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Effects of Underground Saline Water of the UAE on Seed Germination, Seedling Growth and Chemical Constituents of *Prosopis tamarugo*

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Abstract: Underground saline water can constrain agricultural and horticultural production through impairment of germination and early growth of seedlings. Effects of salinity were investigated in legume salt tolerant *Prosopis tamarugo* at germination and early seedling stages. Seeds were treated during germination with either distilled water or one of six concentrations. The results showed that high salt concentrations (50%, 75% and 100% of underground saline water) had significant effects on germination percentage and seedling characteristics, while low concentrations (6.25% and 12.5%) tended to have promotive effect. The best results were obtained by using 25% of saline water. Quantitative variations in protein, carbohydrate, lipids, photosynthetic pigments and oxygen uptake were determined.

Key Words: Constrain Agriculture, Horticultural Production, Impairment of Germination, *Prosopis tamarugo*

Introduction

In arid and semiarid lands such as the United Arab Emirates (UAE) there is a severe shortage of irrigation water and even the limited available water is relatively saline. Certain trees and shrubs can through their physiology and architecture, compete with other vegetation for moisture and nutrients and thus tolerate harsh arid climatic conditions. Their deep roots allow them to with stand blowing by wind and flash floods, which occur in this region to reach very low water tables, such plants also help in stabilizing soil.

Prosopis species are shrubs or trees with very deep tap root systems. It belongs to the family Mimosoiceae and the fruit is a fleshy indehiscent legume. The genus *Prosopis* includes about forty-five species which are widespread throughout North, Central and South America, Northern Africa and Western Asia. Most of the species are concentrated in South America with greatest variety found in Argentina (Catalan and Balzarini, 1992). Mesquite is a common name used to describe *Prosopis* species. *P. cineraria* and *P. juliflora* have been reported to grow in the U.A.E. under high stress condition of drought, *P. cineraria* is associated with the sand dunes in the desert around Al-Ain area in the U.A.E. (El-Ghonemy, 1985).

In Chile *Prosopis tamarugo* is known to grow in salinities equivalent to sea-water (Felker *et al.*, 1981). It is being considered for introduction into the U.A.E. Rhodes and Felker (1988) reported on the mass screening of *Prosopis* seedlings for growth at sea-water salinity concentrations. *P. tamarugo* appears to be multipurpose tree. Fuel-wood has been produced on salt-effected sites from *P. tamarugo* (Midgley *et al.*, 1986). Green leaves of *P. tamarugo* can be used for feeding desert animal. Being nitrogen-fixing legume, *P. tamarugo* adds nitrogen to the soil and renew the soil fertility (Mergen, 1988).

Wells in the Nashalah area of the UAE. Were formerly used for irrigation and domestic purposes, but are now being abandoned because of increasing salinity. This present study was undertaken to find out the effect of irrigation with different concentrations of well-water (moderately saline water) on germination and growth physiology of *P. tamarugo*.

Materials and Methods

P. tamarugo seeds were provided by Corporacion Nacional Forestal Centro De Semillas Forestales, Chile. Water containing approximately 18,000 ppm total salts (sea water = 40,000 ppm) was obtained from wells, formerly used for irrigation, situated at Nashalah UAE, (50 Km NW Al-Ain and stored before use at 5° C for about two months. The well-water was chemically analysed following Varma (1987) and then diluted with distilled water to give six concentrations: 6.25, 12.5, 25, 50, 75 and 100%.

Tested seeds were soaked in concentrated sulphuric acid (96%) for 20 minutes, then washed thoroughly with tap water to remove all acid traces, then socked in distilled water for 6 hours and germinated in pots containing perlite. The pots were irrigated every 3 days with distilled water (control) or with treatment solution. Three replicates of 50 seeds were used for each treatment. Growth experiments and chemical analysis were carried out at the end of 21 days.

Seedlings were dried in an aerated oven at 70° C to constant weight (ISTA, 1985). Total carbohydrate was determined from oven dried materials as described by Naguib (1964). Protein content was determined spectrophotometrically according to Lowry modified method (Peterson, 1977). Total lipid was extracted and determined according to Bligh and Dyer (1959). Photosynthetic pigments were estimated spectrophotometrically according to Metzner *et al.*, (1965). Oxygen uptake was estimated using Warburg apparatus as described by Clark and Switzer (1977).

Results and Discussion

The chemical properties of Nashalah well water are: pH = 7.68, CO_3 = 0.7 meq/l, HCO_3 = 2.0 meq/l, Cl = 600 meq/l, SO_4 = 100 meq/l, Ca = 49 meq/l, Mg = 121 meq/l, Na = 535 meq/l, and K = 6.1 meq/l.

Table 1: Effect of Saline Underground Water of the UAE on Germination and Early Growth of *Prosopis tamarugo*

Concentration of saline water (%)	Total germination (%)	Abnormal seedlings (%)	Seedling length (mm)		Seedling weight (mg)*					
					Fresh			Dry		
			Root	Shoot	Root	Shoot	Seedling	Root	Shoot	Seedling
0.00**	96.7±2.52	2.3±1.16	97.1	47.8	113	722	835	61	101	162
6.25	95.3±3.79	3.7±1.53	99.4	47.8	153	895	1048	66	230	296
12.50	96.3±2.08	1.7±1.16	104.7	52.2	175	971	1146	78	261	339
25.00	98.3±1.16	1.3±0.58	113.6	55.4	217	1342	1559	94	317	411
50.00	89.0±2.65	11.3±2.52	102.5	52.7	213	1249	1462	89	267	356
75.00	75.3±4.51	20.0±3.0	93.5	48.6	158	1116	1274	74	247	321
100.00	57.3±3.79	38.3±3.06	85.3	46.8	134	967	1101	65	211	376

* Weight of 20 seedlings.
** Control.

Table (1) and Fig. (1-a to d) show the results of germination experiment using different concentrations of saline water.

It is clear that concentrations of saline water up to 25% had no significant adverse effect on germination percentage, whereas further increase in concentration resulted in a decrease in germination percentage accompanied by an increase in percentage of abnormal seedlings. Few seeds of annual succulent halophyte *zygophylum simplex* germinated at concentrations above 100 mm NaCl (Khan and Ungar, 1997). Final germination percentage was reduced by 22.1% and 40.7% at 75% and 100% saline water respectively, also 26.6% and 66.8% of germinated seeds were abnormal (Table 1). Root and shoot lengths of seedlings were increased by 16.9% and 15.9% respectively, at 25% saline water, higher concentrations showed adverse effects. At 100% concentration, the length of root was reduced by 12.1%, while the shoot length slightly reduced (2.1%) comparing with the control. Same results has been reported *in Atriplex patula* by Ungar (1996), six halophyte species by Maher and El-Haddad (2000), and *Atriplex cordobensis* by Aiazzi *et al.,* (2002). Fresh and dry weights of seedlings were increased by 31.9% and 132.1% respectively at 100% saline water compared to the control. This may be due to the present of high amount of mineral elements in the saline water, which stimulated the metabolic processes in the seedlings, and/or accumulation of certain osmo-regulating compounds. Similar findings have previously been reported by Miller and Chapman (1978) on three forage grasses, Mahmoud and Malik (1986) on *Atriplex undulata.*, Khan *et al.,* (1987), Rhodes and Felker (1988) on *Prosopis* spp and Ashraf and Wahid (2000) on maize fresh weight.

Fig. (1-e) shows that saline water up to 25% concentration had no effect on protein content, while the protein content was reduced by 56.5% at 50% saline water. In seedlings irrigated with 6.26% and 12.5% saline water, the carbohydrate content increased by 51.3% and 25% respectively, while 75% reduction in carbohydrate content was occurred when high concentration (100%) was used. The increases of total lipids (phospholipids and neutral lipids) were little changed in different concentration levels (Fig. 1-f). The maximum increasing in total lipids (156%) was detected in seedlings irrigated with 12.5% saline water. Reductions in carbohydrate and protein at higher concentrations of salinity may be due to reductions in the enzymatic involved in their synthesis and/or the active transport of certain minerals. Synthesis of other compounds like proline which function as a source of solute for intracellular osmotic adjustments under saline conditions (Stewart and Lee, 1974), or lipids, which greatly increased. Similar results were obtained by Ahmad *et al.,* (1985), and Aslam *et al.,* (1986) in some halophytes and also in fungi grown in the presence of high NaCl concentrations (El-Mougith, 1993).

Fig. (1-g) shows that chlorophyll (a) was the dominant pigment followed by chlorophyll (b) then carotenoids. These pigments decreased in seedlings irrigated with different saline water concentrations. Greater reductions in photosynthetic pigments were occurred as the concentration of saline water was increased (100%). The amount of chlorophyll (a), chlorophyll (b) and carotenoids, were reduced by 86.6%, 89.3% and 89.5% respectively. These results may explain the reduction in protein and carbohydrate in *Prosopis* seedlings. This, findings are supported by the studies of Chavan and Karadge (1986) in *Sesbania grandiflora*, and Shaybany and Kashirad (1978) in *Acacia saligna*, Hajer *et al.,* (1996) in *Nigella sativa*. However Rozema (1975 and 1976) reported that chlorophyll content is not strongly influenced by salt in *Glaux maritima* and in four *Juncus* species.

Oxygen uptake (respiration) of normal and abnormal seedlings irrigated with different concentrations of saline water increased compared to the control (Fig. 1-h), the maximum was found in normal seedlings irrigated with 75% saline water and in abnormal seedlings irrigated by 50% saline water. The percentages of increase were 293% and 115.5% in normal and abnormal seedlings respectively. Such increase in O_2 uptake may explain the reduction in carbohydrate content which may have been consumed to release the required energy to synthesize special compounds for intracellular osmotic adjustments (Storey and Wynn-Jones, 1979).

The control seedlings, which were irrigated with distilled water were totally dependent on their original seed reserves of minerals. These seedlings may suffer deficiencies in some essential or trace elements, leading to reduced rates of anabolic reactions and a below normal concentrations in protein, carbohydrate, lipids and photosynthetic pigments as compared with seedlings irrigated with low concentration of saline water. The slight increases in seedlings length, weight

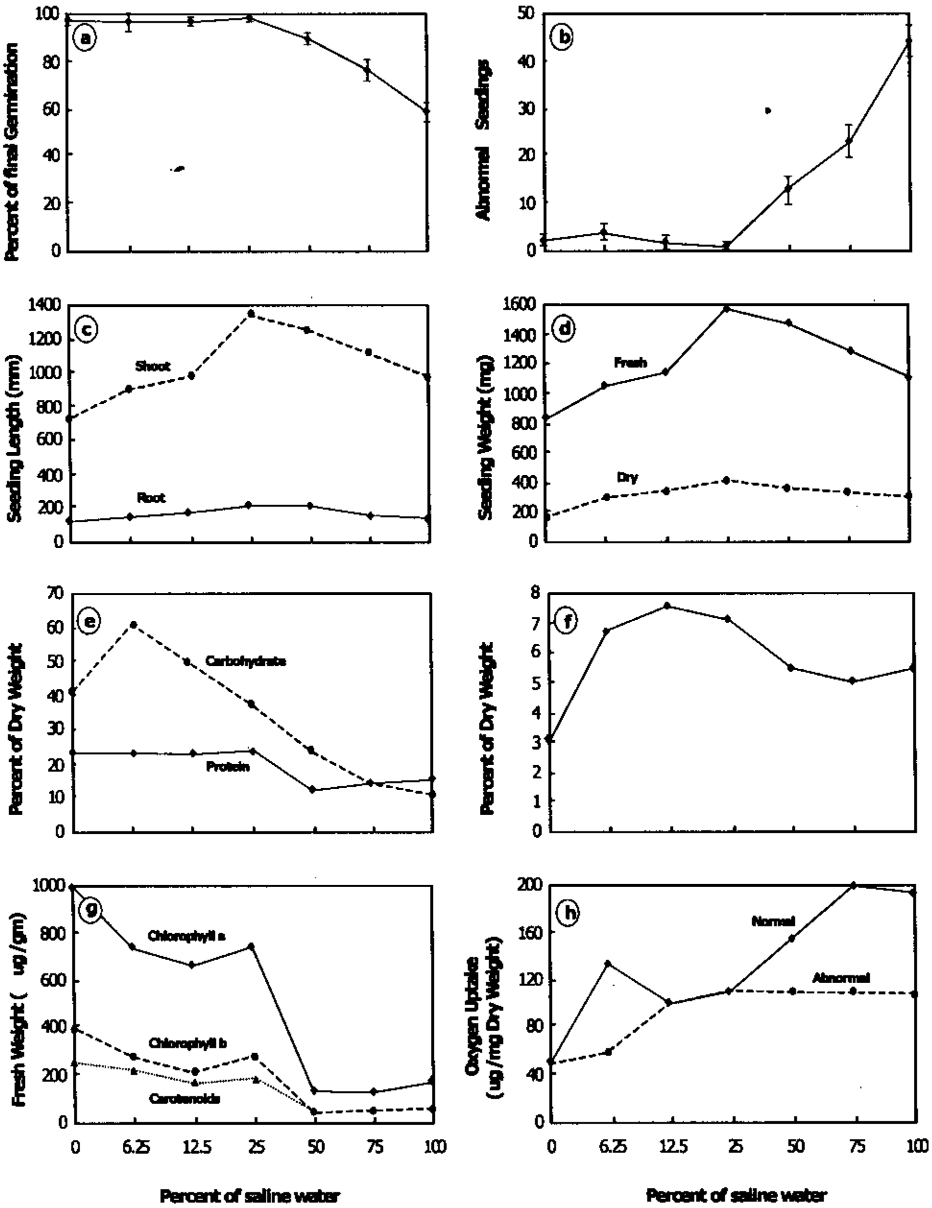

Fig.1. Effect of saline water on (a) find germination percentage. (b) total abnormal seedings. (c) root and shoot lengths. (d) fresh and dry weights. (e) total levels of carbohydrate and protein. (f) total lipids. (g) photosynthetic pigments. (h) respiration. of *Prosopis tamarugo.*

and percentages of carbohydrate, protein and lipid in seedlings irrigated with low concentrations of saline water suggest that a deficiency of mineral elements in the plant and therefore, their supply from saline water gave positive responses while, further increases in saline water concentration resulted in osmotic stress (Mansour, 1994) or toxicity (Tobe *et al.*, 1999). This seems to fit well with the idealized plot suggested by Walworth and Sumner (1988) for plant growth in response to mineral nutrients concentrations.

Conclusion

From the results presented in the current study of *Proropis tamarugo* seeds, showed that high concentrations (50%, 75% and 100%) of saline water had adverse effects on final germination percentage, and seedling characteristics, while low concentrations (6.25% and 12.5%) tended to have promoted effect. The best results were obtained by using 25% saline water. Protein, carbohydrate and photosynthetic pigments were decreased in seedlings irrigated with high concentration of saline water, while lipids and oxygen uptake were increased by using high concentration.

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