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Effect of Different Dilutions of Sea Water on Germination and Seedling Performance of Some Acacia Tree Species

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ABSTRACT

An experiment was conducted in the Faculty of forestry nursery at Shambat campus (University of Khartoum) in plastic containers during the period February- June 2008 to determine the salinity tolerance of the: *Acacia mellifera, Acacia nubica, Acacia seyal, Acacia Senegal, Acacia tortilis.* Authenticated seeds were obtained from Tree Seed Centre - Agricultural Research Corporation at Soba,Sudan. Sea water was transported from Port Sudan and mixed in calculated quantities with tap water to prepare the following concentrations: 5 dSm^{-1},10 dSm^{-1}, 15 dSm^{-1}, 20 dSm^{-1} plus pure tap water (0.4 dSm^{-1}). Soil was Red loamy sand from western Omdurman (El Rawkeep).Initially 50 seeds were sown in each pot then thinned to 10 seeds in the first 5 weeks and watered by tap water every other day. Thereafter, tap water plus sea water was used as per the calculated concentration according to field capacity. The irrigation amount for each plot was One liter plus 25 milliliters as leaching requirement. The following measurements were recorded: germination and survival percent shoot length, root length. Measurements were taken 3 times in the first week, twice in the second week and once in the third and 4th week, then once every two weeks followed by once every three weeks. The final measurements were taken after a month from the last measurements i.e after 18 weeks from seeding. Statistical analysis was done according to SAS program & Duncan's multiple range tests. The results showed that all seeds of the tested species germinated in concentrations of 0.4 dsm^{-1}, 5 dsm^{-1} ,10 dsm^{-1}. But no germination was obtained at 15 dsm^{-1},20 dsm^{-1}. The results further showed that there were significant differences at P=0.05 between 10 dsm^{-1}, 15 dsm^{-1} and 0.4 dsm^{-1}, . Significant differences were found between 10 dsm^{-1}, 15 dsm^{-1} . Significant differences were found between 10 dsm^{-1}, 15 dsm^{-1}, and 20 dsm^{-1} for all measurements. The results indicated that the most salinity tolerant species were *Acacia mellifera* and *Acacia tortilis* followed by *Acacia senegal* while. *Acacia nubica* and *Acacia seyal* were weekly tolerant. The ere fore *Acacia mellifera* and *Acacia tortilis* are recommended. For afforestation-reforestation in saline sites and for utilizing sea water: rain water-mixture in the area. It is further recommended that field trials be conducted for evaluating the performance of these species in the field.

Keywords: *Red Sea water, EC, Acacia species, salinity tolerance*.

1. INTRODUCTION

To meet the ever increasing demands for food and feed, all possible potential resources should be tapped for future need. In this context, sea water is to be used for crop production.

Sea water is a complex solution containing a large number of elements-ions, gases, organic matter, micro-fauna, micro-flora etc. Salinity is measured and expressed on the basis of electric conductivity – ECe {7}. According to {3}, ECe of Red sea water range from 52.3 to 60.7 dsm^{-1}. Moreover, salinity and temperature of Red sea water are higher than other seas of the world {1}. Forestation of salt affected land will be necessary to stop further land degradation and amelioration of local environment thus paving the way for multi- purpose land use such as agroforestry particularly in dry lands. Saline agriculture had gained momentum all over the world viz. Africa Mediterranean, Middle East, Arabian Peninsula, Pakistan, India, East Asia, China, South East Asia, Australia, and America. Agriculture use of saline water can benefit many developing countries. The international center for Bio-

Saline Agriculture in Dubai (U.A.E.) is engaged in developing and promoting the use of sustainable agriculture systems that use saline water to grow crops {15}. In the Arabian Peninsula productive land and renewable fresh water resources are limited and being exploitedat a rapid rate there is need to demonstrate the value of saline water resources for useful plant and crop production{10}. In the Gulf States – saline agriculture is practiced for a long time. Trees such as Acacia and prospis species have valuable role to play in reforestation of degraded lands.In this respect,{9} reported that certain Acacia species such as acacia tortilis, Acacia nilotica, Acacia seyal are tolerant to moderate salinity..;Generally the seedling height decrease with increase in. salinity which affects growth and seedling establishment adversely...along the Red Sea coast certain Shora tree species e.g. Avicennia marina are well adapted and grow luxuriously inside the sea forming excellent habitats for sea life and fish breeding. In addition, the leaves are cherished by camels which are the commonest grazing animals in the region. Rainfall is very low and subject to great variation. But sea water is abundant and may be mixed with rain water for afforestation-reforestation projects with suitable tree species that are relatively salinity tolerant e.g. certain *Acacia species* as reported by Hussein and Ibrahim {9}. *Acacia species* are wide spread in Sudan particularly in the central states and the sub-deserts of North Sudan {4}. The genus *Acacia* is of versatile use: fuel wood, grazing and fodder, gums, soil reclamation, timber, medicinal and desertification control. This research was conducted to test the tolerant of the selected *Acacia* tree species using calculated amounts of sea water - tap water mixtures for rising pot seedlings with the object of gauging the suitable salinity – tolerant tree species for afforestation – reforestation purposes along the Red Sea coast in particular and use of saline water for forestation in general.

2. MATERIALS AND METHOD

Seeds of five common *Acacia species* (*Acacia mellifera, vahl, Acacia nubica, Acacia senegal(L) Acacia seyal, dahl, Acacia tortillis, Forsk*) were tested in the laboratory for confirming their viability before establishing the salinity tolerance test in pot experiments during February – June 2008. To find out the feasibility of the potential use of Red Sea Water mixed with fresh tap water for irrigation. Seeds were procured from the forest seed centre in Elgederef and Eldamazin. Growth media was red loamy sand soil from El Rawkeep site (West Omdurman) with the following attributes: ECe 4.36 dSm^{-1}, SAR 4.61, PH 7.7, F.C. 13%, sand 82.3% Silt 3.2%, Clay 14.5%.

Irrigation water was pure Red Sea Water (ECe 57 dSm^{-1}) mixed with tap water (Ece 0-4dsm-1) to give different dilutions according to Richard et al (1969) :-

$$ECM = \frac{ECs\ Vs + ECf\ \ Vf}{Vs + Vf}$$

Where

ECM = Electric conductivity of Sea Water + Fresh Water

Vs and ECs = Volume and Electric conductivity of Sea water

Vf and ECf = Volume and Electric conductivity of fresh water

The seeds were treated with sulfuric acid and sown in plastic bags (27 cm height, 26 cm internal diameter) filled with loamy sand soil (7kg) arranged in a factorial design at the faculty of Forestry nursery, University of Khartoum – Shambat Campus. Fifty seeds were sown in each pot and thinned to 10 germinant of equal height uniformly distributed in the pot. For the initial, five weeks, pure tap water was used for irrigation every other day. There after mixed sea water and tap water at different salinity levels was used for irrigation according to the calculated soil field capacity. The irrigation requirement was estimated as one liter per pot per irrigation plus an additional 25 ml added as leaching requirements. Growth parameters measured were germination and survival percentage, shoot length, root length. Measurements were taken at different intervals for 18 weeks: 3 times in the first week, twice in the second week, once in the 3th and 4th week, once every 2 weeks, and once every 3 weeks.. Statistical analysis was done according to SAS program and Duncans Multiple Range Test.

3. RESULTS AND DISCUSSION

Germination tests showed that seeds germinated at EC up to 10 dSm^{-1}but failed at EC 15 dSm^{-1} and 20 dSm^{-1}. Significant differences ($p \leq 0.05$) were obtained between the treatments (Table1, 2).The number of seeds germinated was higher in the fresh water treatment throughout the experimental period compared to the different levels of salinity (Table 1). This result is in agreement with {13},{14} and {9} who reported that salinization results in delayed seed germination; the activity of solution constituents including water is reduced by the increase of ionic strength (salt concentration).

Table 1: Salinity effect of mixed Red Seawater/Fresh water on seed germination

Level	Days after growth															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
C 0	5.0 a	8.05a	9.45a	9.65a	9.6 a	9.6 a	9.6 a	9.6 a	9.6 a	9.6 a	9.6 a	9.6 a	9.6 a	9.6 a	9.6 a	9.6 a
C 5	3.55b	6.9 b	8.2 a	8.5 b	8.5 b	8.5 b	8.5 b	8.5 b	8.5 b	8.5 b	8.5 b	8.5 b	8.5 b	8.5 b	8.5 b	8.5 b
C 10	0.8 c	1.9 c	2.70c	2.9 c	2.9 c	2.9 c	2.9 c	2.9 c	2.9 c	2.9 c	2.9 c	2.9 c	2.9 c	2.9 c	2.9 c	2.9 c

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C 15	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d
C 20	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d

Values in the same column having different letter are significantly different by Duncan Multiple Range test (DMRT).
C0≠0.4d sm^{-1} C5≠EC 5 d sm^{-1} C10≠ EC 10 d sm^{-1} C15≠ EC 15d sm^{-1} C20≠ EC 20 d sm^{-1}

Table 2: Effect of Salinity Mixed Red Seawater/Freshwater on Survival %.

	Days after growth									
Level	36 days	38 days	41 days	44 days	48 days	55 days	62 days	76 days	97 days	127 days
C 0	100.00a	100.00a	100.00a	100.00a	100.00a	100.00a	100.00a	100.00a	100.00a	100.00a
C 5	100.00a	100.00a	100.00a	100.00a	100.00a	100.00a	100.00a	100.00a	100.00a	100.00a
C 10	100.00a	100.00a	100.00a	99.500 a	98.500 a	89.500 b	71.500 b	49.000 b	49.000 b	40.0 c
C 15	100.00a	100.00a	100.00a	89.000 b	79.000 b	48.000 c	34.000 c	13.000 c	9.000 c	0.0001 d
C 20	100.00a	100.00a	98.500b	82.000 c	67.500 c	20.500 d	20.500 d	4.000 c	0.000 c	0.0001 e

Values in the same column having different letter are significantly different by Duncan Multiple Range test (DMRT).
C0≠0.4d sm^{-1} C5≠EC 5 d sm^{-1} C10≠ EC 10 d sm^{-1} C15≠ EC 15d sm^{-1} C20≠ EC 20 d sm^{-1}

In the pot experiments, statistical analysis showed significant differences (p>0.05) between EC 10 d sm^{-1} and EC 0.4d sm^{-1} and EC 5dsm^{-1} collectively; likewise between EC 10d sm^{-1} and EC 15d $sm^{-1}$and EC 20d sm^{-1}. The threshold EC value seems to be 10dsm^{-1} beyond which tolerance succumbs (Table2). Shoot length was drastically reduced at 10 d sm^{-1} , 15 d sm^{-1} and 20 d sm^{-1} (Table 3).Similarly with root length (Table 4). This is in agreement with {7}and {11} who reported that soil salinity does not reduce crop performance significantly until a threshold value of ECe is reached. Beyond this value growth and yield decrease almost linearly as salinity increases. {2} ststed that the fodder species tested (*Eragrostis tef*, *Cloris gayana*, *Sorgum bicolr*) grew satisfactorily at all levels of salinity used – up to 1:2:5 sea water: fresh water mix. Elmahi and Eltom {5} concluded that barley plants grew satisfactorily using irrigation water of EC 19.3 dsm^{-1} (1:2 sea water: fresh water mix.) but growth was very poor at EC 28.7 dsm^{-1} (1:1 sea water: fresh water mix.). The tolerance rating of pot experments was as follows: *Acacia mellifera* and *Acacia tortilis* > *Acacia senegal* > *Acacia nubica* > *Acacia seyal*. shoot length showed significant differences (P<0.05) between EC 10d sm^{-1} and EC 5d $sm^{-1;}$ the highest shoot length (42.5cm) was obtained in seed lings irrigated with tap water followed by EC 5 d sm^{-1} (42.1cm) followed by EC 10 sm^{-1} (6 cm) - there was no shoot growth at EC 15 sm^{-1} and EC 20 d sm^{-1} (Table 4.). This is in agreement with {8} who reported that salinity problems inhibit the uptake of eventual macro - nutrients such as nitrates and ammonium and inorganic phosphorus in seedlings. The shoot length were rated as Acacia *mellifera* - *Acacia tortilis* > *Acacia Senegal* > *Acacia nubica* and Acacia *seyal*.

Table 3: Effect of Salinity Mixed Red Seawater/Freshwater on seedling length (cm).

Days after growth										
Levels	**36 days**	**38 days**	**41 days**	**44 days**	**48 days**	**55 days**	**62 days**	**76 days**	**97 days**	**127 days**
C 0	13.6000a	15.7000a	17.700a	20.7000a	23.700a	26.3000a	29.50 a	3`2.5000	37.500 a	42.500 a
C 5	13.8000a	15.45 a	17.455000a	20.4500a	23.4500a	26.0500a	30.050a	33.0500a	37.1000a	42.1000b
C 10	14.0500a	14.2500b	16.2500 b	18.2500b	19.3500b	21.3500b	13.500b	10.550 b	9.95000b	6.00 b
C 15	13.7500a	13.900 b	15.9000 b	16.9000c	16.9000c	17.9000c	11.200b	3.200 c	0.7500 c	0.0000 c
C 20	13.3500a	13.3500c	15.0500c	16.0500d	14.6500d	6.5000 d	5.8500b	2.80 c	0.0000 c	0.0000 c

Values in the same column having different letter are significantly different by Duncan Multiple Range test (DMRT).
C0≠0.4d sm^{-1} C5≠EC 5 d sm^{-1} C10≠ EC 10 d sm^{-1} C15≠ EC 15d sm^{-1} C20≠ EC 20 d sm^{-1}

Table 4: Effect of Salinity Mixed Red Seawater/Freshwater on root length (cm).

Days after gowth										
Levels	36days	38days	41days	44days	48 days	55days	62 days	76 days	97 days	127 days
C 0	13.8000a	14.8500a	16.8500a	19.8500a	22.8500a	25.9500a	29.8000a	32.1500 a	33.1500 a	36.800 a
C 5	13.8000a	14.4500 ba	16.4500 a	19.4500 a	22.4500 a	25.8000 a	29.1500 a	32.80 a	33.8000 a	35.6000a
C 10	13.7000a	14.4 500 ba	15.3684 b	17.4500b	18.5500 a	20.5500 b	13.1500 b	10.30 b	9.8500 b	6.0000 b
C 15	14.0000a	14.5000 ba	14.6000 c	15.500 c	15.5000 c	16.5000 c	10.5500 c	3.200 c	3.000 c	0.0000 c
C 20	13.5500a	13.9500 b	14.000 d	14.9500d	14.200 d	6.05000 d	5.75000 d	2.80 c	0.0000 d	0.0000 c

Values in the same column having different letter are significantly different by Duncan Multiple Range test (DMRT).
C0≠0.4d sm^{-1} C5≠EC 5 d sm^{-1} C10≠ EC 10 d sm^{-1} C15≠ EC 15d sm^{-1} C20≠ EC 20 d sm^{-1}

Significant differences ($P \leq 0.05$) were obtained between EC 10dsm-1 and EC 5 d sm^{-1} .There were no significant differences between tap water ECeo.4 dsm-1and EC 5 d sm^{-1} .The longest roots were obtained by *Acacia mellifera*, *Acacia tortilis*, *Acacia senegal*, *Acacia nubica* and *Acacia seyal* in sequence of magnitude. Variation was greatest between tap water and EC15 d sm^{-1} or EC 10 d sm^{-1} and EC 5 d sm^{-1} .

In conclusion *Acacia mellifera*, *Acacia tortilis* and *Acacia senegal* are salinity tolerant. It is, therefore, recommended that these species be the choice for forestation programs using Red Sea Water mixed fresh water in the Red Sea coast area. It also appropriate that rain water harvesting is encouraged so that fresh water be mixed with sea water for crop production along the Red Sea coast.

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