Assiut J. of Agric. Sci., 42 (Special Issue)(The 5th Conference of Young Scientists Fac. of Agric. Assiut Univ. May,8, 2011) (302-316)

Response of Some Woody Trees Seedlings to Saline Irrigation Water

[1] E.F. Ali, [2]A.F.A. Ebeid;[2]R.M.M. Sayed and [2]H.H. Hammad
[1]Hort. Dept., Fac. of Agric., Assiut Univ., Egypt
[2]Forest. Dept., Hort. Res. Inst., Agric. Res. Center, Egypt

Abstract

The influence of salinity on growth, biomass production and some chemical analysis of some woody trees were studied at their seedling stage in the Tropical Farm, Kom-Ombo, Aswan Botanical Garden, Egypt during 2009 and 2010 seasons. Seedlings of three woody trees species i.e. *Chrysophyllum oliviforme*, *Tamarindus indica* and *Terminalia arjuna* were tested against 0, 40, 80, 120 and 160 mM levels of NaCl. Mortality percentage, stem length, diameter (root & stem), weight of stem (fresh & dry) and weight of root (fresh & dry) of these seedlings were significantly affected by salinity. Moreover, growth and biomass measurements of each tree species decreased as salinity increased. *Terminalia arjuna* appeared more NaCl salt - tolerant than *Chrysophyllum oliviforme* or *Tamarindus indica* trees as its survival was the highest under the different salinity treatments. Meanwhile, the maximum stem length and biomass parameters were detected with *Tamarindus indica* in both seasons compared to other species in the mean of seasons. On the other hand, as salinity level increased, Na^+ and Cl^- concentrations in all plant tissues were significantly increased for the tested seedlings. Raising NaCl in the irrigation solution of the tested trees significantly decreased chlorophyll content in their leaves.

Keywords: Chrysophyllum oliviforme;Tamarindus indica;Terminalia arjuna; Saline irrigation; Growth; Chlorophyll; Ion content.

Introduction:

Salinity is a major problem that negatively affects agricultural activities in many regions in the world, especially the Near East and North Africa region. Generally, salinity problems increase with increasing salt concentration in irrigation water. Crop growth reduction due to salinity is generally related to the osmotic potential of the root-zone soil solution (Abou-Hadid, 2003).Water used for irrigation can vary greatly in quality depending on type and quantity of dissolved salts. salinity is one of the major problems affecting crop productivity in arid and semi-arid regions, especially the Near East and North Africa region. Throughout the world, 100 million hectars or 5% of the arable land is adversely affected by high salt concentration, which reduces crop growth and yield

Received on:12/4/2011 **Accepted for publication on:** 27/4/2011
Referees: Prof.Dr. Farouk S. E. Badran Prof.Dr.Ali M. Hamza

(Ghassemi *et al*., 1995). Almost 50% of the irrigated land is affected by high salinity (Zhu, 2001), often resulting in secondary salinization due to inappropriate use of saline irrigation water. In warm and dry areas, salt concentrations increase in the upper soil layer due to evaporation that exceeds precipitation (Arbol *et al*., 1988).

Growth suppression is initiated at some threshold value of salinity, which varies with crop tolerance. Determination of salt tolerance of various tree species is of immense value before deciding their suitability for plantation on such sites, especially during establishment and early stage of growth when plants are too tender to bear soil salinity. Injury resulting from the presence of soil salts is caused by differences in osmotic potential between the tree and the soil solution; a specific ion effect associated with specific salt ions, such as Na^+, Cl^- and a combination of these two effects (Dirr, 1976). Saline water (as drainage water, groundwater and treated sewage water) in Egypt is a resource that can be used to improve the environment as in afforestation. The decreasing availability of fresh water for agricultural use to face, the need for production of food, wood and fuel from plants is a major problem common in Egypt. This dilemma requires the increasing use of lower quality or saline water for crop production. Salt tolerant plant species should be selected based on salt cocentrations found in saline areas. Stainleaf tree (*Chrysophyllum oliviforme,* L.) belongs to family Sapotaceae. It contributes to the aesthetics of the forests where it grows, helps protect the soil, and furnishes food and cover for wildlife. The wood, which has a specific gravity of 0.9, is hard, heavy, and strong. It is used for construction in Cuba (Little and Wadsworth, 1964). Tamarind tree (*Tamarindus indica* L.) belongs to family Fabaceae, is an important woody perennial tree species that is found throughout the tropics for its beauty as an ornamental, adaptability to variable climatic and edaphic conditions and fruit production (El-Siddig *et al*., 1999). Tamarind timber consists of hard, dark red heartwood and softer yellowish sapwood. Due to its denseness and durability, tamarind heartwood can be used in making furniture, wood flooring, building purposes and furnishes excellent charcoal for gunpowder (Morton, 1987). Argun tree (*Terminalia arjuna* Roxb.) belongs to family Combretaceae, is the large size deciduous tree. Its wood is used in boat and house building as it is very hard. Its wood is also used in the making of agricultural implements and weapons. It is grown in the cities and towns for the purpose of shade (Srivastava *et al.*, 1999.

There are a number of woody species that can tolerate/resist varying degrees of salinity throughout various adaptations to overcome the problem of salinity.

It is generally considered that halophytes have to overcome the additional problem of physiological drought. It has been reported that many drought tolerant plants (Xerophytes) can easily overcome salinity provided there is no hindrance to their root respiration. Fortunately, it is quite easy to select suitable salt tolerant species from our indigenous flora i.e. *Acacia* (kikar), *Tamarix* (Farash) and *Azadirachta* (Neem). The plants growing in saline or sodic have to face some or all of the following problems: 1. concentration of soil solution is greater than that of cell sap in the root, which results in loss (exosmosis) of water from the root. 2. The imbalance of ions in the soil solution may have toxic effect on cell physiology. 3. Water drainage, root penetration and root respiration are restricted due to deflection (break down of soil structure) and rising water table i.e. *Eucalyptus* (Safaidah) and *Atriplex* (Salt bush). Tree species tolerance of salinity is better as reported by Marcar *et al*., (2000b).

Therefore, the aim of the current study was to determine growth, biomass production, leaf chlorophyll concentration and ion content of 1-year-old *Chrysophyllum oliviforme, Tamarindus indica* and *Terminalia arjuna* seedlings under varying NaCl conditions in order to assess their NaCl tolerance and suitability for afforestation and planting in salt-affected soil.

Materials & Methods

The experiment was conducted in the Tropical Farm, Kom-Ombo, Aswan Botanical Garden, Egypt during 2009& 2010 seasons to study the influence of saline irrigation water on growth and some physiological characteristics of *Chrysophyllum oliviforme*, *Tamarindus indica* and *Terminalia arjuna* seedlings.

Mature *Chrysophyllum oliviforme* and *Terminalia arjuna* seeds were collected during February 2008 & 2009 from the Tropical Farm, while *Tamarindus indica* seeds were bought from Aswan Market for the Medicinal Plants. The seeds were cleaned, dried and scarified to overcome hard seed coat dormancy by removing a small portion of the coat at the cotyledon end with steel file. Then, seeds were surface sterilized with 2000 ppm sodium hypochlorite for 5 min, rinsed with sterile distilled water. Seeds were sown directly into the plastic pots containing a mixture of soil and sand (3:2). One-year-old seedlings of *Chrysophyllum oliviforme*, *Tamarindus indica* and *Terminalia arjuna* were selected for uniformity according to leaf number (15) and plant height (30 cm) then transplanted to plastic pots (30 x 20 cm) containing the same potting mixture. The physical and chemical characteristics of the sand and clay soil used in this study were shown in Table (1). Salt concentrations of 40, 80, 120 and 160 mM were prepared by dissolving 2.32, 4.64, 6.96 and 9.28 gm Sodium Chloride

(NaCl)/L distilled water, respectively. Seedlings were treated twice a week with the different concentrations of salinity to produce electrical conductivities of 5, 10, 15, and 20 m S cm^{-1} equivalent to the 40, 80, 120 and 160 mM salt concentrations in the soil medium. To balance the evaporative losses, and also to maintain plants at the required levels of

Table (1): Physical and chemical characteristics of sand and clay soil used for growing seedling species.

Soil characteristics	Sand	Agriculture oil
Physical		
Course Sand %	65.50	3.45
Fine Sand	31.50	37.03
Silt%	0.77	27.75
Clay%	2.50	27.25
Organic matter	0.30	0.33
Texture	Sandy	Clayey
Chemical		
pH	6.70	8.10
E.C.(ds/m)	0.56	2.13
Na(ppm)	3.45	13.40
K(ppm)	0.58	0.85
Biocarbonated (ppm)	1.95	4.00
Chloride(ppm)	2.80	16.50
Sulphur(ppm)	2.28	0.83
Calcium carbonate (ppm)	28.00	3.77
Ca**(ppm)	2.12	5.25
Mg**(ppm)	0.88	1.79
C.E.C(Meg/100g)	5.50	32.60

salts, they were watered every alternate day after a check of the electrical conductivity of the soil medium (Rawat and Banerjee, 1998). Control plants were supplied with tap water only.

The experiment involved three tree species i.e. *Chrysophyllum oliviforme, Tamarindus indica* and *Terminalia arjuna and* five treatments (40, 80, 120 and 160 mM salt besdide the control without salt). Each treatment had three replicates of six seedlings each in a randomized complete block design. Saline irrigation treatments were carried out from March to July 2009 and repeated in 2010 season (20 weeks of continuous salt treatment every season).

After recording observations on survival, plants were harvested to record height, stem diameter and fresh weight of stem and roots. Dry mass of stems and roots was determined after oven drying the samples at 90^{0}C to a constant mass. The pigment density (chlorophyll a&b) was measured with a spectrophotometer type SP8-300 (Pye Unicam, Cambridge, UK) at 664 nm (chl. a) and at 647 (chl. b) following the method of Mackinney (1941).

Leaves, stems and roots were analyzed for sodium (Na^+) and chloride (Cl^-) content. Na^+ concentration was determined from dry, powdered plant tissue after extraction in Hydrochloric acid using an atomic absorption spectrophotometer (905 AA, GBC, Australia). Cl^- was assessed by silver ion titration with chloride meter (6610, Eppendorf, Germany).

The obtained data were tabulated and statistically analyzed according to the method by Snedecor (1956), and L.S.D mentioned by Little and Hills (1978).

Results and Discussion:

Survival

NaCl salinity significantly affected mortality percentage as indicator for survival of the tested seedlings, which generally increased under higher salt levels in both seasons, but decreased under lower salt levels as compared to the controls (Table 2). The highest value of mortality percentage (30.0 %) was recorded with *Tamarindus indica* as mean of salinity levels for the two seasons as compared to the other trees, while the lowest value (26.7 %) was obtained with *Terminalia arjuna* seedlings. Variations in salt tolerance have been observed previously between species and genotypes of woody plants (Bell *et al.*, 1994 and Tal, 1986). Species like *Dalbergia sissoo* and *Eucalyptus camaldulensis* have been reported to survive 160 mM NaCl salinity (Rawat and Banerjee, 1998).

Plant growth:

Vegetative characteristics of the tested seedlings were affected in all salt irrigation water treatments. The greatest reduction of seedlings growth occurred in plants by the 160 mM treatment. NaCl reduced the length of seedlings, which led to significant differences in stem length between the control and all treatments (Table 2). The highest value of stem length (80.3cm) was obtained by *Tamarindus indica* in the two seasons, while the lowest value (54.8 cm) was recorded with *Chrysophyllum oliviforme* in both seasons.

Statistical analysis of data indicated significant decrease in root length of the seedling species after 20 weeks of applying sodium chloride treatments (Table 1). In the present study, the mean root length of *Terminalia arjuna* (27.1 cm) was higher as compared with that of *Tamarindus indica* (23.5 cm) or *Chrysophyllum oliviforme* (20.9 cm) by the end of the experiment. Also, the same Table shows significant differences in stem diameter among the different salt concentrations across the tested seedling species. The decreases in stem diameters of these seedlings were concomitant with the increase in concentrations of sodium chloride in both seasons. However, the highest value (0.83 cm) of stem diameter was resulted from *T. arjuna*, while *C. oliviforme* seedlings recorded the lowest one (0.52 cm) in the mean of different salt treatments for the two seasons. It is well known that salinity affects growth of plants adversely due to disturbance in physiological and metabolic processes occurring in plant body as reported earlier by Afzal *et al.*, 2006; Neves and Bernstin, 2005; Rashid *et al.*, 2004 and Marcar *et al.*, 2000a. However, transplants can tolerate salinity to a certain degree as compared to agricultural field crops (Niazi *et al.*, 1985). Reduced growth was probably caused by the high NaCl level, which increased the osmotic potential of the irrigation solution and also created salt stress from excessive uptake of ions. Gebauer *et al.*, (2001) on *Tamarindus indica* found that plant growth was slightly affected by 40 and 80 mM NaCl, but was markedly reduced at the 160 mM treatment. The reduction of vegetative growth under saline water treatments could be attributed to the decline in the content of endogenous gibberellins and indole acetic acid hormones which are required for both shoot elongation and cambial growth. The plants of increased salinity resistant are expection to maintain higher rates of growth than less resistance plants under equivalent levels of salinity (Hussein and Haggag, 2003 *and* Corser *et al.*, 2001).

Table (2): Mortality percentage, stem length, root length and stem diameter of *Chrysophyllum oliviforme*, *Tamarindus indica* and *Terminalia arjuna* seedlings as influenced by NaCl salinity 20 weeks after initiation of the treatment during 2009 & 2010 seasons.

Tree species	NaCl concentration (mM)	2009 Mortality %	2009 Stem length (cm)	2009 Root length (cm)	2009 Stem diameter (cm)	2010 Mortality (%)	2010 Stem length (cm)	2010 Root length (cm)	2010 Stem diameter (cm)
Chrysophyllum oliviforme	0	0.00	80.3	34.4	0.81	0.00	73.6	30.2	0.75
	40	0.00	70.9	25.4	0.71	0.00	69.7	28.5	0.70
	80	11.11	68.0	24.5	0.59	22.22	64.4	25.8	0.61
	120	22.22	64.9	21.9	0.54	33.33	55.8	18.8	0.53
	160	100.0	00.0	00.0	0.00	100.0	00.0	00.0	0.00
Mean		**26.7**	**56.8**	**21.2**	**0.53**	**31.1**	**52.7**	**20.7**	**0.52**
LSD 5%		**20.69**	**6.30**	**2.30**	**0.06**	**15.66**	**3.8**	**4.1**	**0.06**
Tamarindus indica	0	0.00	97.6	27.4	0.79	0.00	87.2	25.8	0.88
	40	11.11	85.7	23.3	0.74	11.11	84.2	25.7	0.76
	80	33.33	81.5	22.8	0.73	22.22	77.8	25.8	0.78
	120	44.44	76.2	20.8	0.70	55.56	79.8	25.0	0.68
	160	55.56	75.8	15.9	0.62	66.67	57.1	23.0	0.68
Mean		**28.9**	**83.4**	**22.0**	**0.72**	**31.1**	**77.2**	**25.1**	**0.76**
LSD 5%		**29.29**	**8.80**	**2.80**	**0.06**	**29.29**	**8.9**	**1.6**	**0.06**
Terminalia arjuna	0	0.00	81.8	28.6	1.05	0.00	68.3	34.7	0.99
	40	0.00	80.5	26.9	0.94	0.00	65.7	30.4	0.87
	80	11.11	74.7	25.4	0.82	22.22	62.2	29.0	0.77
	120	44.44	72.5	23.8	0.78	55.56	59.2	26.3	0.73
	160	66.67	71.2	23.5	0.76	66.67	51.4	22.6	0.55
Mean		**24.4**	**76.1**	**25.6**	**0.87**	**28.9**	**61.4**	**28.6**	**0.78**
LSD 5%		**8.0**	**2.5**	**0.08**	**23.49**	**7.6**	**5.9**	**0.06**	**19.18**

Biomass production

Sodium chloride reduced the mean stem fresh and dry weights as well as the root fresh and dry weights of the tested seedlings at all four salt concentrations but to different degrees (Table 2). Biomass production of seedlings for each tree species reached the maximum value under non- saline conditions (controls). *Tamarindus indica* gave higher stem fresh weight (25.6 g), root fresh weight (13.5 g), stem dry weight (12.5 g) and root dry weight (7.4g), whereas *Chrysophyllum oliviforme* gave the lowest stem fresh weight, root fresh weight, stem dry weight and root dry weight, in the mean of both seasons. The treatments showed significant variations in these characters for the tested seedlings and showed a decreasing trend with the increasing of salt concentrations. Seedlings growth was only slightly affected by low salinity level, but was greatly reduced by high salinity treatment. These results are consistent with the previous findings of (Gebauer *et al.*, 2001) on *Tamarindus indica*. They found that tamarind seedlings can tolerate salinity level up to 80 mM NaCl, but are sensitive to an excessive high salinity level of 120 mM. Our results revealed that *Chrysophyllum oliviforme* and *Terminalia arjuna* were highly susceptible to increasing salinity with respect to their biomass production, while *Tamarindus indica* was found highly resistant.

The plants growing in saline or sodic have to face some or all of the following problems; Concentration of soil solution is greater than that of cell sap in the root, which results in loss (exosmosis) of water from the root, The imbalance of ions in the soil solution may have toxic effect on cell physiology and Water drainage, root penetration and root respiration are restricted due to deflection (break down of soil structure) and rising water table. The reduction of biomass among the saline water treatments is probably due to the decrease in photosynthesis activity (Afroz *et al., 2005*).

Na^+ and Cl^- content in plant tissues

The highest amount of Na^+ and Cl^- in all salt treatments was found in the roots of the tested woody seedlings (Tables 3 and 4). Application of NaCl increased Na^+ and Cl^- concentrations in all parts of the seedlings. As salinity level increased, Na^- and Cl^- concentrations in all plant tissues increased and there were significant differences between treatments. Moreover, tissue Na^+ concentration was much higher than Cl^-concentration. The highest values of Na^+ and Cl^- contents in plant tissues were resulted from *Tamarindus indica* as compared to the other seedling species in both seasons, while the lowest values were recorded with *Chrysophyllum oliviforme* tissues. In the tested trees, the highest amount of Na^+ and Cl^- was found in the roots, indicating a retention mechanism and are often responsible for leaf injuries in salt- stressed plants as reported by (Mass., 1993). Saline water moves up through vegetation rather than moving through soil capillaries and leaving salts on soil surface. In the presence of vegetation, water transpires into the atmosphere while, leaving the salts in the plant tissue. Concentration of soil solution is greater than that of cell sap in the root, which results in loss (exosmosis) of water from the root. The imbalance of ions high osmotic pressure decreases the availability of soil water and changes the ability of tree to absorb water, causing moisture stress within the plant. Soil salinity can cause nutrient imbalances, while result in the accumulation of elements to plants, and reduction water of initiation if the level of one salt element – sodium – is high.

Table (3): Fresh and dry mass of stem and root of *Chrysophyllum oliviforme*, *Tamarindus indica* and *Terminalia arjuna* seedlings as influenced by NaCl salinity during 2009 & 2010 seasons.

Tree species	NaCl concentration (mM)	2009				2010			
		Stem fresh weight (g)	Root fresh weight (g)	Stem dry weight (g)	Root dry weight (g)	Stem fresh weight (g)	Root fresh weight (g)	Stem dry weight (g)	Root dry weight (g)
Chrysophyllum oliviforme	0	26.78	21.25	11.16	6.91	36.08	17.00	14.6	5.24
	40	23.98	13.44	11.00	4.87	35.53	15.42	13.71	5.04
	80	20.64	10.11	10.59	3.38	17.73	10.96	6.65	4.62
	120	18.44	6.88	7.65	3.01	16.71	8.44	6.41	2.11
	160	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean		**18.0**	**10.3**	**8.1**	**3.6**	**21.2**	**10.4**	**8.3**	**3.4**
LSD 5%		**2.62**	**2.42**	**1.20**	**0.71**	**3.28**	**2.36**	**1.27**	**0.86**
Tamarindus indica	0	29.75	15.52	16.07	8.76	29.19	19.45	17.86	11.00
	40	29.47	10.43	12.52	5.91	29.00	18.46	14.56	9.87
	80	26.40	9.87	11.72	5.53	25.42	18.01	12.55	9.60
	120	25.93	9.57	11.31	4.70	24.12	17.05	11.37	8.94
	160	20.96	6.80	9.93	4.66	16.24	10.45	7.91	5.49
Mean		**26.5**	**10.4**	**12.3**	**5.9**	**24.8**	**16.7**	**12.8**	**9.0**
LSD 5%		**2.78**	**4.45**	**1.59**	**1.15**	**3.78**	**1.53**	**2.16**	**1.19**
Terminalia arjuna	0	30.83	14.71	13.27	5.85	28.27	13.26	10.44	5.87
	40	26.07	13.94	11.85	5.91	24.04	12.29	8.87	4.62
	80	25.59	11.47	11.46	4.75	16.34	9.69	4.87	2.89
	120	23.15	11.12	9.66	4.58	13.71	7.06	4.34	2.58
	160	22.13	9.88	9.48	3.78	9.22	6.09	2.56	1.49
Mean		**25.5**	**12.2**	**11.1**	**5.0**	**18.3**	**9.7**	**6.2**	**3.49**
LSD 5%		**3.47**	**1.41**	**2.20**	**0.58**	**3.56**	**1.69**	**1.36**	**0.83**

Table (4): Ion content of Na^+ (mM) in tissues of *Chrysophyllum oliviforme*, *Tamarindus indica* and *Terminalia arjuna* seedlings as affected by salinity after 20 weeks of the treatments during2009 and 2010 seasons.

Tree species	**NaCl concentration (mM)**	**2009**			**2010**		
		Tissue			Tissue		
		leaf	stem	root	leaf	stem	root
Chrysophyllum oliviforme	0	25.54	18.49	85.55	26.74	19.04	88.67
	40	243.66	161.01	501.19	247.74	166.7	516.87
	80	292.89	170.45	1162.65	301.76	175.01	1193.48
	120	315.78	186.94	1188.22	327.33	190.94	1208.12
	160	0.00	0.00	0.00	0.00	0.00	0.00
Mean		**175.6**	**107.4**	**587.5**	**180.7**	**110.3**	**601.4**
LSD 5%		**4.42**	**6.04**	**3.80**	**5.15**	**6.06**	**18.37**
Tamarindus indica	0	21.67	28.32	86.16	22.00	29.38	88.35
	40	224.84	125.22	520.18	231.56	128.22	528.86
	80	272.89	149.40	1105.24	280.12	152.37	1128.08
	120	293.28	167.79	1132.52	302.05	171.68	1166.91
	160	360.39	188.94	1212.18	368.75	193.86	1236.70
Mean		**214.6**	**131.9**	**811.2**	**240.9**	**135.1**	**833.4**
LSD 5%		**7.73**	**8.25**	**8.05**	**8.51**	**10.43**	**15.85**
Terminalia arjuna	0	40.63	14.73	63.14	41.99	15.41	65.64
	40	250.42	119.98	493.01	260.28	124.08	509.42
	80	311.15	190.33	869.59	318.41	195.79	898.59
	120	352.91	220.05	995.56	364.62	225.80	1025.14
	160	412.88	236.66	1093.60	419.71	243.20	1122.75
Mean		**273.6**	**156.3**	**703.0**	**281.0**	**160.8**	**724.3**
LSD 5%		**6.00**	**4.79**	**8.18**	**6.15**	**9.62**	**12.27**

Table (5): Ion concentration of Cl^- (mM) in leaves, stems and roots of *Chrysophyllum oliviforme, Tamarindus indica* and *Terminalia arjuna* seedlings as affected by NaCl salinity after 20 weeks of the treatments during 2009and 2010 seasons.

Tree species	NaCl concentration (mM)	2009			2010		
		Tissue			Tissue		
		leaf	stem	root	leaf	stem	root
Chrysophyllum oliviforme	0	35.47	18.79	108.60	36.89	19.74	114.03
	40	204.41	158.40	460.25	208.53	161.57	469.45
	80	251.31	170.04	890.25	263.66	171.73	916.95
	120	266.91	185.41	1046.35	275.81	192.83	1067.15
	160	0.00	0.00	0.00	0.00	0.00	0.00
Mean		**151.6**	**106.5**	**501.1**	**157.0**	**109.2**	**513.5**
LSD 5%		**5.20**	**3.00**	**5.34**	**4.72**	**3.08**	**5.46**
Tamarindus indica	0	27.78	31.18	104.82	29.17	32.75	110.13
	40	195.59	189.85	443.13	203.44	205.84	463.72
	80	224.56	206.89	970.00	229.04	211.03	989.40
	120	305.11	255.66	1047.84	314.25	265.88	1079.28
	160	411.08	313.98	1091.13	415.21	317.13	1112.84
Mean		**232.8**	**199.5**	**731.4**	**238.2**	**206.5**	**751.1**
LSD 5%		**6.24**	**5.59**	**6.30**	**6.41**	**5.75**	**23.13**
Terminalia arjuna	0	23.89	31.61	72.38	25.13	33.19	76.00
	40	180.41	242.37	355.03	187.61	247.21	362.12
	80	212.51	270.67	802.44	214.65	281.49	826.52
	120	279.72	311.04	968.31	285.31	280.38	987.67
	160	402.18	380.29	1017.35	416.93	384.10	1027.39
Mean		**219.7**	**247.2**	**643.1**	**225.9**	**245.3**	**655.9**
LSD 5%		**3.36**	**5.63**	**5.49**	**4.25**	**5.77**	**5.63**

Leaf chlorophyll content

After 20 weeks, plants treated with 40 mM, 80 mM, 120 mM or 160 mM NaCl exhibited drop in chlorophyll content of their leaves compared to the control. Increased NaCl salinity was gradually decreased chlorophyll (a&b) content of leaf tissue of the tested trees (Table 5). A marked decline in chlorophyll of seedling leaves was associated with 160 mM treatment. Chlorophyll concentration was comparatively higher for *T. indica* than *T. arjuna* or *C. oliviforme* in both seasons. The highest value (2.27 mg/ g fw) of total chlorophyll was detected with *T. indica* but *C. oliviforme* recorded the lowest one (0.86 mg/ g fw) in the mean of seasons. A decrease in chlorophyll concentration in glycophytes due to salinity has been reported earlier by several workers (Chavan and Karadge, 1986 and Grant and Somers, 1981), and has been attributed to the increased chlorophylls activities (Svitsev *et al.*, 1973). (Choudhary *et al.*, 2003) Concluded that photo–inhibition was the main factor responsible for drastic reduction in net photosynthesis rate and coupled with a toxic of salt ions on cellular metabolism made the survival of the plants impossible under high salinity.

Table (6): Chlorophyll content (a & b) in leaves of *Chrysophyllum oliviforme*, *Tamarindus indica* and *Terminalia arjuna* seedlings as affected by NaCl salinity after20 weeks of the treatments during 2009 and 2010 seasons.

Tree species	**NaCl concentration (mM)**	**2009**			**2010**		
		Chlorophyll (mg/ g fw)			**Chlorophyll (mg/ g fw)**		
		Chl. a	Chl. b	Total Chl.	Chl. a	Chl. b	Total Chl.
Chrysophyllum oliviforme	0	0.85	0.43	1.29	0.88	0.45	1.33
	40	0.76	0.37	1.13	0.78	0.39	1.17
	80	0.67	0.28	0.96	0.68	0.30	0.98
	120	0.49	0.29	0.78	0.49	0.29	0.78
	160	0.00	0.00	0.00	0.00	0.00	0.00
Mean		**0.55**	**0.27**	**0.87**	**0.57**	**0.29**	**0.85**
LSD 5%		0.06	0.06	0.05	0.06	0.06	0.07
Tamarindus indica	0	1.69	1.14	2.83	1.77	1.19	2.96
	40	1.53	0.97	2.50	1.61	0.99	2.60
	80	1.49	0.78	2.28	1.55	0.80	2.35
	120	1.18	0.74	1.92	1.23	0.75	1.98
	160	1.03	0.60	1.63	1.05	0.61	1.66
Mean		**1.38**	**0.85**	**2.23**	**1.44**	**0.87**	**2.31**
LSD 5%		0.06	0.06	0.08	0.08	0.06	0.08
Terminalia arjuna	0	1.38	0.52	1.88	1.44	0.54	1.98
	40	1.27	0.52	1.75	1.31	0.54	1.85
	80	1.26	0.40	1.67	1.29	0.42	1.71
	120	0.99	0.29	1.28	1.00	0.30	1.30
	160	0.77	0.27	1.04	0.78	0.28	1.06
Mean		**1.13**	**0.40**	**1.52**	**1.16**	**0.42**	**1.58**
LSD 5%		0.06	0.06	0.08	0.06	0.06	0.08

Conclusions

The study revealed that NaCl salinity had influenced the mortality percentage, plant growth, biomass production and chlorophyll content in *Chrysophyllum oliviforme*, *Tamarindus indica* and *Terminalia arjuna* transplants. In this regard the influence varied with the species and salt concentrations. In respect of survival, *T. arjuna* appeared more NaCl salt-tolerant than the other two species. NaCl salinity levels up to 80 mM resulted in moderate plant growth and biomass production. At the high salinity levels the roots failed to control the invasion of salt ions, which accumulated in the shoot tissue, resulting in harmful salt concentrations in the leaves. Therefore, in the seedling stage, these trees are moderately salt tolerant tree species and suitable for afforestation and planting of salt- affected lands in Egypt.

References

Abou-Hadid, A .F. (2003): The use of saline water in agriculture in the Near East and North Africa Region: present and future. Journal-of-Crop-Production.", 7: 1-2, 299-323.

Afroz, S. F.; S.H Mohammad and M.H Siddiqui (2005): Exogenous application of gibberellic acid Counteracts the 111 effect of Sodium Chloride in Mustard. Turkish J. Bio., 29:233-236.

Afzal, I.; S.M.A. Basra; A. Hameed and M. Farooq (2006): Physiological enhancement for alleviation of salt stress in wheat. Pak. J. Bot., 38(5): 1649-1659.

Arbol, L.P.; J.S.P. Yadav and F.I. Massoud (1988): Salt- affected soils and their management, FAO Soils Bull., vol. 39, Italy, Rome, 93 pp.

Bell, D.T.; J.A. McComb; P.G. Moezel and E.D. Kabay (1994): Comparisons of selected and cloned plantlets against seedlings for rehabilitation of saline and waterlogged discharge zones in Australian agricultural cantchments. Aust. For. 57, 69-75.

Chavan, P.D.and B.A. Karadge (1986): Growth, mineral nutrition, organic constituents and rate of photosynthesis in *Sesbania grandiflora* grown under saline conditions. Plant Soil 93, 395-404.

Choudhary, R.; S. Joshi; H.S. Gehlot and N. Sankhla (2003): Chlorophyll fluorescence, photosynthesis and enzyme activities in Ber *(Ziziphus rotundifolia)* under salinity stress. In: Proc. Plant Growth Reg. Soc. Amer., 30.

Corser, C.; S. Rrenault.; J. Franklin and J. Zwiazek J.(2001):The effect of salinity on the emergence and seedling growth of *Pinus mariana, Picea glauca* and *Pinus banksiana.* Environ Pollut. 115(1): 9–1

Dirr, M. A. (1976): Selection of trees for tolerance to salt injury. J. Arbor. 2:209- 216.

El- Siddig, K.; G. Ebert and P. Ludders (1999): Tamarind (*Tamarindus indica*): a review on a multipurpose tree with promising future in the Sudan. J. Applied Botany 73, 202-205.

Gebauer, J.; K. El- Siddig and G. Ebert (2001): Response of *Tamarindus indica* to salt stress. J. Appl. Bot.: 75, 97-100.

Ghassemi, F.; A.J. Jakeman and H.A. Nix (1995): Salinisation of Land and Water Resources: Human Causes, Extent, Management and Case Studies, Cab Inter., Wallingford, UK.

Grant, D.H. and G.F. Somers (1981): Salinity, aeration and the growth of *Kosteletzkya vi* A.A *rginica.* Plant Physiol. (Suppl.) 67, 18.

Hussein, M.M.M. and A.A. Haggag (2003): Effect of irrigation intervals and salt concentration on the growth and chemical composiyion of *Asclepias curassavica* L. Annals of Agric. Sci. Cairo. 48:1, 307-327.

Little, I.M. and F.J. Hills (1978): Agricultural Experimentation, Design and Analysis. Johan Wiely and Sons Inc. New York.

Little, E.L. and F.L. Wadsworth (1964): Common trees of Puerto Rico and the Virgin Islands. Agric. Handb. 249, U.S. Dept.Agric., Washington, D.C. p 548.

Mackinney, A.M. (1941): Absorption of light by chlorophyll solutions. J. Giol. Chem. 140, 315–322.

Marcar, N.E.; M.A Hossain, D.F.Crawford and A.T.Nicholson (2000a): Evaluation of tree establishment treatments on saline seeps near Underground aquiferington and Young in New South Wales, Austtralian J.of Experimental

Agrecultre. 40(1):99–106.

Marcar, N.E.; D.I. Leppert; P. Javaovic; T. Flyod and R. Farrow (2000b): Trees for salt land. A guide to selecting species for Australia, CSIRO Press, Melbourne, Australia

Mass, E.V. (1993): Salinity and citriculture. Tree Physiol (12): 195- 216.

Morton, J. (1987): Fruits of warm climates. Tamarind, p. 115-121.

Niazi, M.L.K.; M.I. Haq and K.A. Malik (1985): Salt tolerance studies on *Leucaena leucocephala*. Pak. J. Bot. 17: 43-47.

Neves, P.B.G. and N. Bernsetin (2005): Salinity induced changes in the nutritional status expanding cells may impact leaf growth inhibition in maize. Functional Plant Biol. 32: 141-152.

Rashid, A.; K.F. Hoque and M. S. Iftikhar (2004): Salt tolerance of some multipurpose tree species as determined by germination. J. Biol. Sci. 4: 288-292.

Rawat, J.S. and S.P. Banerjee (1998): The influence of salinity on growth, biomass production and photosynthesis of *Eucalyptus camaldulensis* Dehn and *Dalbergia sissoo* Roxb. Seedlings. Plant and Soil, 205: 163- 169.

Snedecor, G.W. (1956): Statistical Methods 5sted. Iowa State College Press, Ames, Iowa.

Srivastava, N.; V.L. Goel and H.M. Behl (1999): Influence of planting density on growth and biomass productivity of *Terminalia arjuna* under sodic soil sites. Biomass and Bioenergy, V. 17, Issue 3, p. 273- 278.

Svitsev, M.V.; S.A. Ponnamoreva and E.A. Kuznestova (1973): Effect of salinization and herbicides on chlorophyllase activity in tomato leaves. Fizol. Rast. 20, 62- 65.

Tal, E.V. (1986): Salt tolerance of plants. Appl. Agric. Res. 1, 12-26.

Zhu, J.K. (2001): Plant salt tolerance. Trends Plant Sci. 6, 66-71.

Assiut J. of Agric. Sci., 42 (Special Issue)(The 5th Conference of Young Scientists Fac. of Agric. Assiut Univ. May,8, 2011) (302-316)

استجابة شتلات بعض الأشجار الخشبية للري بالماء المالح

[1]عصمت فاروق على أحمد، [2]أحمد فخري على عبيد، [2]رمضان محمدمحمد سيد، [2]حسام حسن حماد

[1]قسم البساتين- كلية الزراعة- جامعة أسيوط- مصر

[2]قسم بحوث الأشجار الخشبية والغابات - معهد بحوث البساتين- مركز البحوث الزراعية- مصر

أجريت هذه التجربة بالمزرعة الاستوائية بكوم أمبو- أسوان خلال عامي 2010/2009، بغرض دراسة تأثير المعاملة بمستويات مختلفة من ملوحة مياه الرى (صفر، 40، 80، 120، 160 مللى مول من كلوريد الصوديوم) على النسبة المئوية للبقاء والنمو وانتاج الكتلة الحيوية ومحتوى الانسجه من أيونات الصوديوم والكلور و كذلك التأثير على محتوى الكلوروفيل في الاوراق.

تمت الدراسة على شتلات ثلاثة أنواع من الأشجار الخشبية الهامة وهي كريزوفيللم، تمر هندى، تيرمينااليا أرجونا *Chrysophyllum oliviforme, Terminalia arjuna and, Tamarindus indica* عمر سنة فى تجربة بنظام القطاعات كاملة العشوائية، بداية من شهر مارس الى شهريولية(20 أسبوع) من كل سنة خلال عامى الدراسة وتمت الزراعه فى بيئه نمو مكونه من الرمل والطين بنسبة 3:2 حجما لحجم. و تم رى الشتلات بمعاملات الملوحة المختلفة مرتين أسبوعيا و للمحافظة على توازن الفقد عن طريق البخر و أيضا للحفاظ علي النباتات عند مستوى الملوحة المطلوب، فقد تم رى النباتات بالماء يوم بعد يوم، أما نباتات المقارنة فقد تم ريها بالماء فقط. بعد تسجيل القياسات الخاصة بنسبة الموت، تم اجراء القياسات التالية ارتفاع النبات، قطر الساق علي ارتفاع 10 سم من سطح التربه، الوزن الطازج و الوزن الجاف للساق و الجذور ، تم أيضا تقدير محتوى الأوراق من الكلوروفيل ومحتوى أنسجة النبات المختلفة من أيوني الصوديوم و الكلور.

<u>أهم النتائج المتحصل عليها ما يلى:</u>

زيادة نسبة الموت فى الشتلات بزيادة تركيز المعاملة بالملوحة وانخفاض صفات النمو و الكتلة الحيوية

تعتبر أشجار التيرمينااليا أرجونا*Terminalia arjuna* أكثر تحملا للملوحة من باقى الأشجار موضع الدراسة حيث قلت بها نسبة الشتلات الميتة.

أعطت شتلات التمر هندي *Tamarindus indica* أعلي القيم الخاصة بصفات طول الشتلة والكتلة الحيوية مقارنة بالشتلات موضع الدراسة.

كلما زاد تركيز المعاملة بالملوحة زاد تركيز أيونات الصوديوم والكلور في أنسجة الشتلات، وكان تركيزها أكثر فى الجذور.

زيادة تركيز الملوحة فى محلول الرى للشتلات أدى الى انخفاض محتوى الأوراق من الكلوروفيل. وبناء على النتائج المتحصل عليها فان هذه الأشجار تعتبر متوسطة التحمل للملوحة، وأن أشجار تيرميناليا أرجونا*Terminalia arjuna* أكثرها تحملا وقد أتضح ذلك في قلة نسبة الشتلات الميتة، يليها أشجار الكريزوفيللم *Chrysophyllum oliviforme* ثم أشجار التمرهندي *Tamarindus indica* لذا يمكن لهذه الأشجار أن تتحمل قدرا من الملوحة خاصة فى ظل وجود الأراضى المتأثرة بالملوحة فى مصر.