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Ecological Studies on *Salix* Distribution in Egypt

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Abstract: The present research studied the ecological factors affecting *Salix* distribution in Egypt. Two species of *Salix* were recorded, *S. tetrasperma* (only male) and *S. mucronata* (both sexes). They were recorded at River Nile canal system and in the Eastern Oasis. Female *S. mucronata* was recorded in the all studied habitats, where the male of same species was recorded only in Fayoum Region. *Salix tetrasperma* neither recorded in Upper Egypt nor Eastern Oasis. Elevation from water surface, soil texture, soil salinity and temperature were the most effective factors affecting the distribution of *Salix* sp.

Key words: *Salix*, distribution, ecology

INTRODUCTION

Salicaceae comprises two main genera, *Salix* (willows) and *Populus* (poplars). It exhibits many characteristics that allow it to grow in habitats subjected to flooding and disturbance through erosion and deposition of sediments (Karrenberg *et al*., 2002).

Salix is a colonizing floodplain genus characterized by vigorous growth rate and production of a massive root system that can rapidly stabilize stream bank sediments (Grissinger and Bowie, 1984; Hupp, 1992; Van Splunder *et al*., 1996; Shields *et al*., 1995; Anonymous, 2005). It also occurs in ditches and on the edges of swamps, lakeshores and other wetland habitats. It is ideal for stream bank restoration because of its easily propagated from cuttings, quickly growth and providing rapid soil stabilization (Bentrup and Hoag, 1998; Cronk and Fennessy, 2001). Willow (*Salix*) has been cultivated for an agricultural crop to many purpose, such as for bioenergy (Perttu, 1998), making baskets, made a tea from the bark and some medical uses (Foster and Duke, 1990).

Several environmental factors such as soil moisture and soil texture have been identified as being critical in determining survival and performance of planted willow cuttings (Pezeshki *et al*., 1998; Schaff *et al*., 2003). Water table decline and the associated water stress have been also, cited as one of the most common causes of mortality in *Salix* species in the field (Mahoney and Rood, 1992; Karrenberg *et al*., 2002). Inadequate soil moisture leading to plant desiccation was reported as one of the causes of first year mortality of willow cuttings planted in riparian habitats (Shields *et al*., 1998; Karrenberg *et al*., 2002). Such unrooted cuttings are especially vulnerable to low soil moisture conditions early in the growing season due to transpiration water losses until root systems, with their vascular tissues have developed (Grange and Loach, 1983; Ikeda and Suzaki, 1986).

Genus *Salix* L. in Egypt represented by two wild species, *Salix tetrasperma* Roxb. and *Salix safsaf* Trautv. (latter treated as *Salix mucronata* Thunb.); as recoreded by Täckholm (1956, 1974) and Boulos (1999). These species, in addition to its medicinal values, attained a special historic and ethnic importance in Egypt. *Salix* species are distributed in Nile and Faiyum Regions, in addition to Mediterranean coastal strip. Earlier study recorded the presence of both species in western desert Oases (Bolous, 1999). In Egypt, *Salix* sp. are used frequently as a restoration species, while other *Salix* sp. are widely used elsewhere (Svejcar *et al*., 1992; Hoag, 1993, 1995; Anonymous, 2005). *Salix tetrasperma* and *S. mucronata*, as many other *Salix* sp., regenerate from root and shoot fragments and is often planted along stream banks as dormant, unrooted cuttings (Bentrup and Hoag, 1998; Cronk and Fennessy, 2001).

Egypt is an arid country which depends almost entirely on the River Nile for its water supply; agriculture is almost totally dependent on this source. It is estimated that the Nile provides 95% of the country's fresh renewable water supply. There is no any earlier study on factors affecting distribution of *Salix* in Egypt. The present study deals with environmental factors affecting the distribution of *Salix* sp. in Egypt.

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MATERIALS AND METHODS

Field trips were carried out during the study years 2005-2008. Fifteen trips were carried out covering the River Nile and its water canal system from Upper Egypt (Aswan) to lower (Alexandria) and Baharia Oasis.

Soil sampling and analysis: For each habitat three soil samples were collected from profiles of 10-50 cm depth under *Salix* sp. These samples were then pooled together to form one composite sample, air-dried and thoroughly mixed. Thirty composite samples were obtained representing all *Salix* habitats. Textures were determined by the hydrometer method, providing quantitative data on the percentage of sand, silt and clay. The concentration of soil minerals Na^+, K^+, Fe^{3+}, Ca^{2+} and Mg^{2+} in soil were determined using a Perkin 403 atomic absorption spectrophotometer (Perkin-Elmer Corp, Norwalk, Conn., USA) according to Analytical Methods for Atomic Absorption Spectrophotometry, Levinson (1983). Chlorides were quantified by titrating 5 mL of the 1 : 5 soil/distilled water extract against 0.01 N silver nitrate solution using potassium chromate (1%) as indicator. Bicarbonates was determined by titrating 5 mL of the 1.5 soil/distilled water extract against 0.01 N HCl using phenolphthalein and methyl orange as indicators (Jackson, 1962). pH and conductivity of the soil samples were determined in saturated soil paste extract by pH and conductivity meters, respectively. Temperature measurements were obtained from the Egyptian Meteorological Station. The percentage of organic carbon in the soil was determined by Walkely and Black's rapid titration method according to Ryan *et al*. (1996).

Statistical anlysis: Pearson correlation coefficient has been calculated to find out the correlations between *Salix* sp. and soil parameters.

RESULTS

The extensive survey in the present study reported two *Salix* species, *S. tetrasperma* and *S. mucronata* (male of the former species and the two sexes of the other one) (Table 1, Fig. 1). *Salix* species were recorded, in canal banks, ditches, on the edges of swamps and lakeshores, a habitats characterized by high moist content.

Table 2 shows that soil analysis where *Salix* found characterized by electric conductivity (as a salinity indicator) ranging from 0.4 to 2.9 mS cm^{-1}, slightly alkaline (with mean pH 7.4). *Salix* sp. reported in varied soil textures but mainly occurred in a medium soil texture, loamy sandy soil. Female *S. mucronata* reported in

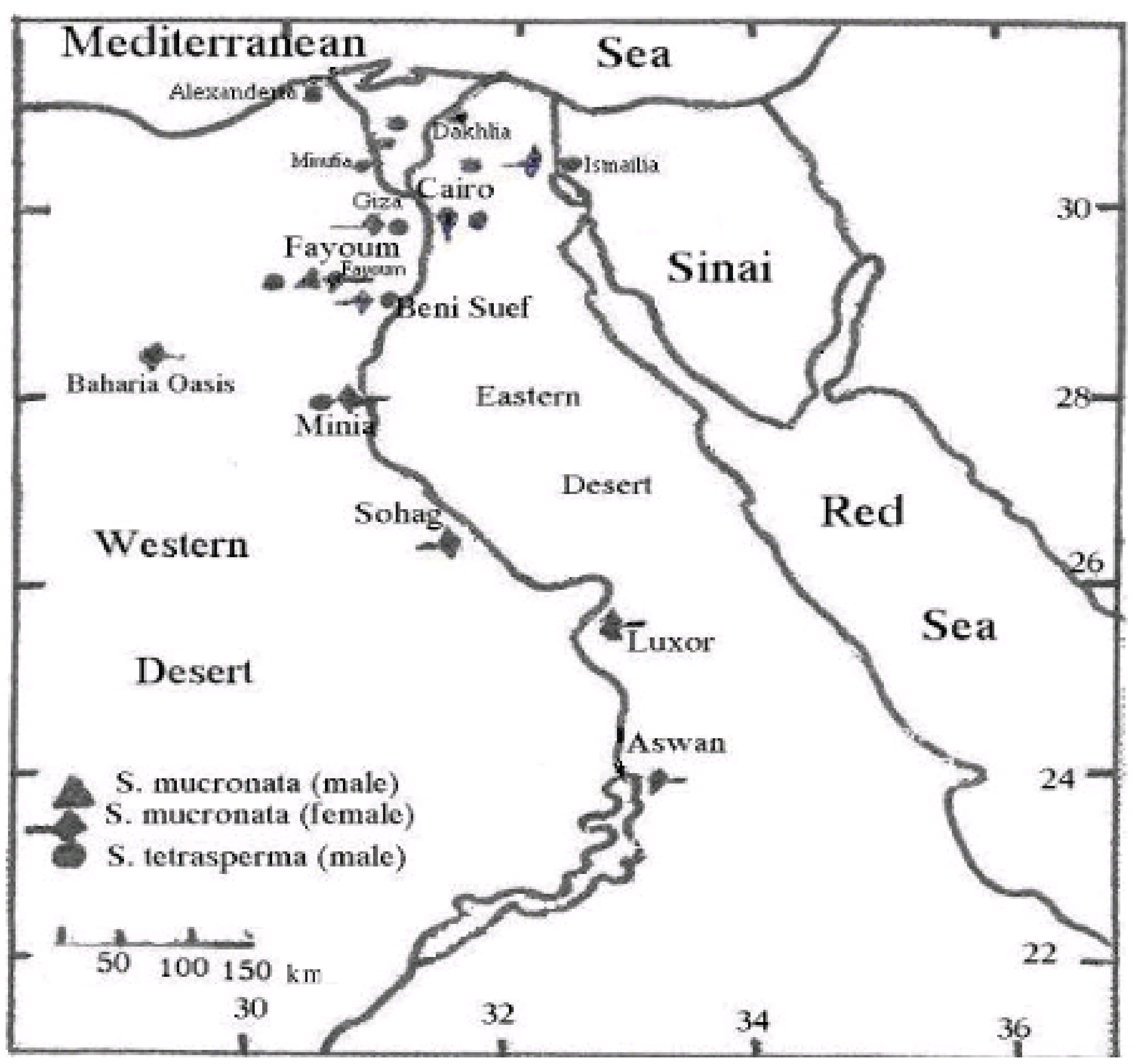

Fig. 1: Distribution of *Salix* sp. in Egypt

Table 1: Distribution of *Salix* sp. in different parts of Egypt

Species	Upper Egypt	Middel Egypt	Lower Egypt	Fayoum	Bahria Oasis
S. tetrasperma (male)	-	+	+	+	-
S. mucronata (male)	+	+	+	+	+
S. mucronata (female)	-	-	-	+	-

+: Present, -: Absent

Table 2: Elevation from water surface and soil parameters of different parts of Egypt

Parameters	Upper Egypt (6)*	Middel Egypt (7)	Lower Egypt (7)	Fayoum (5)	Bahria Oasis (5)
Elevation	1.1±0.1**	0.8±0.1	0.9±0.2	0.5±0.1	0.8±0.2
Sand (%)	85.0±1.4	82.0±00.1	83.2±1.4	81.5±1.7	83.5±1.7
pH	7.3±0.3	7.5±0.4	7.2±0.2	7.4±0.3	7.9±0.4
Organic matter (%)	1.1±0.01	0.3±0.01	1.2±0.1	1.8±0.4	0.1±0.01
EC (mS cm^{-1})	0.4±0.02	0.5±0.1	1.3±0.3	0.6±0.1	2.9±0.5
Na (mg kg^{-1}) soil	289.0±23.1	2500.0±152.6	448.0±53.2	1150.0±47.8	6073.0±140.5
K (mg kg^{-1}) soil	11.0±1.3	109.0±13.7	97.0±16.5	82.0±52.3	257.0±83.2
Ca (mg kg^{-1}) soil	572.0±53.4	540.0±42.3	560.0±47.6	365.0±42.1	570.0±74.2
Mg (mg kg^{-1}) soil	144.0±41.2	180.0±14.3	90.0±12.3	90.0±18.9	185.0±12.6
Fe (mg kg^{-1}) soil	73.0±13.2	28.0±41.2	35.0±13.2	16.0±2.1	288.0±42.6

*: No. of analyzed soil samples; ** Mean±SE

Table 3: Some soil characters of habitats where *Salix* sp. recorded

Soil factor	*S. mucronata*	*S. tetrasperma*
pH	7.35±0.57*	7.630±0.42
EC (mS cm^{-1})	3.43±4.53	0.660±0.41
Organic matter (%)	1.28±0.74	0.646±0.533
HCO_3 (%)	0.21±0.09	0.250±0.08
Cl (%)	0.19±0.1	0.097±0.092
Sand (%)	84.98±8.8	85.800±4.26
Clay (%)	10.10±5.17	9.500±3.11
Silt (%)	4.47±6.6	4.380±3.23
Na (mg kg^{-1}) soil	289.30±63.2	250.000±74.3
K (mg kg^{-1}) soil	4.68±0.23	31.000±11.3
Ca (mg kg^{-1}) soil	370.00±86.3	700.000±85.36
Mg (mg kg^{-1}) soil	450.00±45.7	950.000±102.3
Fe (mg kg^{-1}) soil	113.90±32.4	74.100±4.2

*: Mean±SE

Table 4: Pearson correlations between *Salix* sp. and some soil parameters

Parameters	*S. tetrasperma* ♂	*S. mucronata* ♂	*S. mucronata* ♀
Sand (%)	-0.535	0.241	0.255
EC (mS cm^{-1})	-0.436	-0.524	0.213
OM (%)	0.290	+0.498	0.354
Elvation	-0.485	-0.475	-0.542
Na	-0.440	+0.245	+0.235
K	+0.221	+0.248	+0.432
Ca	-0.412	-0.147	-0.257
Mg	-0.231	-0.214	-0.241
Fe	-0.111	-0.368	-0.324

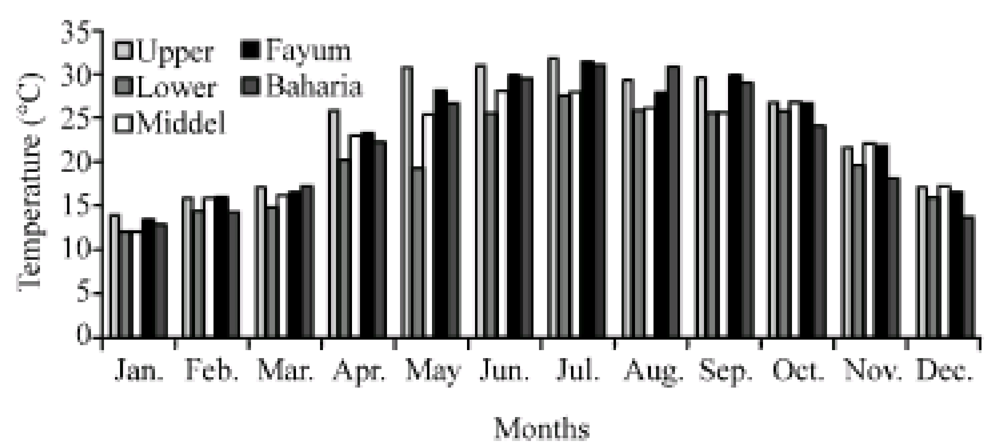

Fig. 2: Average monthely temperaturs recorded in *Salix* habitats

different canal banks all over the country, where the male was recorded only in Fayium region. The male *S. tetrasperma*ta neither recorded in Upper Egypt nor in Baharia Oasis. It appeared from Beni Suef governorate downward to Alexandria.

With regard to elemental analysis, *S. mucronata* prefers soil with high content of organic matter, Na and Fe than *S. tetrasperma* (Table 3). While *S. tetrasperma* was recorded in soil with high concentration from Mg and Ca (ranged from 90 to 1850 mg kg^{-1} soil and from 365 to 900 mg kg^{-1} soil, respectively), compared with *S. mucronata* existed in soil with low concentration of these elements (from 37.8 to 858 mg kg^{-1} soil of magnesium and from 118.4 to 810 mg kg^{-1} soil of calcium) (Table 3).

Temperature recorded a decrease with the direction downward reaching the minimum at Alexandria (Fig. 2). pearson correlations analysis (Table 4) showed a significant positive correlation of *S. mucronata* with organic matter content and significant negative correlation of *S. tetrasperma* with both soil salinity and sodium content. All species showed a significant negative correlation with elevation from water surface.

DISCUSSION

In the present study *Salix* sp. were recorded only on River Nile water systems and besides wells in Baharia Oasis. The earlier finding because of *Salix* roots prefer growing in the saturated groundwater zone and will rapidly elongate to maintain contact with free water (Amlin and Rood, 2002). Moisture content and soil texture are the most important factors affecting *Salix* growth (Hansen and Phipps, 1983; Phipps *et al*., 1983; Woods and Cooper, 2005). Both fine and coarse soil texture components contributed to lower survival rate. Moderate soil texture allowing for an aerated soil condition that also maintained some water-holding capacity. In contrast, fine-textured sediments led to poor plant performance due to compaction and the associated low aeration. Sandy soils, on the other hand, have larger pore spaces but lower water-holding capacity, increasing the risk for periodic drought stress for plants on stream banks. Many studies document the importance of rapid root growth for the survival and growth of *Salix* trees (Mahoney and Rood, 1992; Segelquist *et al*., 1993; Van Splunder *et al*., 1996; Kranjcec *et al*., 1998; Scott *et al*., 1999; Horton and Clark, 2001; Amlin and Rood, 2002). The absence of *S. tetrasperma* from Upper Egypt may be due to high temperature. Lammeranner *et al*. (2005) proved the suitability of *S. tetrasperma* for winter plantation at low temperature. Its absence from Oases can be explained according to its intolerant to salinity. Jackson *et al*. (1990) reported the intolerance of *S. gooddingii* to soil salinity.

The significant negative correlation between *Salix* and elvation from water surface because *Salix* species are relatively shallow-rooted, drought-intolerant tree species. (Horton and Clark, 2001; Glenn and Nagler, 2005), they prefer low elevation from water surface. Fine roots of these trees are concentrated in the capillary fringe, just above the water table; they are sensitive to fluctuation in water table depth, particularly on coarse soils with a narrow capillary fringe. The occurrence of *S. tetrasperma* and both male and female *S. mucronata* in Fayoum due to presence of low elevation from water surface. Fayoum is the largest oasis in Egypt, situated 90 km south-west of Cairo, 75 km from Giza Pyramids. It considers a natural depression in the desert, linked to the River Nile by a branch called Bahr Yosuf and characterized by high quantity of water with nearly permanent full canal banks.

CONCLUSION

It is advisable to cultivate *Salix* sp. By cutting in a saturated soil or at canal banks with low elvation from water surface.

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