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Tree species for inland salty soils

1. Introduction

Ecosystems highly influenced by salt are widespread throughout the world and physiological adaptations to high salt levels occur in several plant families. Areas with a natural high salt content in the soil are tidal areas, where sea water overflows the ground daily, and other coastal areas where salt-sprays from sea water are carried inland. Many arid and semi-arid areas also suffer from salinity. Dried-out inland water reservoirs like lakes and ponds often accumulate salt: as the water evaporates, dissolved salt is left behind at an ever increasing concentration. Long term salt accumulation leads to salt deserts, occurring naturally in many parts of the world. However, various cultivation practices have accentuated the problem of salinization. Soil suffering from high salt concentration is becoming an increasing problem worldwide.

Salts are water soluble and salt problems are consequently always associated with water. The more water, the lower the relative concentration of salt. High rainfall thus helps dissolving and leaching salt, and high rainfall areas are accordingly generally less prone to salt problems. Dry inland areas, on the contrary, often suffer from excess salt because of insufficient precipitation coupled with high evaporation.

Man-accentuated salinity problems are often observed in connection with deforestation and dryland farming. Deforestation may lead to high ground water, which then tends to carry deeper layers of salt up to the surface. Salt problems also occur in many former agricultural lands where irrigation has been practiced. Irrigation with insufficient water to precipitate salt can have the unintentional effect of extracting the salt from deeper layers by capillary attraction and thus cause accumulation of salt at the surface. Such areas have expanded during the last 50-60 years, where marginal areas have come under cultivation by the help of irrigation. No plants can grow in concentrated salt and the ›Dead Sea‹ is practically devoid of life because of the salt concentration. Many species have adapted to high salt concentration, both coastal plants such as mangrove species and ›salt bushes‹ of the genus *Atriplex, Haloxylon* and *Tamarix* on dry land being the most salt tolerant.

2. Measuring salinity

Salinity is not necessarily evenly distributed horizontally or vertically within any short distance. For example, drying out of a pond of water will leave a patch with very high salt concentration compared to a site, where water has leached out salt. Therefore, salinity must, as all other types of soil analysis, be carried out on a number of representative soil samples. Salinity is measured as electric conductivity (EC) by the use of an electric conductivity meter (EC-meter). Conductivity and thus salinity is measured in decisiemens per meter (dS/m) or in millimhos per centimetre (mmhos/cm); the two are numerically equivalent units. The most exact measurement is achieved by measuring the EC of a saturated soil extract: The soil sample is air dried and then saturated with distilled water. EC is measured on extracted water from the saturated sample after 4 hours, and adding a buffer of a drop 0.1% $Na(PO_3)_6$ solution to each 25ml sample. EC is an open scale with 0 as no conductivity and any figure above 0 indicating a certain conductivity. Five salinity classes are recognised: 1) Non-saline, EC_e < 2dS/m; 2) slight, EC_e 2-4 dS/m; 3) Moderate, EC_e 4-8 dS/m; 4) Severe EC_e 8-16 dS/m; 5) Extreme, EC_e > 16 dS/m. Salt sensitive plants react with 0.5-1.0 dS/m; highly tolerant species (e.g. *Atriplex*) may tolerate salinity of up to 5.5-6.0 dS/m.

3. Physiological problems and adaptations to salt

The most common salt in soil is NaCl, which is also the most common in seawater. Other types of salts are Na_2SO_4, $MgSO_4$, $NaHCO_3$, Na_2CO_3, $CaSO_4$ and $CaCO_3$. Salt minerals in small quantities are essential for plants, but salt in high concentration is toxic; in particular chloride (Cl-) has high toxicity.

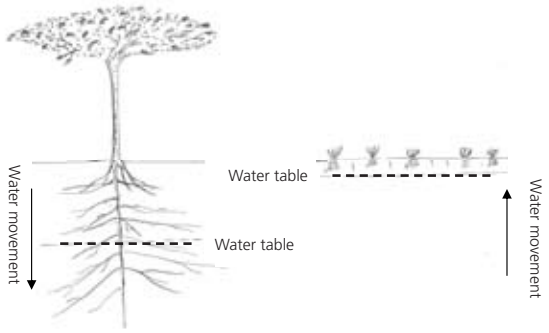
Salt in lower concentration interferes with the osmotic balance and blocks the absorption of water and essential nutrients. The relative enrichment by salt ions like Na+ and Cl- may compete with ab-

Evaporation of salty water from marshland and inland lakes without outlets tends to cause salt accumulation. Many trees can grow under highly saline conditions as long as there is abundant water. If water evaporates, trees will die (left). Highly saline soils are often colonised by high tolerant grasses and dwarf bushes (right). www.rss.dola.wa.gov.au.

sorption of essential nutrients such as potassium (K+) and phosphorus ($P0_4$--). Plants specialised to grow in salty environment, so-called halophytes possess special features to tolerate high salt concentration and exude surplus salt, e.g. through their leaves.

4. Inversing salinization by trees

Trees cannot remove accumulated salt, but can create a favourable micro-environment, which favours a downwards and prevents an upwards movement of water with dissolved salts. Water absorption by deep growing roots will lower the ground water table and hence promote leaching of salt. Canopy shade lowers the temperature and thus evaporation under trees, which in turn will prevent capillary movement of water towards the surface. Plant roots generally promote water infiltration, in particular on clayey soils. Inverting salinization is a long process in low rainfall areas, and where salinization has progressed rehabilitation relies on species with high salt tolerance.



Trees in arid areas reduce evaporation and improve infiltration into the soil. Removal of trees can cause ground water table to raise, increase surface evaporation and imply a risk of salt accumulation in the upper soil layers.

5. List of species adapted to saline soil

High salt tolerance prevails in some families with Chenopodiaceae (*Atriplex*, *Haloxylon*), Tamaricaceae (*Tamarix*) and the mangrove family Rhizophoraceae (*Rhizophora*, *Bruiguiera*, *Ceriops*, *Kandelia*) as the most tolerant. Many families contain genera with high salt tolerance e.g. *Melaleuca* in Myrtaceae, and *Prosopis* and *Milletia* in Leguminosae. In other families and genera, salt tolerance occurs more sporadic, e.g. *Conocarpus latifolius* (Combretaceae) and *Cocos nucifera* (Arecaceae). Most plants found in highly saline soils are grasses and herbs (halobiomes). In below list, tree species with highest salt tolerance are marked ***, less tolerant with **, and those with only moderate tolerance with *.

Acacia[1] cyclops **	*Acacia salicia* *
Acacia saligna **	*Albizia lebbek* **
Albizia procera *	*Atriplex[2] spp* ***
Callitris columellaris *	*Casuarina equisetifolia* *
Casuarina glauca **	*Cocoloba uvifera* ***
Cocos nucifera **	*Colophospermum mopane* *
Conocarpus lancifolius **	*Cupressus macrocarpa* *
Elaegnus angustifolia *	*Eucalyptus butryoides* *
Eucalyptus camaldulensis *	*Eucalyptus gomphocephala* *
Haloxylon aphyllum ***	*Haloxylon persicum* **
Jacaranda copaia *	*Melaleuca spp. (mangr.)* ***
Milletia ichtyochtona **	*Parkia aculeate* *
Parkinsonia aculeate *	
Pongamia pinnata (=Derris indica) ***	
Prosopis[3] chilensis **	*Prosopis juliflora* **
Prosopis pallida ***	*Prosopis tamarugo* **
Pterocarpus indica *	*Salvadora oleoides* *
Salvadora persica	*Sesbania sesban* *
Tamarix[4] aphyllum ***	*Tamarix articula* ***
Tamarix chinensis ***	*Terminalia catappa***
Thespesia populnea **	

1 Several Australian species with high tolerance are listed in Marcar *et al.* 1995
2 The genus mostly consist of herbal species, a few species grow as low shrubs
3 Large genus w/ several with various degrees of salt tolerance
4 50-60 species most of which show high tolerance to salinity

6. References and selected readings

Khan, M.A. and Darrell, D. (eds.) 2006. Ecophysiology of high salinity tolerant plants. Springer.

Marcar, N., Crawford, D., Leppert, P., Jovanovich, T., Floyd, R. and Farrow, R. 1995. Trees for saltland, - a guide to selecting native species for Australia. Division of Forestry, CSIRO, ACT Australia.

Pasternak, D. and Schissel, A. (eds.) 2001. Combating desertification with plants. Kluwer Academic / Plenum Publ.

Anonymous 1990. Saline agriculture. Salt tolerant plants for developing countries. National Academy Press. Washington DC.

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