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EFFECT OF DIFFERENT SALINITY LEVELS ON VEGETATIVE GROWTH AND CHEMICAL CONTENTS OF JOJOBA(*Simmondsia chinensis*) Seedlings

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ABSTRACT

Two pots experiments had done at Faculty of Agriculture's Nursery in Mansoura University , Mansoura city , Egypt . In two summer seasons (2011 and 2012) to study the effect of Sodium chloride salinity levels on (vegetative growth) and (chemical contents) of Jojoba (*Simmondsia chinensis*) seedlings .

Five treatments were arranged in complete block randomize with five salinity levels the control (Tap water) , 2000 , 5000 , 7000 and 10000 PPM .

The most important finding could be summarized as follows:

- The increasing of the salinity from 2000 to 10000 PPM decreased all plant vegetative growth characters and the total chlorophyll content compared to control .
- A marked increasing in the ion leakage , the protein carbonyl group and the lipid peroxidation number in both seasons with the salinity increasing from 2000 to 10000 PPM compared to control .

Keywords: salinity, plant growth, lipid peroxidation, chlorophyll content and Jojoba plant.

INTRODUCTION

Jojoba (*Simmondsia chinensis*) is considered one of the new industrial crops. Selection over years has produced clones having potential seed yield of 3-4 ton/ha^{-1}. Some of these clones are currently being planted in large areas in different countries (Benzioni, 1995).

Jojoba pronounced Ho-Ho-ba or Hoe-Hoe-buh, also called Goat nut, which belongs to the family *Simmondiaceae*, endemic to the Sonora desert of the South-Western of USA and the North- Western of Mexico (Hogan *et al*., 1980).

Jojoba is the ideal substitute for the oil of the Sperm whale. It is classified as an oil seed crop. The seed-oil is used in lubricants, cosmetics, pharmaceuticals, and as a replacement for sperm oil in manufacturing of inks, varnishes, waxes, detergents, resins and plastics. Jojoba oil also filled in as additives to motor oil, transmission oil and differential gear oil. The ability of the oil to withstand high temperatures and carry away large amounts of heat from gear systems was a definite plus for aircrafts. It boils at 398 □C, it is anti-oxidant, it does not become rancid, and can be stored for 25years. (El-Mogy , 1999).

Jojoba particularly tolerates salinity up to 3,000 PPM without any impact to the yield . Salinity of 3,000-10,000 PPM , would negatively affect the plant (El-Mogy, 1999) .

Salinity is a major problem that negatively affects agricultural activities in many regions in the world, especially the Near East and North Africa region. (Zhu, 2001).

Sodium chloride which is the main salt saline water plays an important role through ionic Na that is absorbed by plants in this form. Thus, as salinity is a condition of excess salts in soil solution, it affects plant by increasing in the osmotic pressure of the soil solution, reducing water availability, inducing drought, interfering with normal nutrients uptake, influencing the respiratory pathways in roots and inducing ionic toxicity resulting from the accumulation of Cl in the cytoplasm or a poplast which interferes with plant metabolic functions. (Pascal and Barbieri, 1995).

In spite of information showing that jojoba tolerates fairly high levels of salinity , the selections to date have not been intended for use in regions with extremely high levels of salinity . (Benzioni *et al.,* 1996).

The aim of the search is studying the effect of the different salinities levels on the young seedlings of Jojoba (The vegetative growth and the chemical contents) for knowing what is the highest salinity which the seedlings will effect with that and will show that in results .

MATERIALS AND METHODS

Two pots experiments were carried out at Faculty of Agriculture's Nursery, Mansoura University, Mansoura city , Egypt . During the two summer seasons of 2011 and 2012 to investigate the effect of salinity levels on growth and chemical content of jojoba seedlings (*Simmondsia chinensis*). The Jojoba seedlings were transported from a Jojoba's Farm in Alqassaseen city, Alismailia Governorate, Egypt.

The Jojoba seedlings were around 18 cm with healthy green shape , were 135 plants and were divided into 5 treatments , Each treatment was divided into 3 replicates , Each replicate was contained 9 plants (5 X 3 X 9 = 135 seedling).

The seedlings were put in a mixture soil (1 : 1 clay : sand) , in uniform pots , their sizes were (20 cm) , the whole plants were put in the shadow .

The next results show the analysis of the clay :-

	Soil characters	The amounts
Mechanical analysis (%)	Coarse sand	2.76 %
	Fine sand	17.03 %
	Silt	29.65 %
	Clay	50.56 %
	E.C. $dS.m^{-1}$(past extract)	2.76 $dS.m^{-1}$
	pH (paste)	8.17 PH
	S.P. %	62 %
	O.M. %	1.63 %
	T. $CaCO_3$ %	2.72 %
Available (mg/kg)	N	46.2 mg/kg
	P	5.8 mg/kg
	K	275 mg/kg

The treatments were irrigated by different NaCl concentrations (2000, 5000, 7000 and 10000 PPM of sodium chloride while the control treatment was irrigated with Tap water) .

The salinity of the tap water was 295.04 PPM .

The experiment was carried out from 15th July to 30th October during the two seasons of 2011 and 2012 .

Salty water doses were given to the seedlings once a week at a rate of 100 ml to each seedling .

The samples were collected every about 15 days during the two seasons .

Data were recorded as follows:-

The vegetative growth:-

- **The Plant height (cm):-** All the seedlings heights were admeasured by the ruler from the soil crust to the highest point on the plant
- **The number of leaves / plant** .
- **The Leaf area / plant (cm^2)**:- It was measured in (cm2), by (IMAGEJ) program , Its version is 1.4 (32-bit) (M.D. Abramoff *et al* 2004).
- **The total chlorophyll contents_** :- Freeze-dried samples were added to 5 ml DMF (dimethylformamide) . The suspension was sonicated for 15 min at 4 ◌̊C and then stored at 4 ◌̊C for 16 hours to allow the DMF (dimethylformamide) to leach the pigments from the sample.

Finally, 1 ml of the supernatant was centrifuged for 5 min at 16000 rpm and 4 ◌̊C to remove any suspended material and the clarified supernatant was then analyzed by spectrophotometer on 662 nm (E 662) and on 650 nm (E 650) **(Arafat, 2005)**

E 662:- The spectrophotometer's result at 662 nm (nanometer) when the sample treats with DMF (dimethylformamide) .

E 650:- The spectrophotometer's result at 650 nm (nanometer) when the sample treats with DMF .

The total chlorophyll content= (17.67 X (E 650)) + (7.12 X (E 662)) (Porra., 2002)

.**The chemical analysis :-**

-The ion leakage % :- 5 g sample was added to 10 ml of (4 mole) manitol alcohol and then we calculated the conductivity by EC meter after 3 hours and after 24 hours and then calculated the Ion leakage percentage .

Ion leakage % = (Conductivity after 3 hours / Conductivity after 24 hours) x 100 (Arafat, 2005).

-The Protein carbonyl group :- (PCG) :- 2.5 g sample was added to 10 ml of potassium phosphate solution then we centrifuged them for 16 minutes (5000 rpm) . 1 ml of the isolated liquid is taken and added to .5 ml of a mixture composed of (2,4 dinitrophinylhydrazine + Hcl 34%+ pure water till 1 litre) and leave them 1 hour then shake them every 15 minutes then add .5 ml of a solution (Trichloroacetic acid 20%). Then centrifuge the mixture for 7 minutes (5000 rpm) then take the precipitate and wash it 3 times with (Ethanol alcohol : Ethyl acetate 1 : 1) then add .6 ml of Guanidine solution and leave the mixture for 15 minutes then the mixture is put into spectrophotometer at wavelength (390 nm (nanometer)) then the results are put into the next equation :-

PCG = ({OD at 390 nm} X 48.52) / 1.8 (Arafat, 2005)

Lipid peroxidation number:- (LPN**)** 2.5 g samples were ground in a mortar and mixed with 25 ml of 5% (w/v) metaphosphoric acid, 2% (w/v) butylated

hydroxyltoluene in ethanol, and finally homogenized by a mixer. The homogenates were filtered and centrifuged at 15000 rpm for 20 min. Then chromogen was formed by mixing 1 ml of the supernatant solution + butylated hydroxyl toluene 100 ml micron + (.5 ml of 1% TBA Thiobarbituric acid) in 50 mm (NaOH + .5 ml Hcl 25%)) and incubating the reaction mixture at 95 c for 30 minutes and the resulting liquid is put into Spectrophotometer at wavelength 532 nm (OD) and the resulting numbers are put into the next equation .

LPN = (.1147) X (OD) Whereas :-

(LPN):- Is the lipid peroxidation number.

(OD):- Is the Spectrophotometer reading of the sample at 532 nm **(Arafat, 2005).**

All data were statistically analyzed according to the technique of analysis variance (ANOVA) and the least significant difference (LSD) method was used to compare the difference between the means of treatment values to the methods described by Gomez and Gomez, (1984) All statistical analyses were performed using analysis of variance technique by means of Costate Computer Software . The experiment was complete blocked randomize and the statistical analysis follows that experiment(complete blocked randomize).

RESULTS AND DISCUSSION

Plant growth parameters:-

Plant height (cm) :-

From table (1) can be seen that the plant's height becomes lower at the highest salinity and becomes higher at the lower salinity that's where in the first treatment (the control) the results after 15 days were (16.63 cm in the 1st season , 22.71 cm in the 2nd season) compared to 120 days (22.49 cm in the 1st season , 27.33 cm in the 2nd season) show that the increasing percentage were about 35.2 % in the first season and 20.3 % in the second season while the treatment 10000 PPM after 15 days were (19.15 cm in the 1st season , 24.56 cm in the second season) compared to after 120 days (20.94 cm in the 1st season , 25.26 cm in the 2nd season) show that the increasing percentage were 9.3 % in the first season and 2.85 % in the second season . .

When comparing all the increasing percentages we found that the treatment (control :- Tap water) was the highest number then the treatment (2000 PPM) then the treatment (5000 PPM) then the treatment (7000 PPM) then the treatment (10000 PPM) was the lower number . .

Number of leaves :-

Table number 2 shows that the number of leaves becomes lower at the highest salinity and becomes higher at the lower salinity that's where in the first treatment (the control) the results after 15 days were (18.33 leaves in the 1st season , 41.61 leaves in the 2nd season) compared to 120 days (29.95 leaves in the 1st season , 53.90 leaves in the 2nd season) show that the increasing percentage were about 63.4 % in the first season and 29.53 % in the second season while the treatment 10000 PPM after 15 days were

(17.22 leaves in the 1st season , 26.57 leaves in the second season) compared to after 120 days (14.91 leaves in the 1st season , 26.92 leaves in the 2nd season) show that the increasing percentage were -13.4 % in the first season and 1.3 % in the second season .

When comparing all the increasing percentages we found that the treatment (control :- Tap water) was the highest number then the treatment (2000 PPM) then the treatment (5000 PPM) then the treatment (7000 PPM) then the treatment (10000 PPM) was the lower number .

The leaf area (cm2) :-

In the table (3) can be seen that the leaf area becomes lower at the highest salinity and becomes higher at the lower salinity that's where in the first treatment (the control) the results after 15 days were (13.75 cm2 in the 1st season , 17.27 cm2 in the 2nd season) compared to 120 days (14.94 cm2 in the 1st season , 18.46 cm2 in the 2nd season) show that the increasing percentage were about 8.7 % in the first season and 6.89 % in the second season while the treatment 10000 PPM after 15 days were (15.25 cm2 in the 1st season , 17.86 cm2 in the second season) compared to after 120 days (15.53 cm2 in the 1st season , 18.14 cm2 in the 2nd season) show that the increasing percentage were 1.8 % in the first season and 1.56 % in the second season .

When comparing all the increasing percentages can be seen that the treatment (control :- Tap water) was the highest number then the treatment (2000 PPM) then the treatment (5000 PPM) then the treatment (7000 PPM) then the treatment (10000 PPM) was the lower number .

The total chlorophyll :-

In the next table number 4 can be seen that the total chlorophyll becomes lower at the highest salinity and becomes higher at the lower salinity that's where in the first treatment (the control) the results after 15 days were (19.21 mg/g in the 1st season , 20.55 mg/g in the 2nd season) compared to 120 days (20.62 mg/g in the 1st season , 21.96 mg/g in the 2nd season) show that the increasing percentage were about 7.3 % in the first season and 6.86 % in the second season while the treatment 10000 PPM after 15 days were (18.83 mg/g in the 1st season , 20.17 mg/g in the second season) compared to after 120 days (14.22 mg/g in the 1st season , 15.56 mg/g in the 2nd season) show that the increasing percentage were -24.5 % in the first season and -22.86 % in the second season .

When comparing all the increasing percentages can be seen that the treatment (control :- Tap water) was the highest number then the treatment (2000 PPM) then the treatment (5000 PPM) then the treatment (7000 PPM) then the treatment (10000 PPM) was the lower number .

So, can be concluded that the salinity when becomes higher the total chlorophyll becomes lower and when the salinity decreases gradually the total chlorophyll becomes higher gradually.

A comment on all the vegetative growth results :-

Tables 1 , 2 and 3 illustrated the effect of salinity levels on plant's height, no. of leaves and the leaf area during both seasons of the experiments.

Data in Tables 1 , 2 and 3 ; reveal that there were significant differences between salinity levels for all growth characters of jojoba plant in the two growing seasons at any sample time from 15 to 120 days. In this respect, increasing salinity from 2000 to 10000 decreased plant height, no. of leaves and the leaf area compared to the control . On the other hand, irrigation with 2000 PPM gave the highest values of plant height, no. of leaves and the leaf area in both seasons. in the same Tables all growth characters increased gradually and consistently as plants advanced towards maturity up to the last date, (120 days from transplanting) in the first and second seasons.

This can be attributed to the hazard effect of salinity on absorption of both water and nutrient along with toxic effect of Cl^- and Na^+. As the water content of the plant decreases, its cells shrink and the cell walls relax which results in lower turgor pressure and the subsequent concentration of solutes in the cells, as well as, cell expansion. Because leaf expansion depends mostly on cell expansion, the principals that underlie the two processes are similar.

These results are in harmony with those of (Taiz and Zeiger, 2002) and (Silber *et al.,* 2003) .

And data illustrated in Table 4 shows that raising irrigation water salinity from 2000 to 10000 PPM caused a significant decrease in the chlorophyll compared with the control (Tap water) . The differences were significant among all treatments in the first and second seasons under all sample time except after 15 days . The salinity could seriously change the photosynthetic carbon metabolize, leaf chlorophyll content as well as photosynthetic efficiency . A decline in photosynthesis due to salinity stress could be due to lower stomata conductance, depression in carbon uptake and metabolism, inhibition of photochemical capacity, or a combination of all these factors (Mundree *et al.,* 2009) .

Similar result obtained with (Ali *et al.,* 2013) on Jojoba plant . And (Kaya *et al.,* 2013) found that salinity significantly reduced chlorophylls “a” and “b” and relative water content in the maize plants. .

The chemical analysis :-

The ion leakage :-

In the next table number 5 can be seen that the Ion leakage becomes higher at the highest salinity and becomes lower at the lower salinity that's where in the first treatment (the control) the results after 15 days were (27.46 % in the 1st season , 27.63 % in the 2nd season) compared to 120 days (31.81 % in the 1st season , 32.32 % in the 2nd season) show that the increasing percentage were about 15.8 % in the first season and 16.97 % in the second season while the treatment 10000 PPM after 15 days were (21.46 % in the 1st season , 21.63 % in the second season) compared to after 120 days (25.64 % in the 1st season , 26.32 % in the 2nd season) show that the increasing percentage were 19.5 % in the first season and 21.68 % in the second season .

1-2

3-4

When comparing all the increasing percentages can be seen that the treatment (10000 PPM) was the highest number then the treatment (7000 PPM) then the treatment (5000 PPM) then the treatment (2000 PPM) then the treatment (control :- tap water) was the lower number.

The protein carbonyl

In the next table number 6 can be seen that the protein carbonyl becomes higher at the highest salinity and becomes lower at the lower salinity that's where in the first treatment (the control) the results after 15 days were (51.87 in the 1st season , 52.74 in the 2nd season) compared to 120 days (51.98 in the 1st season , 52.86 in the 2nd season) show that the increasing percentage were about .21 % in the first season and .23 % in the second season while the treatment 10000 PPM after 15 days were (27.08 in the 1st season , 27.95 in the second season) compared to after 120 days (27.47 in the 1st season , 28.35 in the 2nd season) show that the increasing percentage were 1.44 % in the first season and 1.43 % in the second season .

When comparing all the increasing percentages can be seen that the treatment (10000 PPM) was the highest number then the treatment (7000 PPM) then the treatment (5000 PPM) then the treatment (2000 PPM) then the treatment control was the lower number.

The lipid peroxidation number:-

In the next table number 7 can be seen that the lipid peroxidation number becomes higher at the highest salinity and becomes lower at the lower salinity that's where in the first treatment (the control) the results after 15 days were (.182 in the 1st season , .194 in the 2nd season) compared to 120 days (.301 in the 1st season , .314 in the 2nd season) show that the increasing percentage were about 65.04 % in the first season and 61.85 % in the second season while the treatment 10000 PPM after 15 days were (.180 in the 1st season , .192 in the second season) compared to after 120 days (.831 in the 1st season , .843 in the 2nd season) show that the increasing percentage were 361.67 % in the first season and 339.06 % in the second season .

When comparing all the increasing percentages can be seen that the treatment (10000 PPM) was the highest number then the treatment (7000 PPM) then the treatment (5000 PPM) then the treatment (2000 PPM) then the treatment control was the lower number.

A comment on the ion leakage , protein carbonyl group and the lipid peroxidation number :-

Data presented in Tables 5 , 6 and 7 showed a marked increase in leakage of ions, protein carbonyl and lipid peroxidation in both seasons with increasing salinity from 2000 to 10000 PPM compared with the control (tap water). The increase were significantly in measured parameters during both seasons of the experiment at all sample time except with lipid peroxidase after 15 days had no significant effect. The last sample time 120 days recorded the highest values of measured parameters compared with others sample time.

5-6

7

The data recorded were 25.64, 27.47 & 0.831 in the first season and 26.32, 28.35 & 0.843 in second season for leakage of ions, protein carbonyl and lipid peroxidation at 10000 PPM . The increase in lipid peroxidation due to salinity in jojoba plant (especially, at 10000 PPM NaCl in 120 days), may result in an increase in membrane permeability or loss of membrane integrity leading to an increase in solute leakage, hence decreasing resistance to salinity. On the other hand, the extent of membrane damage by salinity was assessed by an indirect measurement of solute leakage. NaCl-stress induced significant increases in electrolyte leakage compared to the control. This phenomenon already observed by (Ghoulam *et al*. 2002).

Overall the ion leakage percentage % , the protein carbonyl group and the lipid peroxidation number become higher when the salinity becomes higher because the abandonment in the plant cell wall becomes higher when the salinity becomes higher so the ions exit outside the plant cell wall and the ions concentration increase gradually so the ion leakage becomes higher and also the abandonment in the plant cell wall when becomes higher by the salinity increasing it means that the proteins and the fats in the plant cell wall and inside the plant cell become abusive more so the result of the protein carbonyl group becomes higher and the lipid peroxidation number becomes higher too because both of the two tests show the amount of the abusive proteins and fats inside the plant cell and in the wall of the plant cell .Would be associated to chain reactions initialized by free radicals. Among these reactions , the lipid peroxidation due to the accumulation of the ROS, are the principal causes of membrane damage (Sairam *et al.* 2005).

Maintaining integrity of the cellular membranes under salt stress is considered an integral part of the salinity tolerance mechanism (Stevens *et al*. 2006).

CONCLUSION

Under the same experimental conditions, it could be recommended that for producing the highest growth with high quality of jojoba plant must irrigate by water with salinity concentration up to 2000 PPM . And can irrigate by water with salinity concentration higher than 2000 PPM but that will affect on the quality of the vegetative growth and the internal contents and when the salinity concentration will increase we will find the affection on the plant will increase too . And never irrigate by water with 10000 PPM .

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تأثير التركيزات المختلفة لملح كلوريد الصوديوم في ماء الري علي نمو شتلات الجوجوبا

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نفذت تجربتين أصص فى مشتل كلية الزراعة بجامعة المنصورة بمدينة المنصورة بمحافظة الدقهلية بجمهورية مصر العربية وتم الحصول علي شتلات التجربة من مشتل الجوجوبا التابع للأستاذ نبيل الموجي (رائد زراعة الجوجوبا في مصر) وهذا المشتل موجود في مدينه القصاصين بمحافظة الإسماعيلية بجمهورية مصر العربية و تمت التجربة فى خلال الموسمين الصيفيين ٢٠١١ و ٢٠١٢ وذلك لدراسة تأثير مستويات الملوحة المختلفة على النمو الخضرى و التركيب الكيميائي لشتلات نبات الجوجوبا .
اشتملت التجربه على ٥ معاملات فى تصميم قطاعات كاملة العشوائية في خمسه مستويات ملوحة (كنترول (ماء الصنبور) ، ١٠٠٠٠، ٧٠٠٠ ، ٥٠٠٠ و ٢٠٠٠ جزء فى المليون) .
وقد أظهرت نتائج التجربة أن:-
النمو الخضرى للنبات:- زيادة مستويات الملوحة من ٢٠٠٠ إلي ١٠٠٠٠ جزء فى المليون أدى إلى نقص معنوى فى كل من طول النبات ، عدد الأوراق ، المساحة الورقية و المساحة الكلية لأوراق النبات إذا ما قورنت بالمعاملة الأولي المروية بماء الصنبور العذب (الكنترول) . ووجد ان اعلى القيم سجلت عند الرى باستخدام ٢٠٠٠ جزء فى المليون مياه مالحة تحت أى ميعاد لأخذ العينة خلال كلا الموسمين .
محتوى النبات من الكلوروفيل:- الرى باستخدام مستويات مختلفة من المياه المالحة من ٢٠٠٠ إلى ١٠٠٠٠ جزء فى المليون أدى إلى نقص معنوى فى محتوى النبات من الكلوروفيل الكلى مقارنة بمعاملة الكنترول ليصل النقص لأعلي مستوي في المعاملة الثانية المروية بماء تركيزه الملحي (١٠٠٠٠ جزء في المليون) و انخفض النقص تدريجيا ليصل لأدني مستوي عند المعاملة الخامسة المروية بماء تركيزه الملحي (٢٠٠٠ جزء في المليون) .
الغلاف الايونى ، مجموعة البروتين كربونايل و رقم البيروكسيد للدهن :- زيادة ملحوظة وجدت فى كل من الغلاف الأيونى والمحتوي من مجموعة البروتين كربونايل و رقم البروكسيد للدهن خلال كلا الموسمين بزيادة مستويات الملوحة من ٢٠٠٠ الى ١٠٠٠٠ جزء فى المليون مقارنة بمعاملة الكنترول وكانت الزيادة بصورة معنوية في الثلاث إختبارات السابقة ووجد أن آخر ميعاد أخذ عينة عند ١٢٠ يوم سجل أعلى القراءات للقياسات تحت الدراسة.
الاستنتاج:-
تحت نفس ظروف التجربة يمكن التوصية بأنه للحصول على أعلى نمو لشتلات الجوجوبا بالإضافة لأفضل صفات جودة بأنه يجب الزراعة بماء ري تركيزه الملحي لايتجاوز ٢٠٠٠ جزء فى المليون . و أنه يمكن زيادة الملوحة في ماء الري عن ٢٠٠٠ جزء في المليون و لكن سيؤثر ذلك علي الصفات الخضرية و صفات الجودة الداخلية و لا ينصح نهائيا باستخدام ماء ري تركيزه الملحي ١٠٠٠٠ جزء في المليون .

Table 1:- Effect of salinity levels on plant height (cm) during two seasons of 2011 and 2012.

Treatment PPM	Plant height cm															
	1st season								2nd season							
	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120
Con 295	16.63	17.29	17.95	18.62	20.57	21.17	21.83	22.49	22.71	23.37	24.03	24.69	25.35	26.01	26.67	27.33
2000	19.47	19.91	20.35	20.79	20.24	20.55	20.99	21.43	24.61	25.05	25.49	25.93	26.37	26.81	27.25	27.69
5000	19.16	19.49	19.82	20.15	20.00	20.07	20.40	20.73	24.45	24.78	25.11	25.44	25.77	26.10	26.43	26.76
7000	19.04	19.27	19.49	19.71	17.94	19.02	19.23	19.45	24.77	24.99	25.21	25.43	25.65	25.87	26.09	26.31
10000	19.15	19.25	19.35	19.44	21.05	20.74	20.84	20.94	24.56	24.66	24.76	24.85	24.95	25.05	25.16	25.26
L.S.D at 5%	0.56	0.64	0.52	0.53	0.66	0.68	0.70	0.71	0.73	0.82	0.67	0.68	0.86	0.88	0.88	0.89

1st =First season 2nd = Second season

Table 2:- Effect of salinity levels on number of leaves during two seasons of 2011 and 2012.

Treatment PPM	No. of leaves															
	1st season								2nd season							
	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120
Con 295 (tap water)	18.33	19.99	21.65	23.31	24.97	26.63	28.29	29.95	41.61	43.94	45.60	47.26	48.92	50.58	52.24	53.90
2000	18.67	20.06	21.45	22.84	24.22	25.61	27.00	28.40	40.06	42.39	43.78	45.17	46.55	47.94	49.33	50.73
5000	19.22	20.55	21.88	23.21	24.54	25.87	27.20	28.53	40.19	42.52	43.85	45.18	46.51	47.84	49.17	50.50
7000	17.00	17.66	18.32	18.98	19.64	20.30	20.96	21.62	33.28	35.61	36.27	36.93	37.59	38.25	38.91	39.57
10000	17.22	16.89	16.56	16.23	15.90	15.57	15.24	14.91	26.57	28.90	28.57	28.24	27.91	27.58	27.25	26.92
L.S.D at 5%	0.55	0.63	0.50	0.52	0.77	0.81	0.79	0.83	1.15	1.29	0.98	0.99	1.49	1.53	1.46	1.49

st = First season 2nd = Second season

Table 3:- Effect of salinity levels on the leaf area cm^2 during two seasons of 2011 and 2012.

Treatment PPM	leaf area cm^2															
	1st season								2nd season							
	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120
Con 295	13.75	13.92	14.09	14.26	14.43	14.60	14.77	14.94	17.27	17.44	17.61	17.78	17.95	18.12	18.29	18.46
2000	14.60	14.73	14.86	14.99	15.12	15.25	15.38	15.51	17.84	17.97	18.10	18.23	18.36	18.49	18.62	18.75
5000	14.26	14.36	14.46	14.56	14.66	14.76	14.86	14.96	17.29	17.39	17.49	17.59	17.69	17.79	17.89	17.99
7000	14.57	14.65	14.72	14.79	14.86	14.93	14.99	15.06	17.39	17.47	17.54	17.61	17.68	17.75	17.81	17.88
10000	15.25	15.29	15.33	15.37	15.41	15.45	15.49	15.53	17.86	17.90	17.94	17.98	18.02	18.06	18.10	18.14
L.S.D $_{at\ 5\%}$	0.44	0.49	0.40	0.40	0.50	0.50	0.51	N.S	0.32	0.32	0.32	0.33	0.33	0.33	0.33	0.33

1st = First season **2nd = Second season**

Table 4 :- Effect of salinity levels on total chlorophyll (mg/g) (F.W) during two seasons of 2011 and2012 .

Treatment PPM	Total Chlorophyll															
	1st season								2nd season							
	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120
Con 295	19.21	19.42	19.61	19.82	20.02	20.22	20.42	20.62	20.55	20.76	20.95	21.16	21.36	21.56	21.76	21.96
2000	19.05	18.73	18.41	18.09	17.77	17.45	17.13	16.81	20.39	20.07	19.75	19.43	19.11	18.79	18.47	18.15
5000	18.77	18.42	18.05	17.69	17.34	16.98	16.62	16.26	20.11	19.76	19.39	19.03	18.68	18.32	17.96	17.60
7000	18.63	18.13	17.64	17.14	16.63	16.13	15.63	15.13	19.97	19.47	18.98	18.48	17.97	17.47	16.97	16.47
10000	18.83	18.17	17.51	16.85	16.19	15.53	14.87	14.22	20.17	19.51	18.85	18.19	17.53	16.87	16.21	15.56
L.S.D $_{at\ 5\%}$	N.S	0.62	0.48	0.47	0.6	0.59	0.57	0.56	N.S	0.67	0.52	0.51	0.64	0.64	0.62	0.61

1st = First season **2nd = Second season** **F.W = Fresh weight** **mg = Milligram** **g = Gram**

Table 5 :- Effect of salinity levels on the ion leakage % during two seasons of 2011 and 2012.

Treatment PPM	Ion leakage %															
	1st season								2nd season							
	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120
Con295	27.46	27.79	28.46	29.13	29.80	30.47	31.14	31.81	27.63	28.30	28.97	29.64	30.31	30.98	31.65	32.32
2000	24.72	24.97	25.64	26.31	26.98	27.65	28.32	28.99	24.89	25.56	26.23	26.90	27.57	28.24	28.91	29.58
5000	23.42	23.55	24.22	24.89	25.56	26.23	26.90	27.57	23.59	24.26	24.93	25.60	26.27	26.94	27.61	28.28
7000	22.74	22.91	23.58	24.25	24.93	25.60	26.27	26.94	22.91	23.57	24.24	24.91	25.59	26.26	26.93	27.60
10000	21.46	21.62	22.29	22.96	23.63	24.30	24.97	25.64	21.63	22.30	22.97	23.64	24.31	24.98	25.65	26.32
L.S.D at 5%	**0.72**	**0.82**	**0.71**	**0.72**	**0.86**	**0.88**	**0.93**	**0.96**	**0.72**	**0.84**	**0.72**	**0.74**	**0.88**	**0.90**	**0.95**	**0.98**

1st = First season **2nd = Second season**

Table 6 :- Effect of salinity levels on protein carbonyl group during two seasons of 2011 and 2012.

Treatment PPM	Protein carbonyl															
	1st season								2nd season							
	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120
Con295	51.87	51.88	51.90	51.92	51.93	51.95	51.97	51.98	52.74	52.76	52.77	52.79	52.81	52.82	52.84	52.86
2000	52.00	52.05	52.10	52.15	52.20	52.25	52.29	52.34	52.87	52.92	52.97	53.02	53.07	53.12	53.17	53.22
5000	43.77	43.85	43.92	44.00	44.08	44.15	44.23	44.31	44.64	44.72	44.80	44.87	44.95	45.03	45.10	45.18
7000	50.82	50.92	51.01	51.10	51.19	51.29	51.38	51.48	51.70	51.79	51.88	51.97	52.07	52.16	52.25	52.35
10000	27.08	27.13	27.19	27.25	27.30	27.36	27.42	27.47	27.95	28.01	28.06	28.12	28.18	28.23	28.29	28.35
L.S.D at 5%	1.47	1.64	1.27	1.27	1.52	1.53	1.64	1.65	1.49	1.66	1.29	1.29	1.56	1.55	1.67	1.68

1st = First season **2nd = Second season**

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Table 7 :- Effect of salinity levels on Lipid peroxidation number during two seasons of 2011 and 2012.

Treatment PPM	Lipid peroxidation															
	1st season								2nd season							
	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120	Days 15	Days 30	Days 45	Days 60	Days 75	Days 90	Days 105	Days 120
Con295	0.182	0.199	0.216	0.234	0.252	0.269	0.285	0.301	0.194	0.211	0.228	0.246	0.264	0.281	0.297	0.314
2000	0.179	0.228	0.276	0.325	0.373	0.422	0.471	0.521	0.191	0.240	0.288	0.337	0.386	0.435	0.484	0.534
5000	0.182	0.238	0.295	0.352	0.410	0.468	0.525	0.581	0.194	0.251	0.308	0.365	0.423	0.480	0.537	0.593
7000	0.178	0.256	0.334	0.411	0.487	0.564	0.640	0.717	0.191	0.269	0.346	0.423	0.499	0.576	0.653	0.730
10000	0.180	0.272	0.364	0.457	0.550	0.643	0.737	0.831	0.192	0.284	0.377	0.469	0.562	0.655	0.749	0.843
L.S.D at 5%	N.S	0.008	0.009	0.010	0.013	0.015	0.019	0.020	N.S	0.008	0.009	0.011	0.013	0.016	0.019	0.021

1st = First season **2nd = Second season**

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