinity applied concentrations, besides, Fg24 had the highest values, followed by Fg10 and Fg22. Whereas, the highest values of leaf proline and total sugars were significantly concomitant to the higher level of salt concentration (9000 ppm). Leaves nutrients (N, P and K) contents were the highest for clone Fg24 and with the control treatment, while it was the lowest by irrigation with saline water 9000 ppm. On the contrary, the highest values of Na, Cl and Na/K were recorded with 9000 ppm of saline water and the lowest values were found with the control. The osmotic pressure (L.O.P) in the leaf increased by increasing the salinity of the irrigation water to 9000 ppm and decreased with the control treatment, clone Fg24 recorded the highest values in this concern. Regarding leaf succulence grad, it followed the same trend of osmotic pressure. Microscopic examination of jojoba leaves showed that increasing the salinity level of the irrigation water increased leaf blade thickness, epidermis thickness for the upper and lower leaf surfaces, upper and lower palisade tissue layer, as well as number and thickness of palisade tissue layer compared to the control treatment. On the other hand, increasing the salinity of the irrigation water decreased number and thickness of spongy tissues. It can be concluded from this study that jojoba transplants can be irrigated with high salinity irrigation water and clone F24 which can survive on high concentrations of saline water (up to 6000 ppm) can be recommended to expand its cultivation in these areas. Moreover, jojoba is an important crop for expansion in the new reclamation areas in Egypt.

Key words: Jojoba · Clones · Saline water · Vegetative growth · Chemical constituents · Anatomical structure

INTRODUCTION

Jojoba plant [*Simmondsia chinensis* (Link) Schneider] is pronounced as hohoba belongs to family Buxaceae. This plant is native to the arid zone of USA and Mexico. Its natural distribution falls between latitudes 25 and 34 (south) in an area which closely approximates the Sonorant Desert [1]. Jojoba plant is an evergreen; diocious and woody long-lived desert shrub even under tolerate extreme temperature (35-40°C). It can grow well on 50 Mm/year of rainfall even 100 mm, but produces light crop. Jojoba have currently received a special attention since, its seeds contain a valuable liquid wax called jojoba oil. This oil is very similar to that obtained from sperm whale. The liquid wax of jojoba is used as a nature base for wide range of cosmetics component of hair oil, shampoo, soap, face creams, sunscreen compounds and medicinal products. It can be used also as antioxidant,

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antifoaming and fire retardant agents. As a suitable carrier or coating for some medical preparations stabilizer of penicillin products, gas a heat resistant lubricating properties and useful in chemical industry [2-7].

Moreover, jojoba oil which is waxy in nature may also have promise in the treatment of industrial wastewater for the recovery of toxic heavy metals [8].

In jojoba plantations there are some horticultural limitations since, only a few cuttings can be obtained besides, the hardened terminal shoots are taken during particular period of the year. Moreover, clonal propagation exhibited elite individuals of known sexually and special relevance in order to make sure of the number of productive plants in a given plat [9].

Jojoba is considered one of the most practical and scientific solutions for desert plantation in Egypt. Hot summers, warm winters, desert soil and minimal water. Lesser possibilities for infection, lesser need for fertilizers and generous financial income, are certainly most encouraging to plant Jojoba in Egypt [6].

Salt-affected soils occupy more than 70% of the earth's land surface and represent a major limiting factor in crop production [10]. The even increasing demand for agricultural products requires a reassessment of the production potential of low quality land and water resources [11]. Salinity considered to be one of the most important constrains to production, soil and water salinity causes great losses to agriculture by lowering yield of various crops [12]. Water scarcity in the Mediterranean basin, especially in countries in the arid zone with high rates of population growth, urbanization and industrialization, appears as one of the main factors limiting agricultural development. In order to overcome water shortage and to satisfy the increasing water demand for agricultural development, the use of water of low quality (brackish, reclaimed, drainage) is becoming very important in many countries [13].

Since the expansion of agriculture in Egypt is currently in lands characterized by high salinity, whether soil salinity or irrigation water and jojoba are among the crops that bear more salinity. Whereas, we had to choose jojoba strains that are characterized by an abundance of seeds production and also a high proportion of oil to seeds.

Thus, the main purpose of this research was to study the extent to which vegetatively propagated jojoba transplants tolerate different levels of salinity and their effects on vegetative growth and physiological aspects and chemical constituents, of three jojoba clones as well as anatomical structures of leaf.

MATERIALS AND METHODS

The present investigation was undertaken over two consecutive seasons of 2014 and 2015 at the experimental farm of the Horticultural Research Institute, Agricultural Research Center (ARC), Giza, Egypt.

Research Plant Materials Preparation: One hundred and forty four transplants have been prepared from three Jojoba "*Simmondsia chinensis* Link) clones 8 years old namely (Fg10, Fg22 and Fg24). These clones were previously evaluated and are distinguished by their high quality and productivity of seeds as well as oil content (Fg10, Fg22 and Fg24) [were previously evaluated and proved to have desirable characteristics whereas clone 24 (yield 3 kg, oil (wax ratio) 52.13%); clone 22 (yield 2.3 kg, oil ratio 50.8%) and clone 10: yield 1.1 kg, oil 52.6%] [14]. Soft wood cuttings were taken from these clones and planted under mist in the month of May. During the first week of February 48 transplants/each clone as total of 144 transplants (one year old) in our study were individually transplanted in plastic pots of 35 cm in diameter and 40 cm in depth, filled with specific weight (10 kgs/pot) of sandy soil. The experiment includes 12 treatments (3 clones x 4 saline water concentrations). The treatments were arranged in a complete randomized block design with three replicates/each treatment which was presented with four transplants. Both mechanical and chemical analysis of soil media were determined according to the method described by Jackson [15] and Piper [16] as shown in Table (1).

Jojoba transplants were irrigated twice a week with tap water till the first week of May. Then, they irrigated with three levels of salinized water by dissolving NaCl, $NaSO_4$, $CaCl_2$, $MgSO_4$ and KSO_4 salts to obtain saline solutions at concentrations 3000, 6000 and 9000 ppm and SAR 12/each saline level. The experimental transplants were irrigated with saline solutions twice a week using 750 ml/pot started in the first week of May and ended at late September in both seasons, whereas, the control treatment (unsalinized transplants) were irrigated with tap water during the whole period of investigation. Method and proportions of the salts in the concentrations under study are presented in Table (2):

On the other hand, to prevent salt accumulation, salts were leached every three weeks by irrigation with tap water followed by re-watering with the corresponding saline solution the next day.

The response of jojoba transplants to both investigated factors and their combinations was evaluated through the following parameters:

Table 1: Physical and chemical analysis of the experimental soil

Cations (Mfq/L)				Anions (Meq/L)						
K^+	Na^+	Mg^{++}	Ca^+	So^-	Cl^-	HCO^3	CO^3	$CaCO^3$	pH	EC
3.70	24.20	24.5	29.6	34.3	45.40	2.3	-	1.30	8.02	1.20

Coarse sand (%)	Fine sand	Silt	Clay (%)
42.90	47.10	8.00	2.00
Field capacity (%)	Wilting point (%)	Available water (%)	Bulk density gm/cm^3
17.30	9.00	8.30	1.64

Table 2: Diluted solutions as (ml/l) were prepared from stock solutions as M/L of water were added to irrigate olive plants in soil experiment during 2014 and 2015 growing seasons

Salt conc.	$CaCl_2$	$MgSO_4$	KCl	K_2SO_4	Na_2SO_4	NaCl	$Cl:SO_4$	SAR
3000 ppm	0.449	0.348	0.053	0.100	0.950	1.100	1:1	12
6000 ppm	1.050	1.250	0.050	0.250	1.550	1.850	1:1	12
9000 ppm	1.499	1.598	0.103	0.350	2.500	2.950	1:1	12

SAR: Ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration

At the end of season (late September) transplants of each treatment were carefully pulled from the pots, the roots were washed and used for estimating the following parameters:

Growth Parameters: Stem length (cm) and its rate of increase [the difference between stem length at the start and end of experiment (cm/season)]. Average number of leaves per transplant. Average leaf area (cm^2) using area meter. Assimilation area (cm^2/transplant). Fresh and dry weights (g) of the three plant organs (leaves, stem and root system) for each transplant. Fresh/dry weight ratio.

Chemical Constituents

Proline and Total Sugars Contents: Leaf proline content (g/100 g fresh weight): was determined in fresh leaves according to the method described by Bates *et al*. [17]. Total soluble sugars (mg/g dry weight): were determined colorimeterically in leaf dry matter according to the method of Dubois *et al*. [18].

Photosynthetic Pigments Content: Leaf photosynthetic pigments were extracted by pure acetone. Chlorophyll a and b as well as carotene were determined as described by Wettstein [19].

Chl. A = (9.784 x E 662) – (0.99 x E 644) = mg/L.
Chl. B = (21.426 x E 644) – (4.650 x E 662) = mg/L.
Carotenoids = (4.685 x E 440) – (0.268 x chl.a + chl. b) = mg/L.

Leaf salinity hazard coefficient (L.S.H.C.). This value as determined according to be formula:
L.S.H.C. = [Total soluble sugars/chlorophyll (a + b)] x Carotenoids
As described by Fadl and Sari El-Deen [20].

Leaf Minerals Content: Leaf contents of N, P, K, Na and Cl were determined as follows:

Total nitrogen: was determined by the modified micro-kjeldahl method as described by Pregl [21].

Total Phosphorus: was carried out by spekol spectrophotometer at 882 U.V. according to the method described by Murphy and Riely [22].

Potassium and sodium: were determined by Atomic amission analysis according to A.O.A.C. [23].

Chloride: was extracted from ash samples with hot water titrated with standard silver nitrate solution and then determined according to Murphy and Riely [22].

Leaf Physiological Characteristics

Leaf Osmotic Potential (L.O.P.): Adequate leaf samples were immediately frozen. The cell sap was then extracted in the laboratory with a piston pressure. When the frozen tissue has been thawed. The sap total soluble solids were determined by refractometer and the equivalent values of the osmotic pressure (in bars) were estimated according to Gusov [24].

Leaf Succulence (L.S.G.): It was estimated as grams H_2O/cm^2 of leaf according to the following equation as described by Poljakoff and Mayber [25].

$$(L.S.G.) = \frac{Leaf\ fesh\ weight - leaf\ dey\ weight}{Leaf\ area\ (cm)^2} = g\ water\ content / (dec)^2 leaf\ area$$

Anatomical Structure: Fresh samples (the fourth leaf from the top plant from of mature leaves) were taken at the end of the experimental period (2015), cleaned from dust and immediately killed and fixed in formalin-acetic-alchol (FAA) solution. Then, dehydrated with N-butanol and paraffin wax (56-58°C) for inflitration and embedding. Serial transverse section of 10 micron thickness were prepared using a rotary microtome. Saffranin and fast green stains technique were followed then the cross section washed in absolute ethanol and cleared in xylol and mounted in Canada balsam [26].

The parameters were Epidermis thickness (upper and lower); upper palisade tissue (thickness); spongy tissue (thickness); lower palisade tissue (m) (thickness) and blade thickness were measured.

Statistical Analysis: All the obtained data in this study were statistically analyzed using the factorial experiment (2 factors) using Analysis of Variance method according to Snedecor and Cochran [27]. However, means were distinguished by the Duncan's multiple test range test for means comparison [28].

RESULTS AND DISSUSSIONS

Growth Parameters: In this regard stem length (cm), number of leaves/plant, leaf area (cm^2) leaf area (cm^2)/plant, both fresh and dry weight ratio and leaf fresh weight were the thirties growth measurements of jojoba transplants investigated pertaining their response to the specific effect of investigated variables of each studied factors i.e., (3 clones of jojoba plants and 3 salinity concentrations in irrigation solution) as well as interaction effect of (9) combinations between 3 variables of both investigated factors.

Stem Length, Rate of Increase, Number of Leaves/transplant, Leaf Area and Leaf Assimilation Area: Regarding the specific effect of the three Jojoba clones under study, data in Table (3) displayed that the five characters abovementioned were responded specifically to the different investigated Jojoba clones during both 2014 and 2015 seasons. Whereas the greatest and the highest significant values exhibited by Fg24, while, the last values of aforesaid 5 characters were significantly induced by Fg22 which was statistically the inferior during 2014 and 2015 seasons.

Concerning the specific effect of salinity concentrations, data in the same Table revealed that, the three concentrations of saline solutions i.e., (3000, 6000 and 9000 ppm) resulted in an obvious decrease in stem length, rate of increase in stem length, number of leaves/transplant, leaf area and leaf assimilation area during the first and second seasons of study. Such decrease was significant as compared to transplants irrigated with tap water (control) from one hand and the differences between the three salinity concentrations were significant as each compared to the two other ones from the another. Moreover, data show that the saline solution at 9000 ppm concentration in irrigation water had the greatest depressive effect on tested characters while, 3000 ppm concentration resulted in the lowest decrease. Meanwhile, the treatment of 6000 ppm was an intermediate in this respect. Such trends were true during both first and second seasons and with investigated three jojoba clones under study. Furthermore, in all cases, data indicated clearly that, the control treatment resulted significantly in the highest and the greatest values of all abovementioned investigated five characters during the two seasons of study.

As for the interaction effect, data in Table (3) showed obviously that, the combination treatment between (control x Fg24) exhibited statistically the highest values in stem length, rate of increase and leaf area. However, the control x Fg10 was statistically the superior as exhibited the greatest values of number of leaves/ transplant and assimilation leaf area during both seasons of study. On the other hand, the opposite trend was observed with (9000 ppm x Fg22) which was always resulted significantly in the least values of all investigated abovementioned characters in both seasons of study.

These results are agree with Bernstein *et al.* [29] who pointed out that the accumulation of specific ions such as sodium and chloride in different plant tissues would probably exert an inhibitory effect on plant growth and development. Also, in this observation, is coinciding with Benzioni *et al.* [30] on Jojoba clones irrigated with saline water.

Fresh and Dry Weights of Leaves, Stem and Root as Well as Fresh/dry Weight Ratio: With regard to the fresh and dry weights of stem and root as well as leaves dry weight only in response to specific effect of different salinity concentrations. Tables (4 and 5) indicated clearly that,

Table 3: Response of three jojoba clones transplants to different concentrations of saline irrigation water and its effect on some vegetative growth measurements (stem length; rate of increase; No. of leaves/shoot, leaf area and leaf assimilation area during both 2014 and 2015 seasons

	Stem length (cm)				Rate of increase (cm)				No. of leaves/plant				Leaf area (cm^2)				Assimilation area (cm^2)/plant			
Treatments	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*
First season; 2014																				
Untreated	59.50ab	59.00b	60.00a	59.50A	19.50b	18.00d	21.40a	19.63A	270.0b	306.0a	275.0b	283.7A	6.90b	4.80e	7.40a	6.37A	1863.0c	2355.0a	2035.0b	2084.0A
3000 ppm	56.40d	54.30e	58.40c	56.37B	18.70c	17.10f	19.50b	18.43B	202.0f	134.0h	231.7d	189.2B	6.20c	5.10d	6.70b	6.00B	877.1g	283.4j	1776.0d	978.7B
6000 ppm	53.60f	50.60g	56.20d	53.47C	17.60e	16.33g	17.80de	17.24C	195.0g	110.0i	247.0c	184.0C	5.10d	3.90f	5.10d	4.70C	994.5f	429.0i	1260.0e	894.4C
9000 ppm	47.30i	46.40j	49.40h	47.70D	9.40i	8.70j	10.50h	9.53D	193.0g	87.00j	225.0e	168.3D	3.90f	2.80g	3.90f	3.53D	702.0h	243.5k	877.5g	607.7D
Mean**	54.20B	52.58C	56.00A		16.30B	15.03C	17.30A		215.0B	159.3C	244.7A		5.53B	4.15C	5.78A		1109.0B	827.7C	1487.0A	
Second season; 2015																				
Untreated	62.70b	61.80c	64.00a	62.83A	21.80c	20.90f	21.80c	21.50A	282.0c	426.0a	294.0b	234.0A	7.20b	6.20d	7.80a	7.07A	2030.0c	2641.0a	2293.0b	2322.0A
3000 ppm	58.40e	57.80f	62.80b	59.67B	21.10e	22.90b	19.70g	21.23B	224.0f	155.0i	285.0c	221.3B	6.50c	5.50e	7.10b	6.37B	1456.0f	852.5i	2024.0d	1444.0B
6000 ppm	56.40g	55.90g	61.70c	58.00C	24.60a	20.90f	19.20h	21.57A	214.0g	137.0j	269.0d	206.7C	5.10f	4.20g	5.60e	4.97C	1091.0g	575.4k	1506.0e	1058.0C
9000 ppm	54.80h	53.70i	59.40d	55.97D	21.40d	19.70g	21.20e	20.77C	194.0h	106.0k	248.0e	182.7D	3.90h	2.80i	4.20g	3.63D	756.6j	296.8l	1042.0h	698.3D
Mean**	58.08B	57.30C	61.98A		22.23A	21.10B	20.48C		228.5B	206.0C	274.0A		5.68B	4.68C	6.18A		1334.0B	1091.0C	1716.0A	

* and ** refer to the specific effect of investigated salt levels and clones, respectively. Capital letters were used for distinguishing between values in specific effect for each investigated factor. Meanwhile, small letters used for interaction effect of their combinations. Means followed by the same letters are not significantly different at 0.05 level.

Table 4: Response of three jojoba clones transplants to different concentrations of saline irrigation water and its effect on some vegetative growth measurements (stem fresh & dry weight and root fresh & dry weight) during both 2014 and 2015 seasons

	Stem fresh weight (g)				Stem dry weight (g)				Root fresh weight (g)				Root dry weight (g)			
Treatment	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*
First season; 2014																
Untreated	40.00b	40.00b	41.00a	40.33A	16.20d	16.40c	16.80b	16.47A	21.80c	22.40b	23.10a	22.43A	11.30c	11.80b	12.50a	11.87A
3000 ppm	37.00c	35.30d	39.40b	37.23B	15.40f	17.60a	15.70e	16.23B	19.20g	20.10e	20.70d	20.00B	10.40e	10.70d	10.70d	10.60B
6000 ppm	32.00e	31.70e	37.60c	33.77C	13.30i	13.50h	14.90g	13.90C	18.40i	17.00j	19.80f	18.40C	9.90f	9.10g	10.40e	9.80C
9000 ppm	25.00g	24.20h	27.30f	25.50D	10.60k	10.20l	11.10j	10.63D	16.60k	13.20l	18.70h	16.17D	8.90g	7.00h	9.80f	8.57D
Mean	33.50B	32.80C	36.33A		13.88C	14.43B	14.63A		19.00B	18.17C	20.58A		10.13B	9.65C	10.85A	
Second season; 2015																
Untreated	44.00b	43.60b	45.30a	44.30A	17.55b	17.30c	18.20a	17.68A	24.10b	23.50c	25.40a	24.33A	13.11b	12.98bc	14.20a	13.43A
3000 ppm	41.30d	41.00d	42.60c	41.63B	15.60e	15.30f	17.40bc	16.10B	21.20e	20.90f	22.90d	21.67B	11.70d	11.21e	12.80c	11.90B
6000 ppm	35.20g	34.90g	38.90e	36.33C	14.70g	13.90h	15.90d	14.83C	19.80g	19.40h	21.40e	20.20C	9.90g	9.84g	11.90d	10.55C
9000 ppm	28.60i	32.70h	36.80f	32.70D	12.90j	12.30k	13.60i	12.93D	17.30j	18.20i	19.80g	18.43D	8.40h	7.99i	10.20f	8.86D
Mean**	37.28C	38.05B	40.90A		15.19B	14.70C	16.27A		20.60B	20.50B	22.38A		10.78B	10.51C	12.27A	

* and ** refer to the specific effect of investigated salt levels and clones, respectively. Capital letters were used for distinguishing between values in specific effect for each investigated factor. Meanwhile, small letters used for interaction effect of their combinations. Means followed by the same letters are not significantly different at 0.05 level.

Table 5: Response of fresh & dry weights of leaves and fresh/dry weight ratio to different concentrations of saline irrigation water of three jojoba clones transplants during both 2014 and 2015 seasons

	Leaves fresh weight				Leaves dry weight				Fresh/dry weight ratio			
Treatment	Fg10	Fg22	Fg24	Mean*	F g 10	F g 22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*
First season; 2014												
Untreated	49.60h	48.10h	52.80f	49.83D	17.05c	16.83c	18.48a	17.45A	2.91j	2.86j	2.86j	2.87D
3000 ppm	50.30g	50.10g	56.70d	52.37C	16.96c	15.93e	17.81b	16.90B	2.97i	3.15h	3.18g	3.10C
6000 ppm	56.50d	55.70e	59.30b	57.17B	15.25f	14.43h	16.43d	15.37C	3.70e	3.86d	3.61f	3.72B
9000 ppm	59.80b	57.90c	61.20a	59.63A	13.75i	13.52i	14.83g	14.03D	4.35a	4.28b	4.13c	4.25A
Mean**	53.80B	52.95C	57.50A		15.75B	15.18C	16.89A		3.48B	3.54A	3.44C	
Second season; 2015												
Untreated	50.30h	49.20i	53.90e	51.13D	19.32b	18.53c	20.45a	19.43A	2.60k	2.66j	2.64j	2.63D
3000 ppm	52.70f	51.70g	54.90d	53.10C	18.43c	17.74d	19.62b	18.60B	2.86h	2.91g	2.80i	2.86C
6000 ppm	57.20c	53.90e	59.80b	56.97B	17.73d	16.31f	18.73c	17.59C	3.23e	3.30d	3.19f	3.24B
9000 ppm	60.10b	57.30c	62.40a	59.93A	16.31f	15.26g	17.25e	16.27D	3.68b	3.75a	3.62c	3.69A
Mean**	55.08B	53.03C	57.75A		17.95B	16.96C	19.01A		3.09B	3.16A	3.06C	

* and ** refer to the specific effect of investigated salt levels and clones, respectively. Capital letters were used for distinguishing between values in specific effect for each investigated factor. Meanwhile, small letters used for interaction effect of their combinations. Means followed by the same letters are not significantly different at 0.05 level.

the five abovementioned measurements followed typically the same trend during two seasons of study. However, the highest values of fresh and dry weights of both stem and root leaves dry weight were significantly in descending order by the lowest level of salinity concentration (3000 ppm). Moreover, an opposite trend was found with the highest level of salt concentration (9000 ppm) treatment which induced significantly the least values and lightest weights of fresh and dry of stem and root and leaves dry weight only. Furthermore, the greatest values of either leaves or leaf fresh weights and fresh/dry ratio were enclosed relationship with the highest salt concentration (9000 ppm) in irrigation water.

Referring the specific effect of various investigated Jojoba clones transplants on abovementioned eight growth characters, data in Table (4 and 5) revealed clearly that, the highest values of eight growth characters were always in concomitant with those transplants of Fg24 which the superior clone followed statistically in a descending order by Fg10 whereas, the transplants of Fg22 showed least values in this concern in most cases. Such trends were true during 2014 and 2015 seasons of study.

With regard to the interaction effect on eight growth parameters aforesaid, data presented in Tables (4 and 5) indicated obviously that, the specific effect of each factor (salinity levels and Jojoba clones) was directly reflected on their combinations during both seasons of study. Hence, the combination treatments of control x Fg24 fresh and dry weights of stem and root and leaves dry weight only during both seasons were resulted significantly in the greatest values. Meanwhile, an opposite trend was observed with the combination treatment of 9000 x Fg22 which exhibited statistically the least values in fresh and dry weights of stem and roots as well as leaves dry weight only during both the first and second seasons. On the other hand, the highest significant values in leaves fresh weight and both fresh/dry weight ratio and leaf fresh weight were inclosed relationship with those transplants irrigated with saline solutions at 9000 ppm concentration combined with either Fg24 or Fg22, respectively during both 2014 and 2015 seasons. However, the reverse trend was detected with transplants of Fg22 and Fg10 which were irrigated with tap water (control), since those two combinations induced significantly the least values of leaves fresh weight and both fresh/dry weight ratio and leaf fresh weight, respectively during both seasons. In addition to that, other combinations treatments came in between the abovementioned two extents with a tendency of variability in their effectiveness.

The present results regarding the influence of both different levels of salinity in irrigation water and jojoba plants on all the studied parameters of growth characteristics are in harmony with those reported by Marin *et al.* [31] under analyzed the tolerance of 26 olive (*Olea europaea* L.) cultivars; El-Said Marin *et al.* [32] on 14 olive cultivars; Chartzoulakis Marin *et al.* [33] on six olive cultivars; Laz [34] on Jojoba transplant and Kchaou Marin *et al.* [35] on five olive cultivars, found a broad genotypic variability to salt stress due to its closely associated with some physiological mechanism and morphological response.

These results coincide with, Benzioni Marin *et al.* [36] who showed that NaCl is preferentially accumulated in Jojoba leaves without causing visible damage. In this respect, jojoba resembles crops like cotton or typical halophytes Story and Jones [37]; Brugnoli and Bjorkman [38]. So, Benzioni Marin *et al.* [36] found that salts induced syntheses of additional organic material made only a small quantitative contribution to the total increase in fresh weight and the improved morphological appearance of the plant. Moreover, Al-Darweesh [39] pointed out that olive hybrids obtained from crossing between salt tolerant parents (Arbiquena, Picual and Hamed cvs.) revealed higher dry weight as compared with the originated from less salt tolerant ones (Kronaki and Aggizi cvs.).

Leaf Chemical Constituents:

Proline and Total Sugars Content: Referring both leaf contents of proline and total sugars, data in Table (6) showed clearly that, both chemical parameters followed typically the same trend during 2014 and 2015 seasons of study. Whereas, the highest values of proline and total sugars were significantly in concomitant to the higher level of salt concentration (9000 ppm) irrigated water. However, an opposite trend was detected with those transplants irrigated with saline water solutions at the lower concentration i.e., (3000 ppm). Moreover, the differences in both proline and total sugars contents were significant as three salinity concentrations in irrigation water (3000, 6000 and 9000 ppm) treatments were compared each other from one hand and control (tap water) which exhibited the least statistical values in both studied characters during the first and second seasons.

As for the response of both proline and total sugars to specific effect of three studied jojoba clones transplants in Table (6) that, both characters responded significantly. Whereas, Fg24 was generally induced the highest and greatest statistical values of proline and total

Table 6: Effect of irrigation with different concentration of saline water on proline and total sugars of three jojoba clones (2014/2015)

Treatment	Proline (µg/gm D.W.)				Total sugars (gm/100 gm D.W.)			
	Fg10	Fg22	Fg24	Mean*	Fg10	Fg 22	Fg24	Mean*
				First season; 2014				
Untreated	0.250i	0.210j	0.290h	0.250D	6.22h	5.73i	6.85g	6.27D
3000 ppm	0.290h	0.260i	0.320g	0.290C	7.63f	6.83g	7.83e	7.43C
6000 ppm	0.370e	0.350f	0.390d	0.370B	8.45c	7.91e	8.72b	8.36B
9000 ppm	0.480b	0.460c	0.510a	0.483A	8.64b	8.25d	8.94a	8.61A
Mean**	0.348B	0.320C	0.378A		7.74B	7.18C	8.09A	
				Second season; 2015				
Untreated	0.240gh	0.220h	0.270f	0.243D	6.41h	5.82i	6.91g	6.38D
3000 ppm	0.280f	0.260fg	0.310e	0.283C	7.72f	6.84g	7.87e	7.48C
6000 ppm	0.380c	0.350d	0.410b	0.380B	8.51c	7.93e	8.84b	8.43B
9000 ppm	0.440a	0.390bc	0.460a	0.430A	8.73b	8.35d	8.99a	8.69A
Mean**	0.335B	0.305C	0.363A		7.84B	7.24C	8.15A	

* and ** refer to the specific effect of investigated salt levels and clones, respectively. Capital letters were used for distinguishing between values in specific effect for each investigated factor. Meanwhile, small letters used for interaction effect of their combinations. Means followed by the same letters are not significantly different at 0.05 level

sugars and more effective than both Fg10 and Fg22 from standpoint of statistical view, respectively. Such trend was so firmer during both seasons of study. Moreover, the lowest values of both proline and total sugars contents were significantly exhibited and always in concomitant to those transplants of Fg22 during both 2014 and 2015 seasons.

It could be obviously noticed from data in Table (6) that, the specific effect of each investigated factor was directly reflected on their combinations, whereas as the combination treatment of (9000 ppm x Fg24) exhibited statistically the greatest values of both proline and total sugar contents. Meanwhile, contrary to that the combination treatment of (control x Fg22) resulted significantly in the least values. Such trend was true during both seasons of study. In addition to that, other combination treatments came in between aforesaid two extents with a variable tendency of effectiveness during both the first and second seasons of study.

The abovementioned results are in line with Bates *et al.* [17]; Stewart and Lee [40]; Petrosyan *et al.* [41]; El-Hefnawi [42]; Sweidan *et al.* [43]; El-Hammady *et al.* [44]; El-Sayed *et al.*[45] and Chartzoulakis Marin *et al.* [33] who mentioned that proline was increased gradually as levels of salinity raised; they also suggested that, proline function as a source of solids for intracellular osmotic adjustments under saline conditions.

Leaf Pigments Content (Chlorophyll A; B and Carotenoids): Data presented in Table (7) distinct the influence of the different investigated salinity concentrations in water irrigation solution on leaf pigments contents of Jojoba transplants, indicated obviously that, leaf pigments contents (chlorophyll a; b and carotenoids) were significantly responded to the investigated level of salt concentrations soil applied. There was a negative relationship between leaf pigments contents and salinity applied concentrations. In other words, leaf pigments contents were decreased significantly by increasing salts concentrations in water irrigation solutions. However, the richest leaves in their pigments contents (chlorophyll a; b and carotenoids) were statistically in closed relationship with those of control treatment (tap water) followed in a descending order by those transplants irrigated with 3000 ppm and 6000 ppm treatments, respectively. On the other hand, jojoba transplants irrigated with salinized water contains the higher concentration (9000 ppm) induced statistically the poorest leaves in their pigments contents as compared to either 3000 or 6000 ppm. Such trends were true during both seasons of study.

Considering the specific effect of jojoba clones on leaf pigments contents, data obtained in the same Table revealed that, Fg24 induced the greatest significant values of the leaf chlorophyll a and b as well as carotenoids contents than either Fg10 or Fg22, respectively. Whereas, transplants of Fg22 exhibited statistically the least values in this concern such trend was true during both 2014 and 2015 seasons of study.

Concerning the interaction effect data in Table (7) displayed clearly that, the transplants of (Fg24) irrigated with tap water (control) i.e., (Fg24 x control) combination treatment exhibited generally the highest significant values of leaf pigments contents during both 2014 and 2015 seasons of study. The superiority of the abovementioned combination treatment over the other

Table 7: Effect of irrigation with different concentrations of saline water on chlorophyll a, b and carotenoids % of three jojoba clones (2014/2015)

	Chlorophyll a (%)				Chlorophyll b (%)				Carotenoids (%)			
Treatment	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*
First season; 2014												
Untreated	1.430b	1.220c	1.710a	1.453A	0.870b	0.760c	0.960a	0.863A	0.520ab	0.490bc	0.580a	0.530A
3000 ppm	0.950d	0.810e	1.150c	0.970B	0.760c	0.730c	0.840b	0.777B	0.440c-e	0.380ef	0.460b-d	0.427B
6000 ppm	0.710f	0.630f	0.940d	0.760C	0.630d	0.590d	0.730c	0.650C	0.380ef	0.270gh	0.400de	0.350C
9000 ppm	0.530g	0.490g	0.710f	0.577D	0.490e	0.430f	0.620d	0.513D	0.320fg	0.250h	0.390e	0.320C
Mean**	0.905B	0.788C	1.128A		0.688B	0.628C	0.788A		0.415B	0.348C	0.458A	
Second season; 2015												
Untreated	1.240b	1.100c	1.400a	1.247A	0.820a	0.630c	0.840a	0.763A	0.510ab	0.470bc	0.530a	0.503A
3000 ppm	0.890d	0.790d	1.100c	0.927B	0.740b	0.540d	0.790ab	0.690B	0.430cd	0.410d	0.470bc	0.437B
6000 ppm	0.680e	0.620e	0.830d	0.710C	0.610c	0.410f	0.610c	0.543C	0.330e	0.320e	0.340e	0.330C
9000 ppm	0.510f	0.430f	0.620e	0.520D	0.470e	0.380f	0.540d	0.463D	0.240f	0.220f	0.250f	0.237D
Mean**	0.830B	0.735C	0.988A		0.660B	0.490C	0.695A		0.378AB	0.355B	0.398A	

* and ** refer to the specific effect of investigated salt levels and clones, respectively. Capital letters were used for distinguishing between values in specific effect for each investigated factor. Meanwhile, small letters used for interaction effect of their combinations. Means followed by the same letter's are not significantly different at 0.05 level

investigated ones was clearly observed during the two seasons of the experimental study. On the other hand, the combination of the transplants of Fg22 irrigated with saline solutions at 9000 ppm concentration was statistically the inferior. In addition to that, other combination treatments came in between with tendency of variability in their effectiveness. Such trend was detected during the first and second seasons.

The obtained results are in general agreement with those mentioned by Saad El-Deen *et al.* [46] on transplants of 14 olive cultivars. Moreover, Abo El-Khashab [47] on peach and olive seedlings; Shereen [48] on olive; Chartzoulakis Marin *et al.* [33] on jojoba transplant; El-Hammady *et al.* [44] and El-Tarawy [49] on olive all demonstrated that leaf chlorophyll a, b and carotenoids content of different olive cultivars and jojoba transplants, were decreased by salinity.

Leaf Mineral Content: Regarding the leaf N, P and K contents (%) of three jojoba transplants clones in response to specific effect of the different salt concentrations in the irrigation water. It could be observed from obtained data in Tables (8 and 9) that; there are a negative relationship between leaf mineral content (N, P and K) and salts concentrations. However, leaf contents of N, P and K were gradually decreased significantly with increasing salts concentrations in the irrigation water from 3000 ppm to 9000 ppm comparing of those transplants irrigated with tap water (control / non salinized water) which appeared to contain usually the higher levels of N, P and K than those irrigated with salinized ones during 2014 and 2019 seasons of study. On the other hand, an opposite trends were detected with leaf contents of Na and Cl as well as Na/k ratio. Data in the same Tables indicated clearly that the three studied saline solutions (3000, 6000 and 9000 ppm) resulted significantly in an obvious increase in leaf Na, Cl and Na/K ratio contents as compared to control. The differences between the three salinity concentrations were significant as each was compared to the two other ones during both experimental seasons of study.

With respect to the specific effect of various jojoba transplants clones on six characters abovementioned, results in Tables (8 & 9) revealed obviously that, the richest leaves in their contents of N, P, K, Na and Cl were statistically with those jojoba transplants of Fg24 followed in a descending order by those of Fg10 and Fg22 jojoba transplants, whereas leaves of the later clone (Fg22) were significantly the poorest leaves in their mineral (N, P, K, Na and Cl) contents. Such trends were true during both first and second seasons of study. On the other hand, the reverse trend was observed with specific effect of salts concentrations on Na/K ratio. Hence, the greatest ratio was resulted by the higher salinity concentration (9000 ppm) followed statistically in a descending order by 6000 ppm and 3000 ppm of salts concentrations. Moreover, control treatment (transplants irrigated with tap water) exhibited statistically the least value of Na/K ratio during both seasons of study. On the other hand, transplants of Fg22 was statistically the superior whereas, it resulted significantly in the highest value of Na/K ratio as compared to either Fg24 or Fg10 which were equally effective from the standpoint of statistic. Such trends were detected throughout first and second experimental seasons.

Table 8: Effect of irrigation with different concentrations of saline water on N; P and K of jojoba clones (2014/2015)

	N (%)				P (%)				K (%)			
Treatment	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*
					First season; 2014							
Untreated	2.25a	2.03bc	2.31a	2.20A	0.350b	0.230g	0.410a	0.330A	1.420b	1.100e	1.570a	1.363A
3000 ppm	1.93c	1.73de	2.09b	1.92B	0.300d	0.200h	0.320c	0.273B	1.350c	1.000f	1.420b	1.257B
6000 ppm	1.62e	1.45f	1.80d	1.62C	0.250f	0.150j	0.270e	0.223C	1.220d	0.920g	1.310c	1.150C
9000 ppm	1.40f	1.10g	1.69de	1.40D	0.150j	0.120k	0.170i	0.147D	1.050ef	0.850h	1.250d	1.050D
Mean**	1.80B	1.58C	1.97A		0.263B	0.175C	0.293A		1.260B	0.968C	1.388A	
					Second season; 2015							
Untreated	1.98ab	1.75c	2.05a	1.93A	0.390b	0.270d	0.430a	0.363A	1.350b	1.000f	1.490a	1.280A
3000 ppm	1.81c	1.65d	1.91b	1.79B	0.320c	0.240e	0.340c	0.300B	1.300bc	0.950f	1.320bc	1.190B
6000 ppm	1.50e	1.31f	1.54e	1.45C	0.270d	0.210f	0.280d	0.253C	1.210d	0.840g	1.270c	1.097C
9000 ppm	0.99h	0.76i	1.10g	0.95D	0.170gh	0.150h	0.190fg	0.170D	1.100e	0.750h	1.190d	1.013D
Mean**	1.57B	1.37C	1.65A		0.288B	0.218C	0.310A		1.240B	0.878C	1.317A	

* and ** refer to the specific effect of investigated salt levels and clones, respectively. Capital letters were used for distinguishing between values in specific effect for each investigated factor. Meanwhile, small letters used for interaction effect of their combinations. Means followed by the same letter's are not significantly different at 0.05 level.

Table 9: Effect of irrigation with different concentration of saline water on Na; Na/K and Cl of jojoba clones (2014/2015)

	Na				Na/K				Cl			
Treatment	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*	Fg10	Fg22	Fg24	Mean*
					First season; 2014							
Untreated	0.18g	0.17g	0.19g	0.18D	0.127i	0.155i	0.121i	0.134D	0.25f	0.23f	0.27f	0.25D
3000 ppm	1.01f	0.98f	1.31e	1.10C	0.749h	0.980g	0.921g	0.883C	1.35de	1.22e	1.51d	1.36C
6000 ppm	1.60d	1.59d	1.93c	1.71B	1.311f	1.727d	1.473e	1.504B	1.68c	1.51d	1.79c	1.66B
9000 ppm	2.44ab	2.34b	2.53a	2.44A	2.326b	2.757a	2.025c	2.369A	2.29b	2.23b	2.55a	2.36A
Mean**	1.31B	1.27B	1.49A		1.128B	1.405A	1.135B		1.39B	1.30C	1.53A	
					Second season; 2015							
Untreated	0.22i	0.19i	0.25i	0.22D	0.163f	0.190f	0.167f	0.173D	0.20h	0.19h	0.21h	0.20D
3000 ppm	1.21g	0.99h	1.34f	1.18C	0.931e	1.042e	1.015e	0.996C	1.24f	0.99g	1.39ef	1.21C
6000 ppm	1.62d	1.49e	1.64d	1.58B	1.339d	1.839c	1.291d	1.490B	1.69cd	1.52de	1.74c	1.65B
9000 ppm	2.23b	2.01c	2.41a	2.22A	2.027b	2.687a	2.025b	2.246A	2.41b	2.31b	2.65a	2.46A
Mean**	1.32B	1.17C	1.41A		1.115B	1.440A	1.124B		1.39B	1.25C	1.50A	

* and ** refer to the specific effect of investigated salt levels and clones, respectively. Capital letters were used for distinguishing between values in specific effect for each investigated factor. Meanwhile, small letters used for interaction effect of their combinations. Means followed by the same letters are not significantly different at 0.05 level

Concerning the interaction effect on leaves content of N, P, K, Na, Cl and Na/K ratio, data in Tables (8 and 9) indicated obviously that, the specific of each factor (salts concentrations and three jojoba clones) was directly reflected on their combinations during both seasons of study. Since, the combination treatment of control x Fg24 was significantly the most effective in increasing the leaf N, P and K contents whereas, the combination treatment of 9000 ppm x Fg22 induced the poorest leaves in their N, P and K contents. Meanwhile, the other combinations were in between the abovementioned two extents during both seasons. Such trends were detected during both seasons of study. On the other hand, the combination treatments of either 9000 ppm x Fg24 or 9000 x Fg22 exhibited generally the highest significant values of leaf Na x Cl or Na/k ratio content, respectively during 2014 and 2015 seasons. Whereas, the opposite trend was true with those combination treatments of control x Fg24 and control x Fg22 resulted statistically in the lowest values of leaves Na/K ratio and Na and Cl contents, respectively.

The obtained results regarding the response of leaves content of N, P, K, Na, Cl and Na/K ratio to salts concentrations are in accordance with those mentioned by Bernstein *et al.* [29] on jojoba; El-Hammady *et al.* [44] on olive and Chartzoulakis Marin *et al.* [33] on jojoba transplants.

Leaf Physiological Characteristics [Leaf Osmotic Potential (LOP) and Leaf Succulence Grad (L.S.G.)]: According to leaf osmotic potential and leaf succulence

Table 10: Effect of irrigation with different concentration of saline water on leaf osmotic potential and leaf succulence grade of jojoba clones (2014/2015)

Treatment	Leaf osmotic potential				Leaf succulence grade			
	Fg10	F g 22	Fg24	Mean*	Fg10	F g 22	Fg24	Mean*
				First season; 2014				
Untreated	13.22h	13.05h	14.53g	13.60D	0.250g	0.210h	0.290f	0.250D
3000 ppm	15.47e	15.03f	15.96d	15.49C	0.290f	0.270fg	0.340e	0.300C
6000 ppm	16.92c	16.23d	17.05c	16.73B	0.470c	0.380d	0.620b	0.490B
9000 ppm	18.21a	17.89b	18.43a	18.18A	0.730a	0.620b	0.750a	0.700A
Mean**	15.95B	15.55C	16.49A		0.435B	0.370C	0.500A	
				Second season; 2015				
Untreated	12.74g	12.13h	13.93f	13.93D	0.230gh	0.200h	0.280f	0.237D
3000 ppm	14.86e	14.12f	15.93d	14.97C	0.270fg	0.250fg	0.360e	0.293C
6000 ppm	15.92d	14.99e	16.24c	15.72B	0.410d	0.400de	0.590c	0.467B
9000 ppm	17.88a	16.91b	18.13a	17.64A	0.650ab	0.630bc	0.690a	0.657A
Mean**	15.35B	14.54C	16.06A		0.390B	0.370B	0.480A	

* and ** refer to the specific effect of investigated salt levels and clones, respectively. Capital letters were used for distinguishing between values in specific effect for each investigated factor. Meanwhile, small letters used for interaction effect of their combinations. Means followed by the same letters are not significantly different at 0.05 level

grade of the three jojoba clones in response to the. specific effect of salts concentrations in soil irrigation water, data in Table (10) indicated that, there are a positive relationship between salt concentrations applied and both leaf abovementioned character. In other words, both characters were increased significantly by increasing the applied rate of salinity. However, the highest values in their both osmotic potential and succulence grad were statistically with transplants applied with 9000 ppm followed in a descending order by 6000, 3000 and 400 ppm treatments, respectively. Since, leaves in the latter level (control treatment) were significantly the poorest and the least values in this respect. Such trend was true during both 2014 and 2015 seasons of study.

Regarding the response to specific effect of jojoba clones data obtained in the same Table revealed that, transplants of Fg24 clone induced leaves with the highest significantly of both leaf studied characters than both other clones (Fg10 and Fg22). In other words, Fg24 exhibited statistically the highest values of both osmotic potential and leaf succulence grad as compared to either clones Fg10 and Fg22 during both seasons of study. On the other hand, transplants of clone Fg22 were statistically the inferior as resulted significantly in the lowest values of both aforesaid leaf characters. Such trend was detected during both experiment seasons of study.

As for the interaction effect (clones x salt concentration) on both leaf osmotic potential and succulence grade, Table (10) displayed clearly that, the specific effect of each investigated factor was reflected on interaction effect of its combinations. However, transplants of both Fg24 and Fg10 irrigated with 9000 ppm treatments tended to relatively more effective than the other combinations treatments. On the contrary, jojoba transplants of Fg22 irrigated with tap water (400 ppm) combination treatment was always in concomitant to the lowest values from standpoint of statistic of both physiological characters under study. Such trend was true during both 2014 and 2015 seasons of study.

These results are in harmony with those reported by David *et al.* [50] and Hsiao *et al.* [51] and Chartzoulakis Marin *et al.* [33] who pointed that raising the concentration of NaCl in hydroponic solutions resulted in greater osmotic potential and leaf succulence (mg H_2O cm^{-2}).

Leaf Anatomical Structure: Average thickness of different tissues of mature jojoba leaf blade, in addition to anatomical structure of leaf mesophyll tissues as affected by salinity treatments are presented in Table (11) and Figure (1).

Epidermis Thickness

Upper Epidermis Thickness: Upper epidermis also showed Data presented in Figure (1) the same trend of increase in the thickness of the lower epidermis of jojoba leaves applied the saline water 9000 ppm than the control plants (irrigated with tap water). The highest increase was recorded with Fg24 clone (79.75%) compared with the other clones Fg10 (14.57%) and Fg22 (11.67%), respectively.

Table 11: Effect of irrigation with different concentrations of saline water on leaf anatomy of jojoba clones (x=40).

	Epidermis thickness							
	Upper				Lower			
Treatments	Fg10	Fg22	Fg24	Mean	Fg10	Fg22	Fg24	Mean
Untreated	91.3	84.8	71.1	82.40	80.21	80.1	80.4	80.24
3000	94.7	86.8	76.5	86.00	80.6	80.1	82.3	81.00
6000	97.5	90	81.9	89.80	86.15	83.9	89.25	86.43
9000	104.6	94.7	127.8	109.03	149.5	121.5	152.7	141.23
Mean	97.03	89.08	89.33		99.12	91.40	101.16	

	Upper palisade tissue thickness			
	Fg10	Fg22	Fg24	Mean
Untreated	245.00	247.50	248.70	247.07
3000	260.50	282.20	294.20	278.97
6000	283.50	290.90	315.80	296.73
9000	299.00	301.60	344.40	315.00
Mean	272.00	280.55	300.78	

	Spongy tissue thickness			
	Fg10	Fg22	Fg24	Mean
Untreated	155.70	150.30	124.00	143.33
3000	145.60	131.90	119.60	132.37
6000	135.40	117.00	113.90	122.10
9000	120.00	90.00	107.30	105.77
Mean	139.18	122.30	116.20	

	Lower palisade tissues thickness			
	Fg10	Fg22	Fg24	Mean
Untreated	255.60	257.20	206.10	239.63
3000	260.20	260.50	216.70	245.80
6000	262.60	260.90	226.80	250.10
9000	281.20	267.30	292.50	280.33
Mean	264.90	261.48	235.53	

	Blade thickness (mm)			
	Fg10	Fg22	Fg24	Mean
Untreated	763.1	767.9	789.7	773.6
3000	786.2	776.2	796.1	786.2
6000	791.6	778.7	802.5	790.9
9000	877.0	870.8	936.0	894.6
Mean	804.5	798.4	831.1	

Lower Epidermis Thickness: The results also showed an increase in the thickness of lower epidermis due to salinity treatments. The highest increase was recorded in the plants irrigated with saline water 9000 ppm in Fg24 clone (152.7 mm), meanwhile it was only (121.5 mm) in Fg22 clone.

This result goes in line with that found by El-Tarawy [52], Chartzoulakis Marin *et al.* [33] and El-Tarawy [53] on some olive cultivars and jojoba transplants.

Mesophyll Tissue Thickness

Upper Palisade Tissue Thickness: Figure (1) indicated that response to the differential investigated saline water concentrated were too slight to be taken into consideration, except with the severest saline water (9000 ppm). Whereas, the highest increase was recorded with clone Fg24 (38.48 %) followed by clone Fg10 (22.04 %) then clone Fg22 (21.09 %), respectively. The examined sections also show that thickness of upper palisade tissue layers were increased in severs saline water.

This result is in general agreement with that previously found by Chartzoulakis Marin *et al.* [33] and El-Tarawy [52] on jojoba transplants.

Spongy Tissue Thickness: Data presented in Figure (1) show that Spongy tissue thickness was decreased with saline water treatments compared with control (tap water treatment) and decreased in saline water

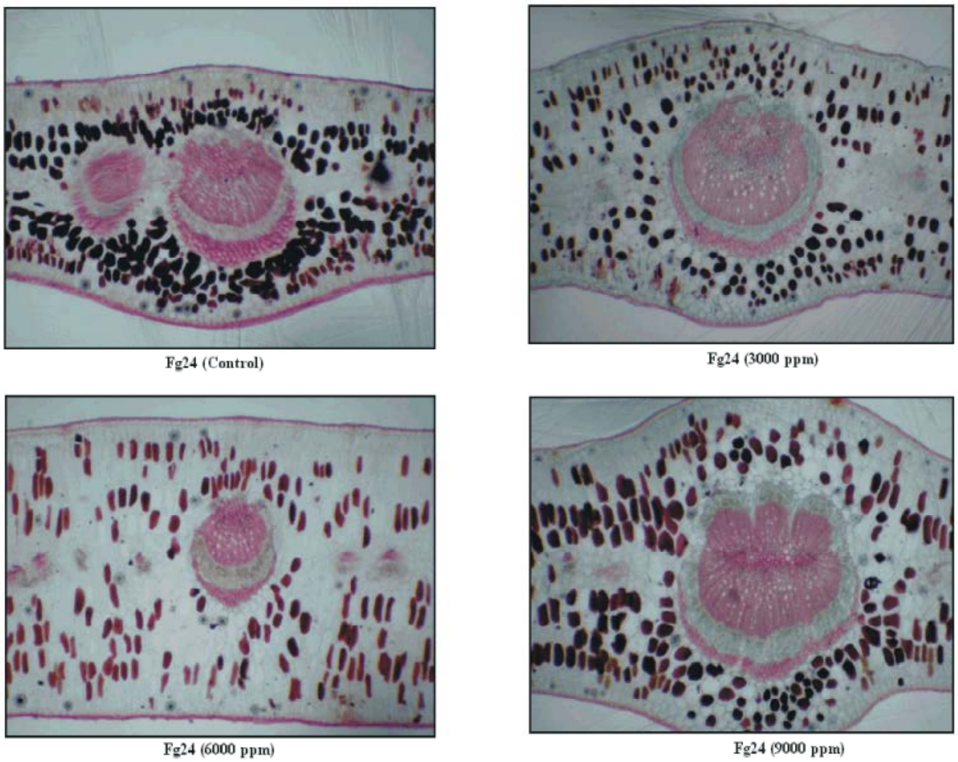

Fig. 1: Effect of irrigation with different concentration of saline water on the anatomy of the jojoba leaf colne Fg24

treatment (9000 ppm) for Fg22 clone (40.20%), meanwhile Fg24 clone had the lowest decreases in spongy tissue (13.47 %) and Fg10 clone was in between (22.92%).

This result is in general agreed with that previously found by Hsiao *et al.* [51]; Chartzoulakis Marin *et al.* [33] and El-Tarawy [52] some olive cultivars and jojoba transplants.

Lower Palisade Tissue Thickness: From this investigation it was found that the response of lower palisade tissue thickness to saline water treatments showed the same behavior of the upper palisade tissue and so, an increase in thickness of palisade tissue layer was detected by increasing of saline water treatment (9000 ppm). Meanwhile, the Fg24 clone was the highest thickness of lower palisade tissue (41.92%) under the same treatments.

This result is in harmony with that previously by Chartzoulakis Marin *et al.* [33] and El-Tarawy [52] on jojoba plant and transplants.

Blade Thickness: The cross sections and measurements record in Table (10) and Figure (1) revealed the increase in the jojoba leaves blade thickness with the increase in salinity compared to the control plants irrigated with tap water. The highest increase due to salinity treatments was recorded for Fg24 clone (18.53%) especially at 9000 ppm.

This result is in general agreed with that previously found by David *et al.* [50] and Hsiao *et al.* [51] on olive, Chartzoulakis Marin *et al.* [33] and El-Tarawy [52] on jojoba plant and transplants.

CONCLUSION

We can conclude from this study that jojoba seedlings can grow in areas with high salinity irrigation water and clone F24 which can survive on high concentrations of saline water (up to 6000 ppm) can be recommended to expand its cultivation in these areas. Moreover, jojoba is an important crop for expansion in the new reclamation areas in Egypt.

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