Effect of Irrigation Water Salinity, Potassium Silicate Levels and Their Interaction Treatments on *Eucalyptus camaldulensis* Dehn.

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Abstract: A field experiment was carried out at the Experimental Farm in Faculty of Agriculture, Suez Canal University, Ismailia Governorate, Egypt, to study the effect of saline irrigation water, potassium silicate and their interaction treatments on growth and chemical contents of *Eucalyptus camaldulensis* Dehn. seedlings during the two successive seasons of 2013 and 2014. The seedlings were irrigated with tap water (control) one month after transplanting two times/week. The saline irrigation water was prepared from seawater obtained from Suez Canal in Ismailia region, included five treatments (control (tap water), 3000, 6000, 9000 and 12000 ppm),. Plants were irrigated with the treatments twice/week during 10 month starting 1 month after planting at the rate of 5 liters per plant. Seedlings were sprayed with potassium silicate levels (0, 2, 4, 6 and 8 cm^3/l) one time every month during 10 months. The results showed that, vegetative growth characters (percent of plant height and stem diameter increment, fresh and dry weights of leaves, stem and roots/plant), chemical contents in the leaves (N, P, K, chlorophyll a, b and carotenoids) and some physical properties of wood [specific gravity (g/ml), lignin % and fiber length (mm)] were decreased with the high rates of saline irrigation water, but raised with the highest concentration of potassium silicate. However, the relative water content (RWC), sodium and proline contents in the leaves were increased by increasing the concentration of saline irrigation water but decreased when using the high rate of potassium silicate. The results revealed that, potassium silicate application alleviates the detrimental effect of salinity stress on vegetative growth, chemical content and physical properties of wood in this study.

Keywords: *Eucalyptus camaldulensis* Dehn., saline irrigation, potassium silicate, pigments, relative water content (RWC), lignin, specific gravity, fiber length, proline.

INTRODUCTION

Eucalyptus species (Fam. Myrtaceae) grow naturally in all Australian Mainland States, (Ladiges *et al*., 2003). They have been widely planted overseas in areas with Mediterranean climate. However*, Eucalyptus* species are believed to be introduced into Egypt in the 1800`s (El-Lakany *et al.,* 1980). Eucalyptus tree is one of the most common trees in the world. *Eucalyptus* species is probably the world's most widely planted tree in arid and semi-arid lands. It is planted in many tropical and subtropical countries. Under natural conditions, Eucalyptus occurs typically along watercourses and on floodplains but occasionally extends to hills or ranges, from temperate to hot and from humid to arid zone (ICRAF, 2010). These species are traditionally planted as: windbreaks, shade and to supply wood for lumber, particle board and charcoal production and planted on the edges of waterways and install them and prevent them from drifting.

Salinity has long been recognized as a problem in many parts of the world that affects the plant growth and quality. Excess soil and water salinity causes soil compaction which leads to drainage problems and low soil organic matter. Plants are affected by the impenetrability of the soil which limits root growth, water uptake, and adversely affects plant metabolism and nutrient uptake. Salinity and raising of soil water levels may be considered the major of serious problems in agriculture (Anonymous, 2000) and (Munns and Taster; 2008).

Silicon (Si) is the second most abundant element in the soil after oxygen (Richmond and Sussman, 2003). Most silicon is present in the soil as insoluble oxides or silicates, although soluble silicic acid occurs in the range of 0.1–0.6 mM. Silicon is also one of the most abundant mineral elements in plant tissues and shoot concentrations in excess of 10% dry weight. Silicon (Si) application alleviates the detrimental effect of salinity stress on plant growth and photosynthetic activity. (Hamayun, 2010). The beneficial effects of Si, include increasing the activity of some enzymes involved in the photosynthesis which led to promote greater photosynthetic activity in plants grown under different stresses, as well as reducing the availability of toxic elements such as Mn, Fe and Al to roots of plants and increasing plant resistance to salt stress, therefore, Si is recognized as a beneficial element required for plant unless it is not defined until now as either macro or micro nutrient essential element (Ma, 2004).Silicon enhances water economy and crop growth in moisture stress (Kaya *et al.,* 2006). Potassium silicate is a source of highly soluble potassium and silicon. It is used in agricultural production systems primarily as a silica amendment and has the benefit of supplying small amounts of potassium. Potassium silicate contains no volatile organic compounds and applications will not result in the release of any hazardous or environmentally persistent by-products (Abou-Baker *et al*., 2011). The present study investigated the effect of saline water irrigation levels, potassium silicate and their interaction treatments on the vegetative growth and chemical composition of *Eucalyptus camaldulensis*.

MATERIALS AND METHODS

A field experiment was carried out at the Experimental Farm in Faculty of Agriculture, Suez

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Canal University, Ismailia Governorate, Egypt, during the two successive seasons of 2013/2014 and 2014/2015. to investigate the effect of saline irrigation water and potassium silicate treatments on growth and chemical content of *Eucalyptus camaldulensis* seedlings. The seedlings were planted in polyethylene bags containing 18 kg of soil, every bag contained one seedling in the first March. The experimental unit contained 3 seedlings arranged in one row, the distance between rows was 1 meter and 60 cm between bags. The experiment was subjected to combinations of water salinity (tap water, 3000, 6000, 9000 and 12000 ppm) and five levels from potassium silicate (0, 2, 4, 6 and 8 cm^3/l). This experiment included 25 treatments which were the combinations between five concentrations of both salt water and potassium silicate. These treatments were arranged in a split plot design in the three replicates. Water salinity treatments were arranged in the main plot and potassium silicate treatment were distributed in the sub plot.

The physical and chemical properties of the experimental soil used in this experiment are shown in Table (1). The chemical analysis of seawater obtained from Suez Canal was shown in Table (2)

The following measurements were recorded:

Percent of plant height and stem diameter increment (%), fresh weight of leaves, stem and roots (g/plant) and dry weight of leaves, stem and roots (g/plant).

Chlorophyll a, b and carotenoids contents in the fresh leave were estimated according to the method of Arnon (1949). Samples of fresh leaves were taken as 3 leaves from 3 shoot per plant. Chlorophyll a, b and carotenoids were extracted from representative samples using acetone 85%. The optical density of the samples was then measured at wavelengths 662,644 and 440.5 nm using a Beckman Dk-2 spectrophotometer. Concentrations of chl. a, chl b and carotenoids were calculated as follows:

Chlorophyll (a) = $9.784_{E662} - 0.99_{E664}$ = µg/ml.

Chlorophyll (b) = $21.264_{E664} - 4.65_{E662}$ = µg/ml.

Carotenoids= $4.695_{E440.5}$ – (0.268 Chlorophyll a + Chlorophyll b = mg/g f.wt.

Chlorophyll mg/g f.w = µg/ml. x acetone size/1000 x sample weight.

E = Optical density at the specific wavelength.

Nitrogen, phosphorus, potassium and sodium % in the leaves:

The leaves were washed with distilled water and dried at 72 ºC for 48 hours. Dried leaves were wet digested using perchloric sulfuric acid mixture to useless. Total nitrogen was estimated using semi-micro-Kieldahle method according to Mazumder and Majumder (2003). Phosphorus was analyzed by a van date- molybdate by spectrophotometer Chapman and Pratt (1982). Potassium and sodium were determined using Flame photometer (Page *et al*, 1982)

Proline content:

Proline content was determined in dry leaves according to the method described by Bates (1973). Plant tissues (0.5 g) were homogenized with 5 ml of 3% sulfosalicylic acid and the homogenates were centrifuged at 3000xg for 20 min. In a test tube, 1 ml of the supernatant was mixed with 1 ml acid ninhydrin reagent and 1 ml of glacial acetic acid and incubated in 100^oc in water bath for 1h and then absorbance at 520 nm was determined. Free proline content in sample is estimated by referring to a standard curve made from known concentration of proline and the results were expressed as $_u$mol proline g^{-1} dW.

Lignin content:

Lignin, expressed as Klason lignin, was determined according to TAPPI T222 om-97 (2007).

Some physical properties of wood:

Two radial strips (nominal, 5 cm tangentially), were machine-cut from each disk. One strip free from any visible defects was selected for specific gravity (SG) and fiber length (FL) determinations. The strip was machined systematically into a number of specimens at 1.0 cm interval from pith to the bark. Thereafter, each specimen was radially divided into two matched specimens, one specimen for SG and the other for FL determinations.

Specific gravity (g/ml):

Specimens assigned for specific gravity determination were aspirated under vacuum until fully saturated condition was reached. The saturated weight of the specimens was obtained. After drying specimens at 103±2 °C until a constant weight was reached, the over dry weight of the specimens was determined and the maximum moisture content was calculated. Specific gravity of each specimen was calculated using the following equation developed by Smith, (1954).

SG = 100 / [M.M.C % + (100 / Gso)]

Where: SG = Specific gravity of specimen

Gso = specific gravity of wood substance.

M.M.C % = Maximum moisture content as percent of oven dry weight.

Fiber length (mm):

Each specimen assigned for fiber length determination was macerated in glacial acetic acid and 30% hydrogen peroxide (1:1 by volume) at 60°C for approximately 48 hours (Franklin, 1964). After delignification was completed the material was washed with distilled water several times and reduced to individual fiber by mild shaking. The macerated fibers at each sampled point were strained with safranin dye and their lengths were measured. For each point, 50 randomly selected fibers were measured in wet condition to the nearest 1 mm by using projecting fiber images onto a screen.

The relative water content in leaves (RWC) %:

Measurements of RWC were performed on leaves collected from branches of *Eucalyptus camaldulensis* trees according to Yamasaki and Dillenburg (1999).

Statistical analysis:

Analysis of variance of the data for each attribute was by Dunkan′s multiple range test at 5 % probability (Steel and Torrie (1997).

Table (1): The physical and chemical properties of the used soil in the two seasons

Properties	Saturation (capacity) percent (%)	Field capacity %	Wilting coefficient (point) (%)	Available water (%)	Sand (%)	Silt (%)	Clay (%)	Soil texture	EC dS_m^{-1}	pH	Ca^{2+}	Mg^{2+}	Na^+	K^+	Cl^-	CO_3^{2-}	HCO_3	SO_4^{2-}	Nitrogen (mg/kg)	Phosphorus (mg/kg)
First season	**26**	**12**	**7**	**5**	**87**	**7.26**	**5.64**	**sandy**	**1.5**	**7.7**	**5.7**	**2.6**	**7.0**	**0.8**	**7.4**	**0**	**2.7**	**5.4**	**7.1**	**2.1**
Second season	**25**	**12**	**6**	**5**	**87**	**7.36**	**5.54**	**sandy**	**1.6**	**7.8**	**5.4**	**2.6**	**7.02**	**0.7**	**7.5**	**0**	**2.9**	**5.6**	**7.3**	**2.8**

Table (2): Chemical properties of used seawater

EC (ppm)	Anions (meq/l)				Cations (meq/l)			
	CO_3^-	HCO_3^-	CL^-	SO_4^-	Ca^{++}	Mg^{++}	Na^+	K^+
36240	--	6.50	360.61	85.00	58.6	37.0	347.9	8.46

RESULTS AND DISCUSSION

Effect of saline water and potassium silicate on growth measurements:

The results presented in Table (3) show that, the percent of plant height and stem diameter increments decreased by increasing irrigation water salinity concentrations, while increased with increasing of potassium silicate rates. Therefore, the highest results were obtained from the treatments of 3000 ppm irrigation water salinity and 8 cm/l potassium silicate, during both seasons. However, the least values were noticed when using 12000 ppm irrigation water salinity. This reduction in plant height and stem diameter as a result of water salinity might be attributed to reduction of cell size or the cell number. Concerning the effect of interaction treatments the highest percent of plant height and stem diameter increments were observed with the combined treatment of 3000 ppm irrigation water salinity + 8 cm/l potassium silicate, in both seasons. This treatment recorded 97.4 and 90.4 % for increment in plant height and 196.4 and 192.9 % for increment in stem diameter during the 1st and 2nd seasons, respectively. From the previous data we can mention that, potassium silicate leads to reduce the harmful effect of water salinity. These results were in harmony with those obtained by Hussein and Nesreen (2014).

Table (3): Effect of different levels of irrigation water salinity and potassium silicate on percentage of plant height increment and stem diameter of *Eucalyptus camaldulensis* during the two seasons

Treatments		Percentage of plant height increment (%)		Percentage of stem diameter increment (%)	
Water salinity	Potassium silicate	1st season	2nd season	1st season	2nd season
Main effects of irrigation water salinity (ppm)					
Tap water		60.7 b	70.2 a	127.3 b	117.6 a
3000 ppm		69.9 a	76.9 a	138.4 a	127.5 a
6000 ppm		52.2 a	63.6 a	109.9 b	103.4 a
9000 ppm		42.4 c	54.5 b	97.3 c	89.1 b
12000 ppm		37.1 c	40.8 c	76.2 d	69.5 c
Main effects of potassium silicate (cm^3/l)					
	0 cm3/l	34.4 d	43.8 c	65.4 d	64.7 e
	2 cm3/l	41.5 c	52.5 b	87.8 c	78.2 d
	4 cm3/l	49.2 b	61.8 a	112.3 b	97.4 c
	6 cm3/l	68.9 a	71.1 a	131.3 a	120.4 b
	8 cm3/l	69.3 a	75.9 a	151.2 a	136.3 a
Interaction effects of irrigation water salinity and potassium silicate					
Tap water	**0**	38.3 h-k	50.3 d-g	81.7 h-k	71.2 f-i
	2 cm^3/l	44.3 f-k	57.8 c-e	97.6 gh	88.3 e-h
	4 cm^3/l	53.8 d-i	70.6 bc	131.7 ef	109.6 ef
	6 cm^3/l	81.1 a-c	77.9 ab	144.4 de	136.2 b-d
	8 cm^3/l	86.1 a-d	94.5 ab	181 bc	182.5 bc
3000 ppm	**0**	4.5 g-k	66.6 c-e	79.0 h-k	90.7 e-h
	2 cm^3/l	61.9 b-f	65 c-e	115 fg	96.2 e-h
	44 cm^3/l	59.8 b-g	76.2 bc	137.7 ef	111.7 d-g
	6 cm^3/l	85.9 a	86.2 ab	183.3 ab	145.8 b-d
	8 cm^3/l	97.4 a	90.4 a	196.4 a	192.9 a
6000 ppm	**0**	33.4 i-k	43.7 gh	51.4 i-l	56.7 g-i
	2 cm^3/l	39.6 d-h	52.6 b-d	80.1 gh	84.8 e-g
	4 cm^3/l	50.2 a-e	65.9 ab	114.9 ef	103.9 c-e
	6 cm^3/l	60.9 ab	78.8 ab	143.9 cd	125.7 b-d
	8 cm^3/l	71.8 a	76.0 ab	152.4 bc	145.7 ab
9000 ppm	**0**	30.3 jk	34.5 hi	51.7 i	65.4 g-i
	2 cm^3/l	34.2 i-k	51.9 e-h	86.1 h-i	70.7 f-i
	4 cm^3/l	49.3 e-i	61.8 c-f	97.7 gh	88.4 e-h
	6 cm^3/l	41.9 f-k	63.8 cde	127.7 ef	107.9 c-f
	8 cm^3/l	56.0 g-k	65.8 f-h	133.1 ef	113 c-e
12000 ppm	**0**	26.3 k	21.9 i	63.4 i-l	39.6 i
	2 cm^3/l	27.7 k	35.3 hi	58.2 kl	50.8 hi
	4 cm^3/l	32.7 jk	44.5 gh	79.4 h-k	73.7 f-i
	6 cm^3/l	44.2 jk	48.9 e-h	86.9 h-i	86.1 e-h
	8 cm^3/l	55.1 f-k	53.1 hi	93.2 hi	97.4 e-g

Within a column values having the same letter are not significantly different according to Duncan's multiple range test (DMRT)

Fresh weights of leaves, stem and roots (g/plant):

Data presented in Table (4) reveal that, irrigation water salinity significantly decreased fresh weights of leaves, stem and roots g/plant. The lightest weights were noticed with using 12000 ppm water salinity, while, the best results were recorded with 3000 ppm. On the other hand, the fresh weights were gradually increased with increasing of potassium silicate rates. The heaviest fresh weights obtained with 8 cm^3/l potassium silicate. In a similar trend, combined treatment of 3000 ppm salinity + 8 cm^3/l potassium silicate gave the highest weights. These results are in harmony with those mentioned by Munns and Tester (2008) on *Eucalyptus camaldulensis* and Hussien and Nesreen (2014) on moringa.

Table (4): Effect of different levels of irrigation water salinity and potassium silicate on fresh weight of leaves, stem and roots (g/plant) of *Eucalyptus camaldulensis*. during the two seasons

Treatments		Leaves		Stem		Roots	
Water salinity	**Potassium silicate**						
		1st season	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**
Main effects of irrigation water salinity (ppm)							
Tap water		55.8 b	58.9 b	85.8 b	89.9 b	63.7 b	71.1 b
3000 ppm		59.4 a	71.0 a	89.5 a	95.0 a	69.2 a	77.0 a
6000 ppm		54.3 c	54.1b	83.2 b	85.7 c	62.4 c	63.4 c
9000 ppm		44.1 d	48.1 c	72.2 c	77.3 d	51.9 d	59.4 d
12000 ppm		41.9 e	40.1 d	69.5 d	69.2 e	48.5 e	49.3 e
Main effects of potassium silicate (cm^3L.)							
	0 cm^3/l	39.9 d	42.6 c	68.8 e	69.5 e	51.7 d	54.6 e
	2 cm^3/l	47.5 c	47.7 c	73.9 d	76.0 d	56.4 c	59.2 d
	4 cm^3/l	52.3 b	53.4 b	77.7 c	83.6 c	59.7 b	65.3 c
	6 cm^3/l	56.8 a	62.8 a	88.5 b	92.2 b	63.8 a	69.3 a
	8 cm^3/l	59.8 a	65.9 a	91.4 a	95.8 a	64.3 a	71.8 a
Interaction effects of irrigation water salinity and potassium silicate							
Tap water	**0**	45.8 ik	50.5 e-h	73.8 i-k	75.7 k	56.3 i	62.3 gh
	2 cm^3/l	50.1 fg	55.9 d-f	77.6 fg	80.5 i	60.2 g	65.3 ef
	4 cm^3/l	56.9 d	43.8 f-i	81.4 e	88.2 f	63.3 cd	70.8 d
	6 cm^3/l	62.8 bc	70.6 bc	96.8 c	101.0 c	68.1 bc	75.7 c
	8 cm^3/l	65.2 b	73.8 bc	99.7 c	104.4 b	70.4 b	81.5 b
3000 ppm	**0**	46.0 ik	54.2 d-g	75.6 hi	81.2 i	59.6 g	66.1 e
	2 cm^3/l	45.0 e	60.3 c-e	81.1 e	85.7 g	65.7 e	71.2 d
	4 cm^3/l	60.9 c	72.5 bc	85.8 d	94.3 d	69.8 bc	77.3 c
	6 cm^3/l	67.1 a	82.0 ab	100.5 b	106.1 a	75.0 a	84.3 a
	8 cm^3/l	70.9 a	86.1 a	104.3 a	107.6 a	76.2 a	86.1 a
6000 ppm	**0**	38.6 m	40.3 g-k	66.0 i	70.6 l	49.3 k-m	53.6 kl
	2 cm^3/l	51.9 f	47.2 e-i	75.9 f	78.6 i	59.1 gh	58.3 i
	4 cm^3/l	57.3 d	58.8 c-e	80.9 e	84.0 h	65.5 e	64.1 h
	6 cm^3/l	59.1 b	61.0 c-e	95.2 c	92.2 e	70.7 d	69.8 eg
	8 cm^3/l	64.5 bc	63.3 cd	98.1 c	103.0 c	67.7 b	71.4 d
9000 ppm	**0**	35.7 n	37.7 i-k	65.6 m	62.0 n	47.5 m	50.0 m
	2 cm^3/l	42.3 l	39.2 h-k	68.1 l	71.3 l	49.4 kl	54.6 ik
	4 cm^3/l	44.1 kl	50.4 e-i	72.1 k	80.8 i	51.1 k	62.9 i
	6 cm^3/l	48.6 gh	55.2 d-f	76.0 gh	85.6 gh	54.0 i	63.7 gh
	8 cm^3/l	50.1 hi	58.1 hi	79.1 f-h	86.9 g	57.6 hi	65.8 fg
12000 ppm	**0**	33.5 o	30.1 k	63.0 n	57.9 o	45.6 n	41.1 o
	2 cm^3/l	39.0 m	35.7 jk	66.5 m	63.8 m	47.4 m	46.7 n
	4 cm^3/l	42.6 i	41.4 h-k	68.4 l	70.8 l	49.0 lm	51.2 m
	6 cm^3/l	46.4 ij	45.0 f-i	74.0 ik	76.2 k	51.1 kl	53.2 im
	8 cm^3/l	48.1 ij	48.4 f-i	75.4 ii	77.1 k	49.7 k	54.1 kl

Within a column values having the same letter are not significantly different according to Duncan′s multiple range test (DMR)

Dry weight of leaves, stem and root (g/plant):

The results presented in Table (5) pointed out that, dry weight of leaves, stem and roots (g/plant) of *Eucalyptus camaldulensis* took the same manner as mentioned in fresh weights. This reduction may be due partially to excess accumulation of Na^+ and Cl^- in the leaves. These might be attributed to the process of building up the osmotic pressure of the developing cell, by osmotic adjustment of salt accumulation to meet the increasing osmotic pressure of rooting media. The heaviest dry weights were recorded with 3000 ppm water salinity, 8 cm^3/l potassium silicate and their interaction treatments, during the two seasons. These results are combatable with those mentioned by Abdel Aziz *et al.* (2006) on *Khaya sengalensis*, Tewari *et al.* (2006) on *Dalbergia sissoo* and *Acacia nilotica* and Hishida *et al.* (2014) on *Jatropha curcas*.

Table (5): Effect of different levels of irrigation water salinity and potassium silicate on dry weight of leaves, stem and roots (g/plant) of *Eucalyptus camaldulensis*. during the two seasons

Treatments		Leaves		Stem		Roots	
Water salinity	Potassium silicate						
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Main effects of irrigation water salinity (ppm)							
Tap water		25.5 b	30.4 b	48.2 b	53.8 b	38.0 b	42.5 b
3000 ppm		28.5 a	35.4 a	52.7 a	57.7 a	41.8 a	46.6 a
6000 ppm		23.6 b	27.0 c	46.6 b	49.2 c	37.4 b	37.0 c
9000 ppm		20.7 c	22.8 d	39.3 c	45.1 d	29.5 c	33.4 d
12000 ppm		19.0 c	20.4 e	37.5 d	40.6 e	27.9 c	29.3 e
Main effects of potassium silicate (cm^3l.)							
	0 cm^3/l	17.7 d	20.4 d	37.1 e	40.3 d	29.6 e	32.3 c
	2 cm^3/l	21.3 c	23.0 c	41.6 d	44.3 c	33.1 d	35.7 d
	4 cm^3/l	23.9 bc	27.6 b	44.0 c	48.5 b	35.0 c	39.3 b
	6 cm^3/l	25.6 b	31.2 a	50.4 b	55.4 a	37.0 b	42.1 b
	8 cm^3/l	28.6 a	33.6 a	51.2 a	57.9 a	39.9 a	44.7 a
Interaction effects of irrigation water salinity and potassium silicate							
Tap water	**0**	20.6 e-h	22.2 l	40.9 i-k	44 i	33 g-i	36.4 f
	2 cm^3/l	21.8 e-g	24.2 i	44.0 g	47.8 h	35.4 e-h	40.4 e
	4 cm^3/l	25.9 c-e	30.8 f	47.0 ef	50.8 fg	37.4 c-g	43.0 d
	6 cm^3/l	29.5 a-c	34.7 e	54.1 c	60.7 c	40.7 a-e	45.8 c
	8 cm^3/l	29.6 a-c	39.8 c	55.2 c	65.8 b	43.3 a-d	47.1 c
3000 ppm	**0**	22.5 d-g	25.7 i	41.2 ii	47.9 h	34.8 f-i	40.2 e
	2 cm^3/l	25.0 c-f	29.6 g	48.0 e	51.3 f	39.7 b-f	43.6 d
	4 cm^3/l	28.0 b-d	35.6 d	52.2 d	55.3 d	42.2 a-c	46.3 e
	6 cm^3/l	32.3 ab	40.4 b	60.5 a	66.3 a	43.9 ab	50.1 b
	8 cm^3/l	34.4 a	45.7 a	61.7 a	67.8 a	48.3 a	52.7 a
6000 ppm	**0**	16.9 g-i	20.7 m	34.8 l	40.9 k	28.4 ik	31.8 h
	2 cm^3/l	21.4 e-g	23.0 k	43.6 f	45 ii	36 d-h	35.1 f
	4 cm^3/l	26.0 e-g	27.4 h	44.5 f	49.6 g	38.0 c-g	39.3 e
	6 cm^3/l	21.2 c-e	30.9 g	54.8 b	55.1 e	41.2 a-d	42.1 f
	8 cm^3/l	32.8 ab	32.8 f	55.3 b	55.5 d	43.6 a-d	43.1 d
9000 ppm	**0**	15.1 hi	17.3 n	34.8 mn	36.3 l	26.4 k	28.2 i
	2 cm^3/l	19.6 f-h	20.0 m	36.7 l	40.7 k	27.8 ik	31.2 h
	4 cm^3/l	20.5 e-h	23.7 k	39.4 k	46.0 i	29.7 i-k	36.5 h
	6 cm^3/l	23.6 d-f	26.8 ik	42.2 hi	50.0 fg	30.6 h-k	38.9 f
	8 cm^3/l	24.7 c-f	26.1 h	43.2 gh	52.4 fg	33.3 h-k	42 e
12000 ppm	**0**	13.6 i	16.2 o	33.7 n	32.6 m	25.6 k	24.8 i
	2 cm^3/l	18.9 f-i	18.0 n	35.6 lm	36.6 l	26.8 k	28.2 i
	4 cm^3/l	19.2 f-i	20.4 m	37.0 l	41.0 k	27.8 ik	31.1 i
	6 cm^3/l	21.6 e-g	23.5 m	40.3 jk	35.0 ii	28.5 ik	33.6 h
	8 cm^3/l	21.7 e-g	23.8 ik	40.7 i-k	47.5 i	31.0 ik	38.5 g

Within a column values having the same letter are not significantly different according to Duncan's multiple range test (DMR)

Chemical composition:

Pigments content:

Chlorophyll (a), chlorophyll (b) and crotenoids contents:

Data presented in Table (6) show the effect of irrigation water salinity, potassium silicate levels and their interaction treatments on chlorophyll a, b and carotenoids content in the leaves. They took a similar trend in regard to the influence of the irrigation water salinity and potassium silicate treatments on growth characters. Concerning the effect of water salinity on chlorophyll a, b and carotenoids contents, the data reveal that, there was a decrease in content with increasing of salinity level. However, the content increased with increasing of potassium silicate level. The interaction treatment of water salinity at tap water (control) + potassium silicate level at 8 cm^3/l treatment gave the higher values of chlorophyll a, b and carotenoids. The recorded data in both seasons showed gradual decreases when raising irrigation water salinity levels, while observed increases with increasing in potassium silicate levels. The effect of saline water treatments on chlorophyll a, chlorophyll b and carotenoids resulted in significant (at $p < 0.05$) stating with increase in accumulation of pigments with tap water then tend to decrease in response to increasing saline water (Karnack *et al.,* 2001) Total chlorophyll content in saline water treatment was reduced by 55% compared to control treatment. These results were in harmony with those of Hishida *et al* (2014) on *Jatropha curcas* and Bayoumi *et al*. (2015) on wheat.

Table (6): Effect of irrigation water salinity and potassium silicate levels on chlorophyll (a), (b) and carotenoids (mg/gfw) on *Eucalyptus camaldulensis*

Potassium silicate (cm^3/l) (B) / (A) Water salinity	0	2	4	6	8	$M_{(A)}$	0	2	4	6	8	$M_{(A)}$
	First season						Second season					
	Chlorophyll a (mg/g fw)											
Tap water	0.63	0.65	0.68	0.73	0.82	0.70	0.67	0.72	0.76	0.85	0.92	0.78
3000 ppm	0.58	0.61	0.64	0.67	0.71	0.64	0.57	0.64	0.68	0.73	0.8	0.68
6000 ppm	0.46	0.48	0.52	0.55	0.58	0.52	0.49	0.52	0.57	0.61	0.65	0.57
9000 ppm	0.40	0.43	0.46	0.49	0.52	0.46	0.38	0.48	0.49	0.53	0.52	0.48
12000 ppm	0.35	0.35	0.39	0.40	0.43	0.38	0.33	0.38	0.42	0.45	0.49	0.41
$M_{(B)}$	0.48	0.50	0.54	0.57	0.61		0.49	0.55	0.58	0.63	0.68	
	Chlorophyll b (mg/g fw)											
Tap water	0.33	0.37	0.41	0.48	0.56	0.43	0.28	0.35	0.39	0.46	0.51	0.40
3000 ppm	0.27	0.31	0.35	0.39	0.43	0.35	0.23	0.29	0.32	0.37	0.43	0.33
6000 ppm	0.2	0.23	0.25	0.26	0.31	0.25	0.18	0.23	0.27	0.26	0.3	0.25
9000 ppm	0.17	0.18	0.21	0.23	0.25	0.21	0.16	0.19	0.24	0.27	0.29	0.23
12000 ppm	0.14	0.16	0.19	0.21	0.22	0.18	0.15	0.17	0.2	0.23	0.26	0.20
$M_{(B)}$	0.22	0.25	0.28	0.31	0.35		0.20	0.25	0.28	0.32	0.36	
	Carotenoids (mg/g fw)											
Tap water	0.48	0.52	0.56	0.62	0.71	0.58	0.45	0.48	0.53	0.6	0.67	0.55
3000 ppm	0.35	0.38	0.41	0.46	0.52	0.42	0.38	0.41	0.46	0.53	0.55	0.47
6000 ppm	0.29	0.32	0.36	0.4	0.45	0.36	0.31	0.35	0.38	0.44	0.48	0.39
9000 ppm	0.23	0.25	0.28	0.32	0.38	0.29	0.26	0.27	0.3	0.34	0.37	0.31
12000ppm	0.22	0.22	0.24	0.27	0.31	0.25	0.23	0.25	0.28	0.28	0.3	0.27
$M_{(B)}$	0.31	0.34	0.37	0.41	0.47		0.33	0.35	0.39	0.44	0.47	

Table (7): Effect of irrigation water salinity and potassium silicate levels on N, P and K percentages of *Eucalyptus camaldulensis* in the two seasons

(A) Water salinity \ Potassium silicate (cm^3/l) (B)	0	2	4	6	8	$M_{(A)}$	0	2	4	6	8	$M_{(A)}$
	First season						**Second season**					
	Nitrogen %											
Tap water	1.37	1.45	1.53	1.65	1.77	1.55	1.46	1.51	1.59	1.69	1.81	1.61
3000 ppm	1.22	1.30	1.39	1.50	1.61	1.40	1.33	1.40	1.45	1.58	1.65	1.48
6000 ppm	1.16	1.24	1.30	1.40	1.45	1.31	1.31	1.36	1.41	1.49	1.57	1.43
9000 ppm	1.12	1.19	1.25	1.33	1.37	1.25	1.24	1.30	1.37	1.34	1.40	1.33
12000 ppm	1.08	1.12	1.19	1.24	1.26	1.18	1.14	1.19	1.25	1.30	1.34	1.24
$M_{(B)}$	1.19	1.26	1.33	1.42	1.49		1.30	1.35	1.41	1.48	1.55	
	Phosphorus %											
Tap water	0.77	0.85	0.88	0.93	1.12	0.91	0.71	0.79	0.86	0.94	1.08	0.88
3000 ppm	0.66	0.70	0.81	0.86	0.92	0.79	0.58	0.63	0.68	0.75	0.87	0.70
6000 ppm	0.55	0.61	0.76	0.77	0.82	0.70	0.51	0.57	0.67	0.71	0.79	0.65
9000 ppm	0.49	0.51	0.53	0.65	0.71	0.58	0.47	0.54	0.62	0.65	0.72	0.60
12000ppm	0.30	0.47	0.50	0.56	0.64	0.49	0.35	0.38	0.46	0.58	0.60	0.47
$M_{(B)}$	0.55	0.63	0.70	0.75	0.84		0.52	0.58	0.66	0.73	0.81	
	Potassium %											
Tap water	0.63	0.68	0.71	0.76	0.81	0.72	0.73	0.79	0.82	0.88	0.94	0.69
3000 ppm	0.56	0.59	0.62	0.67	0.68	0.62	0.60	0.61	0.70	0.78	0.81	0.70
6000 ppm	0.51	0.54	0.57	0.59	0.62	0.57	0.52	0.55	0.59	0.64	0.72	0.60
9000 ppm	0.46	0.49	0.50	0.54	0.57	0.51	0.48	0.51	0.54	0.59	0.63	0.55
12000ppm	0.42	0.42	0.46	0.52	0.50	0.46	0.41	0.46	0.48	0.53	0.57	0.49
$M_{(B)}$	0.52	0.54	0.57	0.62	0.64		0.40	0.58	0.63	0.68	0.73	

Minerals:

Nitrogen, phosphorus and potassium percentages:

The effect of different rates of water salinity, potassium silicate levels and their interaction treatments on N, P and K % in the leaves of *Eucalyptus camaldulensis* was presented in Table (7). Concerning the effect of water salinity, the data show that, there was a gradual decrease in N, P and K % with increasing salinity levels, while there was a positive effect of potassium silicate on N, P and K percentages. Total K content in E.C seedlings roots and aerial parts was increased progressively with decreasing saline water, particularly under light condition .The percentages increased with increasing the levels of potassium silicate. With regard to the effect of interaction treatments, we can observe that, using potassium silicate levels decreased the negative effect of high water salinity concentration (12000 ppm) on N, P and K %, during the two seasons. These results are in harmony with those of Tattini *et al.* (2002) on *Phillyrea latifolia* seedlings, Hanafy Ahmed *et al.* (2009) on globle artichoke and Gao *et al.* (2013) on *Jatropha curcas.*

Sodium percentage:

In Fig. (1), Na % in *Eucalyptus camaldulensis* transplants was gradually increased with increasing of salinity levels in irrigation water in the two seasons. The highest value was recorded in leaves from the treatment of 12000 ppm. Also, data indicated that, Na % was decreased with increasing of potassium silicate levels. The lowest values of Na in the leaves were obtained with using 8 cm^3/l potassium silicate in the two seasons. The results presented in the same Figure demonstrated that, Na % in the leaves was increased with increasing water salinity levels, but when using potassium silicate levels combining with salinity levels, the Na% was decreased. The highest value was obtained from the interaction treatment of 12000 ppm salinity + 0 potassium silicate, while, the lowest was recorded with tap water (control) + 8 cm^3/l potassium silicate. These results were replicated in the two seasons. Similar finding were mentioned by Sohail *et al.* (2009) on *Ziziphus spina-christi*.

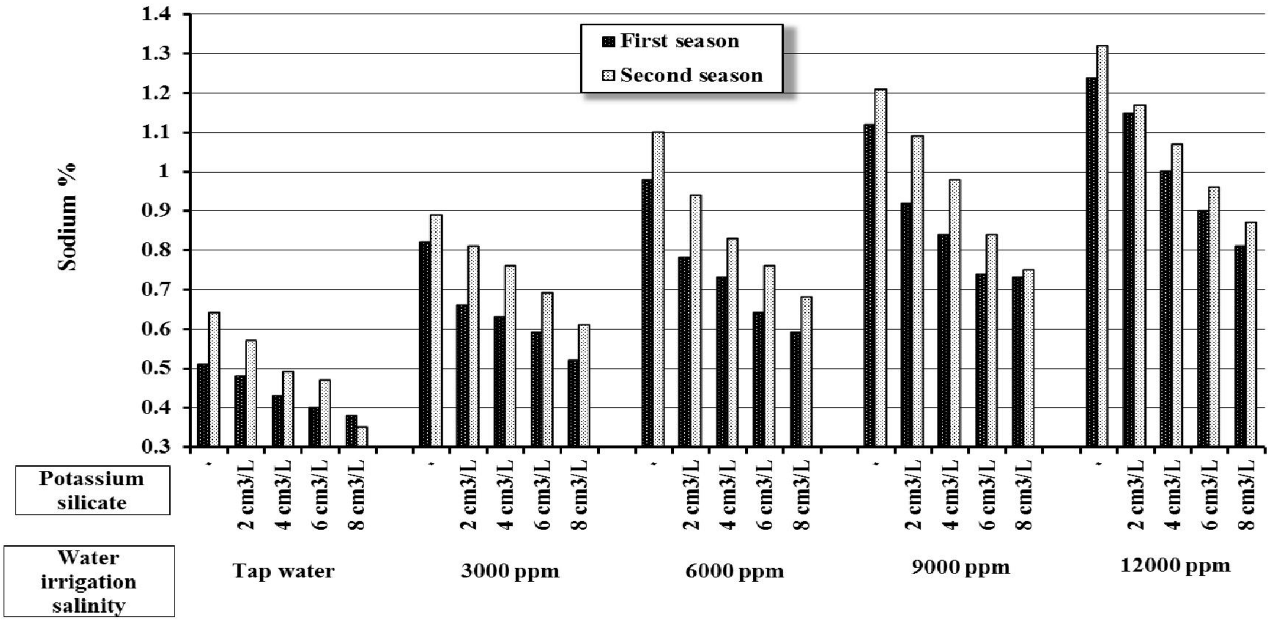

Fig. (1): Effect of irrigation water salinity and potassium silicate levels on sodium percentage in leaves of *Eucalyptus camaldulensis* during the two seasons

Proline content:

Fig. (2) indicate that, proline % in *Eucalyptus camaldulensis* was increased as irrigation water salinity concentration increased. It reached maximum value at 12000 ppm compared to control. From the same Fig., proline content recorded gradual decrease when using gradual increases of potassium silicate level. The results showed also that, the interaction between saline irrigation water rates and potassium silicate levels treatments affected proline content in the leaves. Proline during stress may be possible reason for proline accumulation. Proline is one of the most important osmoprotectants in plant. under water stress most plant species exhibit a remarkable increase in their proline content (Metwali *et al.,* 2011). From the data, we can observe that, using the different levels of potassium silicate from 0 to 8 cm^3/l with the high concentration of salinity (12000 ppm) gradually decreased the proline %. Similar results were also found by Woodward and Bennett (2005) on *Eucalyptus camaldulensis* and Bayoumi *et al*. (2015) on wheat.

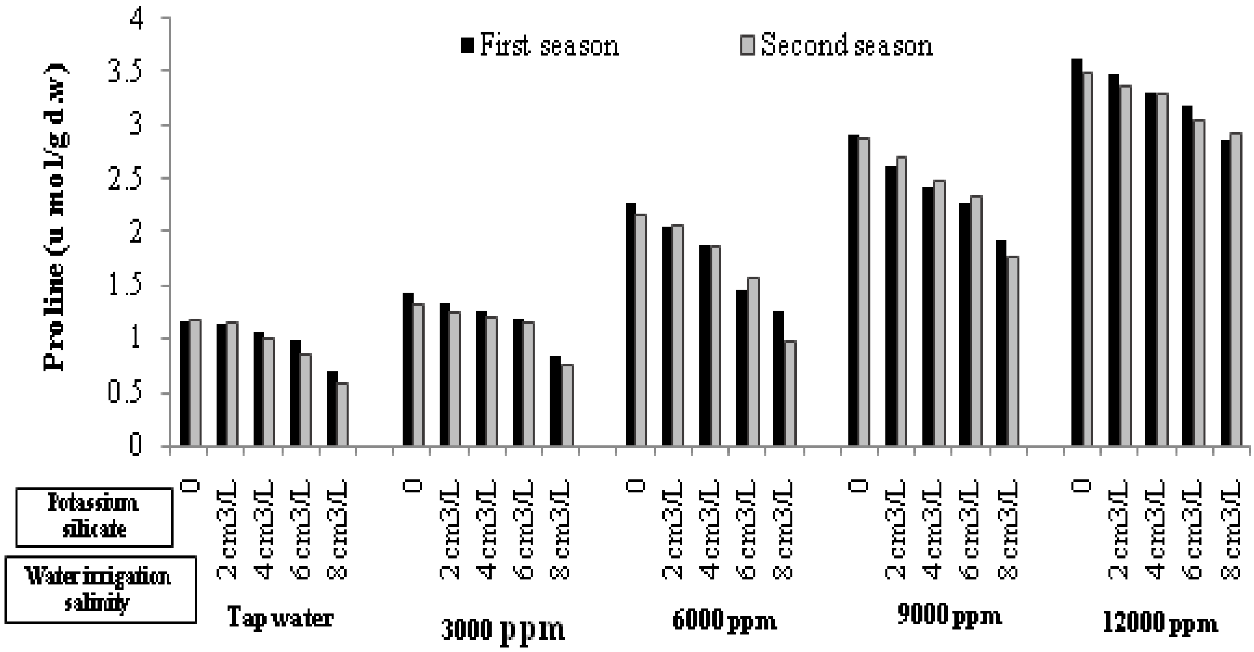

Fig. (2): Effect of irrigation water salinity and potassium silicate levels on proline content in leaves of *Eucalyptus camaldulensis*

Lignin %:

In Fig. (3), lignin % of *Eucalyptus camaldulensis* stem was decreased gradually with increasing of irrigation water salinity levels, in the two seasons. The lowest value was recorded in the stem from the treatment of 12000 ppm which recorded 21.26 and 21.44 % in the first and second seasons, respectively. On the other side, potassium silicate levels increased the percent of lignin from 25.24 to 27.04 % and from 25.31 to 26.83 %, in the 1st and 2nd seasons, respectively compared with non-treated plants. As for the interaction treatments, the highest lignin values (31.06 and 29.47 %) were recorded with tap water (control) + potassium silicate at 8 cm^3/l, while the interaction treatment of 12000 ppm water salinity + 0 potassium silicate gave the lowest value (20.41 and 20.64 %), during the two seasons, respectively. We can from data notice that, using potassium silicate levels reduced the harmful effect of water salinity on lignin % in the stem.

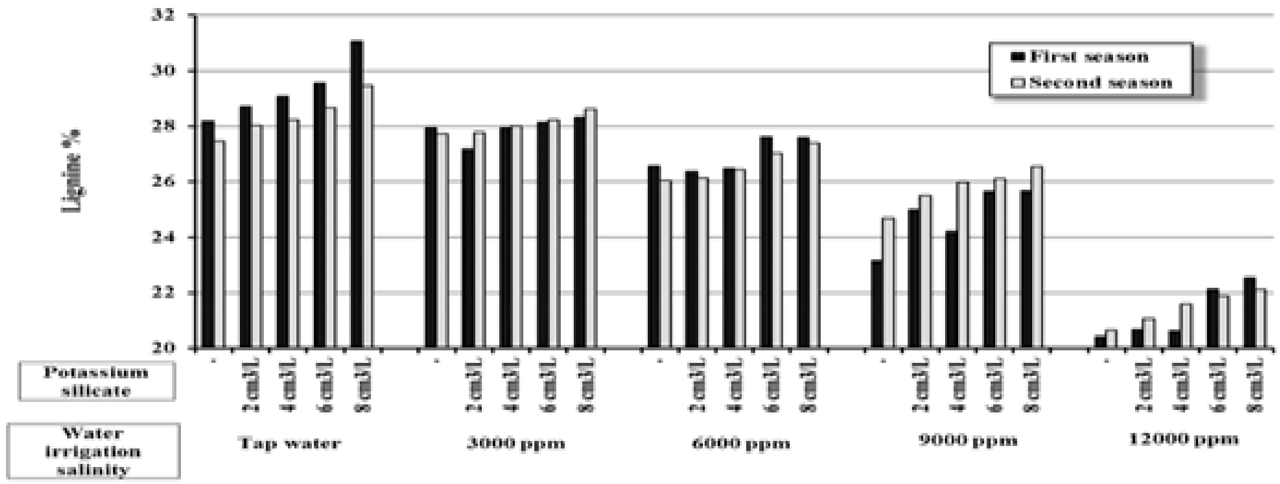

Fig. (3): Effect of irrigation water salinity (ppm) and potassium silicate levels on lignin (%) in the stem of *Eucalyptus camaldulensis* during the two seasons

Some physical properties of wood:

Fiber length (mm):

It's clear from the results showed in Fig. (4) that, the fiber length was decreased with increasing of water salinity levels. The tallest fiber were observed with 3000 ppm (1.10 and 1.14 mm), while, the shortest fiber was obtained from 12000 ppm (0.74 and 0.73 mm) during the two seasons, respectively. There were contrast effects with potassium silicate as the treatment of 8 cm^3/l gave the tallest fiber and recorded 1.11 and 1.08 mm in the 1st and 2nd seasons, respectively. The data presented show also that, fiber length in stem was decreased with increasing water salinity levels, but when using potassium silicate levels combining with salinity levels, the fiber length was increased. The highest values (1.26 and 1.28 mm) were obtained from the interaction treatment of 3000 ppm salinity + 8 cm^3/l potassium silicate, while, the lowest (0.60 and 0.58 mm) were recorded with 12000 ppm + 0 potassium silicate during the two seasons, respectively. Similar results were found by Catchpoole *et al.* (2000) on *Eucalyptus* spp.

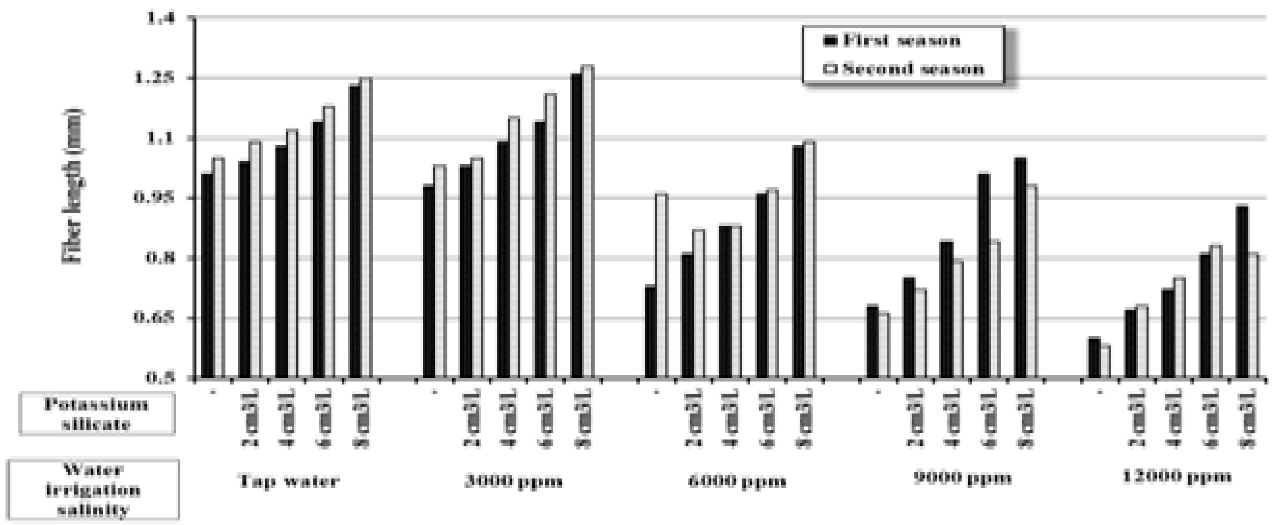

Fig. (4): Effect of interaction treatments of irrigation water and potassium silicate levels on fiber length (mm) of stem of *Eucalyptus camaldulensis* during the two seasons

Specific gravity (g/ml):

Irrigation water salinity treatments decreased specific gravity from 0.68 to 0.56 g/ml in the first season, while, in the second one from 0.69 to 0.57 g/ml from tap water compared to 12000 ppm, respectively, as showed in Fig. (5). On the other hand, potassium silicate treatments slightly increased specific gravity from 0.59 to 0.66 g/ml in the 1st season, and from 0.61 to 0.66 g/ml in the 2nd one from 0 to 8 cm^3/l, respectively. When using salinity levels, specific gravity was decreased, but with adding potassium silicate the values were raised. So, the lowest value (0.52 and 0.55 g/ml) were obtained from the interaction treatment of 12000 ppm + 0 potassium silicate, while the highest specific gravity (0.72 and 0.74 g/ml) resulted from the combined treatment of tap water (control) + 8 cm^3/l potassium silicate, during both seasons. These results are in harmony with those of Catchpoole *et al.* (2000) on *Eucalyptus spp.*

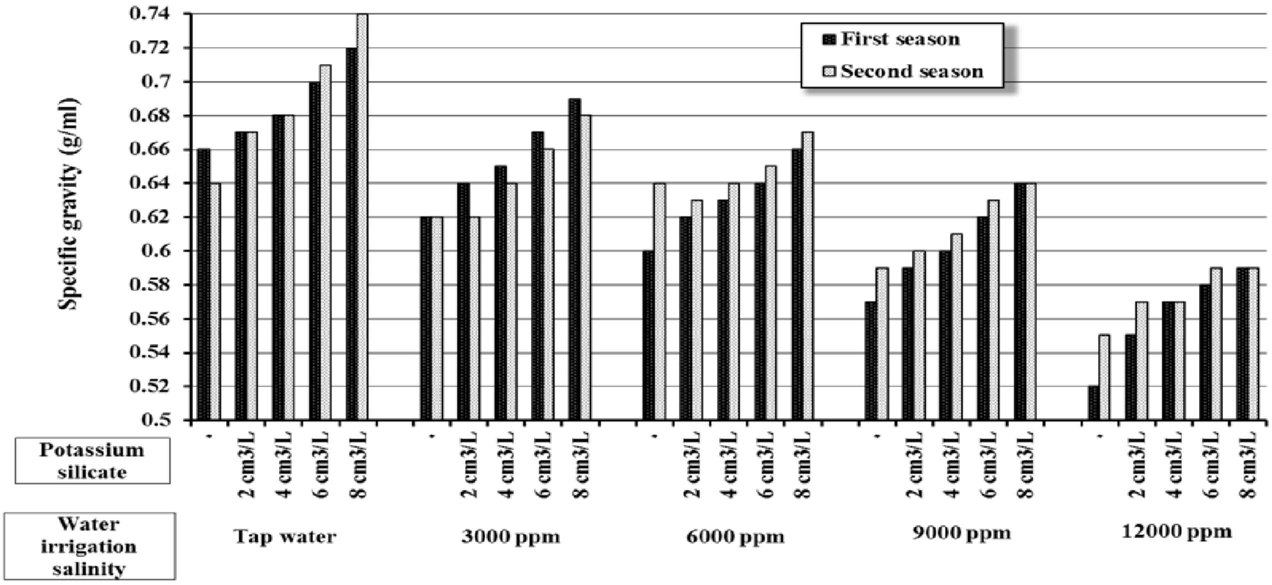

Fig. (5): Effect of the interaction treatments of irrigation water salinity (ppm) and potassium silicate levels on specific gravity (g/ml) of the stem of *Eucalyptus camaldulensis* during the two season

The relative water content % (RWC):

Fig (6) showed the change percent in relative water content (RWC) of *Eucalyptus camaldulensis*. as affected by saline irrigation water levels in the two seasons.Saline irrigation water treatments increased the change percent in relative water content (RWC) as salinity concentrations were increased up to 12000 ppm. This increase reached 79.1 and 78.2 % compared to control (53.2 and 54.9 % in first and second seasons respectively). From the same Fig., relative water content (RWC) recorded gradual decrease with using gradual increase in potassium silicate levels as decreased from 72.5 to 65.4 % in the first season, and from 70.3 to 64.8 % in the second one from 0 to 8 cm^3/l potassium silicate treatments, respectively.

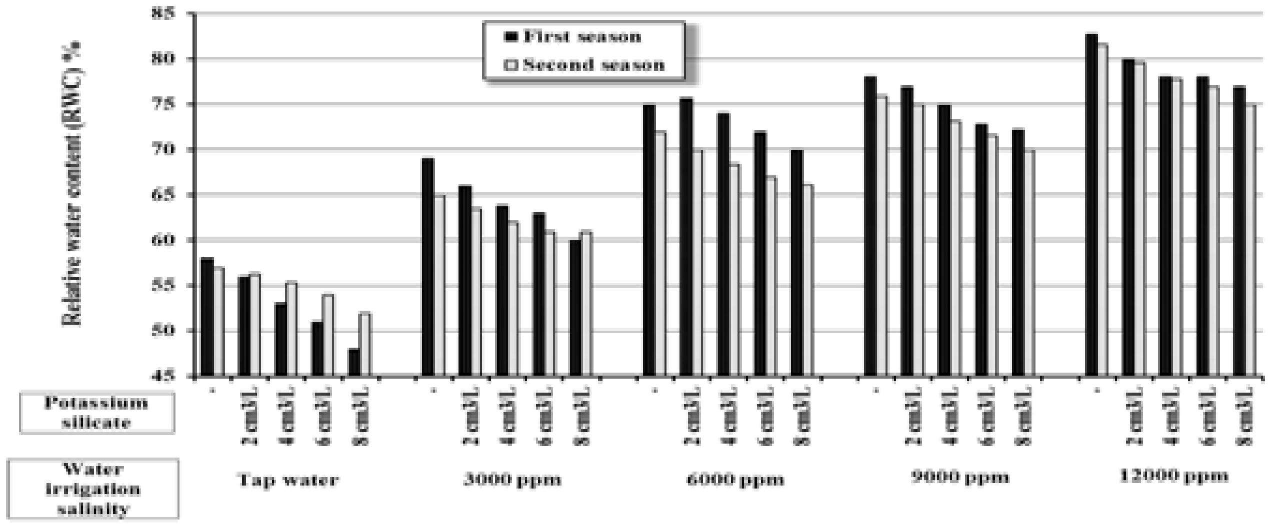

Fig. (6): Effect of the interaction treatments of irrigation water salinity (ppm) and potassium silicate levels on relative water content (%) in leaves of *Eucalyptus camaldulensis*. during the two seasons

The results illustrated in Fig. (6) reveal that the interaction between saline irrigation water and potassium silicate levels were associated with an increase in relative water content (RWC). The high concentration of saline irrigation water with 0 potassium silicate gave the highest value. These results are in harmony also with Diaz *et al.* (2012) on *Jatropha curcas*.

From the previous results it can recommended the following:

When irrigate the seedlings of *Eucalyptus camaldulensis* with water salinity, more than 3000 ppm until the concentration of 12,000 ppm, is recommended to use potassium silicate at the rate of 8 cm^3/liter spray on leaves once a month from the beginning of agriculture during the vegetative growth, to get the highest rate of vegetative growth and increase the affordability of salinity and improve the growth characteristics of *Eucalyptus camaldulensis.*

REFERENCES

Abd El-Aziz, N. G., A. A. M. Mazher and E. El-Hobba (2006). Effect of foliar spraying with ascorbic acid on growth and chemical constituents of *Khaya senegalensis* grown under salt condition. American Eurasian J. Agri. & Environ. Sci., 1(3): 207-214.

Abou-Baker, N. H., M. Abd-Eladl and M. M Abbas (2011). Use of silicate and different cultivation practices in alleviating salt stress effect on bean plants. Australian Journal of Basic and Applied Sciences, 5(9): 769-781.

Anonymous (2000). Extent and causes of salt-affected soils in participating countries. Global network on integrated soil management for sustainable use of salt affected soil. (online) http://www.Fao.Org/ag/agl/agll/spush/topic2.htm

Arnon, D. I. (1949). Upper enzymes in isolated chloroplasts. Polyphone oxiclase in *Beta vulgaris*. Plant Physiology, 24: 1_15.

Bates, L. S. (1973). Rapid determination of proline for water stress studies. Plant and Soil, (39): 205 – 207.

Bayoumi, T. Y., A. M. AbdEL-Mageed, E. S. Ibrahim, S. A. Mahmoud, I. S. El-Demardash and A. Abdel-Raheem (2015). The impact of draught stress on some morpho-physiological traits and RAPD markers in wheat genotypes. Journal of Plant Production Sciences Suez Canal University, (15): 27-37.

Catchpoole, S. J, G. Downes and S. M. Read (2000). The effect of salt on wood and fiber formation in Eucalypts. Rural Industries Research & Development Corporation Publication No.00/162.http://www.rirde.gov.au/reports/HC.00-162sum.html

Chapman, H. D. and P. F. Pratt (1982). Methods of Analysis for Soils, Plants and Water, Chapman publisher , Riverside ,CA . 179pp.

Diaz, L., V. Gimeno, V. Lidon, I. Simon, V. Martinez and F. Garcia (2012). The tolerance of *Jatropha curcas* seedlings to NaCl: an ecophysiological analysis. Plant Physiology and Biochemistry, (54): 34-42.

El–Lakany, M. H., M. L. M. El-Osta and O. A. Badran (1980). Evaluation of newly introduced *Eucalyptus camaldulensis* provenances in Egypt. Alex. J. Agric. Res., 28 (3): 309-319

Franklin, G. L. (1964). A rapid method for softening wood for microtome sectioning. Trip. Woods, Yale Univ. Sch. For., 88: 35-36.

Gao, S., K. T. Liu, T. W. Chung and F. Chen (2013). The effects of NaCl stress on Jatropha cotyledon growth and nitrogen metabolism. Journal of Soil Science and Plant Nutrition, 13(1): 99-113.

Hamayun, M. (2010). Effect of silicon on growth and salinity stress of soybean plant grown under hydroponic system. Agroforestry Systems Impact Factor, 80(3): 333-340.

Hanafy, A. A. H., H. A. Hassan, T. M. A. Kasim and S. M. Sayed (2009). Effect of silicon and putrescine foliar application on growth and yield of globe artichoke plants. J. Agric. Sci., Mansoura Univ., 34(9): 9589-9611.

Hishida, M., V. F. Ascencio, H. Fujiyama, C. A. Orduno, T. Endo and M. J. A. Larrinaga (2014). Response to salt stress in growth, water, and ion content of *Jatropha curcas* and *J. cinerea* seedlings. Cinerea seedlings, 38(4): 298-304.

Hussein, M. M. and H. A. B. Nesreen (2014). Growth and mineral status of moringa plants as affected by silicate and salicylic acid under salt stress. Journal of Applied Sciences Research, 3(2): 163-177.

I.C.R.A.F (2010). Agroforestry tree database. http://kammika.com/woodinfopictures/*Eucalyptus camaldulensis*. pdf., April 28, 2010.

Karnak, H, C. I. Kayam and D. Higgs (2001). The influence of water deficit on vegetative growth, physiology, fruit, yield and quality in eggplants . Bulg. J. of Plant Physiology 27 (3_4): 36_46.

Kaya, C., L. Tuna and D. Higgs (2006). Effect of silicon on plant growth and mineral nutrition of maize grown under water stressed conditions. Journal of Plant Nutrition, 29: 1469-1480.

Ladiges, P. Y., F. Udovicic and G. Nelson (2003). Australian biogeographic connections and the phylogeny of large genera in the plant family Myrtaceae. Journal of Biogeography, 30: 989-998.

Ma, J. F. (2004). Role of silicon in enhancing the resistance of plants to biotic and abiotic stresses. Soil Sci. Plant Nutr., 50(1): 11-18.

Mazumdar, B. C. and K. Majumder (2003). Methods of Physiochemical Analysis of Fruits. Daya Publishing House Delhi, India.

Metwali E. M. R., M. H. Eid and T. Y. Bayoumi (2011). Agronomical traits and biochemical genetics markers associated with salt tolerance in wheat cultivars *Ttriticum aestivum L*. Physiol. Mol Bio. Plants, 18(1): 101-104.

Munns, R. and M. Tester (2008). Mechanisms of salinity tolerance. Ann. Rev. Plant Biol., 59: 651-681.

Page, A. L., R. H. Miller and D. R. Keeney (1982). Methods of Soil analysis. Part 2: Chemical and Microbiological Properties ASA, Madison, WI.

Richmond, K. E. and M. Sussman (2003). Got silicon? The non-essential beneficial plant nutrient. Current Opinion in Plant Biology, 6: 268–272.

Smith, D. M. (1954). Maximum moisture content method for determining specific gravity of small wood samples. U.S. For Served. FOL Rep. 2014. Forest Product Lab., Madison, WL.3pp.

Sohail, M., A. S. Saied, J. Gebauer and A. Buerkert (2009). Effect of NaCl salinity on growth and mineral composition of *Ziziphuus spina-christi* Willd. Journal of Agriculture and Rural Development in the Tropics and Subtropics, 110(2): 107-114.

Steel, R. G. D. and J. H. Torrie (1997). Principles and Procedures of Statistics. McGraw Hill Book Co., Inc., New York, USA.

Tappit test Methods T 222 om-97 (2007). Technical Association of the Pulp and Paper Industry. Tappi Press, Atlanta. GA.

Tattini, M., G. Montagni and M. L. Traversi (2002). Gas exchange, water relations and osmotic adjustment in *Phillyrea latifolia* grown at various salinity concentrations. Tree Physiology, 22 (6): 403-412.

Tewari, P., A. K. Saxena and O. P. Rao (2006). Effect of sodicity and salinity on seedling growth of two early successional agroforestry tree species. Tropical Ecology, 47 (1): 125-132.

Woodward, A. J. and I. J. Bennett (2005). The effect of salt stress and abscisic acid on proline production, chlorophyll content and growth of *in vitro* propagated shoots of *Eucalyptus camaldulensis*. Plant Cell Tissue and Organ Culture, 82(2): 189- 200.

Yamasaki, S. and L. R. Dillenburg (1999). Measurements of leaf relative water content in *Araucaria angustifolia*. Revista Brasileira de Fisiologia Vegetal, 11(2): 69-75.

تأثير معاملات ملوحة ماء الري وسليكات البوتاسيوم والتفاعل بينهما على الكافور العادي

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تمت هذه التجربة في المزرعة البحثية لكلية الزراعة جامعة قناة السويس، محافظة الإسماعيلية، مصر، لدراسة تأثير معاملات الري بالماء المالح وسليكات البوتاسيوم والتفاعل بينها على النمو والمحتويات الكيميائية لشتلات الكافور العادي خلال موسمي ٢٠١٣ و ٢٠١٤. تم ري الشتلات بالماء العذب (كنترول) لمدة شهر بعد عملية الشتل مرتين في الأسبوع. تم تجهيز الماء المالح من مياه البحر وتم الحصول عليها من مياه قناة السويس في منطقة الإسماعيلية، وهذا العامل يشمل خمسة معاملات (مياه عذبة، ٣٠٠٠، ٦٠٠٠، ٩٠٠٠ و ١٢٠٠٠ جزء في المليون)، حيث أن النباتات قد رويت بالمعاملات مرتين أسبوعيا خلال ١٠ أشهر تبدأ من بعد نقل الشتلات بشهر بمعدل ٥ لتر لكل نبات. تم رش الشتلات بمستويات من سليكات البوتاسيوم (صفر، ٢، ٤، ٦ و ٨ سم/لتر) مرة كل شهر خلال ١٠ أشهر بعد الزراعة بشهر. وقد بينت النتائج أن صفات النمو الخضري (نسبة الزيادة في طول النبات وسمك القطر والوزن الطازج والجاف لكل من الأوراق والساق والجذور/نبات)، المحتويات الكيميائية في الأوراق (النيتروجين، الفسفور، البوتاسيوم كلوروفيل أ، كلوروفيل ب، الكاروتينويدات) وبعض الصفات الفيزيقية للخشب (الكثافة النوعية جم/مل، نسبة اللجنين و طول الليفة مم) قد قلت مع المستويات العالية من ملوحة ماء الري، ولكنها ارتفعت مع التركيزات العالية من سليكات البوتاسيوم. في حين أن المحتوى الرطوبى النسبي والصوديوم والبرولين في الأوراق قد ازدادت بزيادة تركيز ملوحة ماء الري، ولكنها قلت عند استخدام المعدل العالي من سليكات البوتاسيوم. وقد أشارت النتائج أن المعاملة بسليكات البوتاسيوم قللت من التأثير الضار للإجهاد الملحي على النمو الخضري والمحتوى الكيماوي للنبات والصفات الفيزيقية للخشب في هذه الدراسة.