SALT TOLERANCE OF FOREST TREE SPECIES AS DETERMINED BY GERMINATION OF SEEDS AT DIFFERENT SALINITY LEVELS

by

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Summary. *Salt tolerance studies were carried out on seeds and seedlings of six species: Acacia arabica, Albizzia lebbek, Parkinsonia aculeata, Prosopis spicigera, Robinia pseudoacacia, Zizyphus jujuba. The salt concentration was varied from* 0.05% *to* 0.80% *for all species. It was found that under the experimental conditions Zizyphus jujuba, Albizzia lebbek and Acacia arabica were the most salt tolerant of the species studied.*

Introduction. Tree plantations are being established in the form of compact blocks along roads and canals in order to provide congenial conditions and to meet other requirements of the nation. The silvicultural characteristics of most of the species are known but the limits of tolerance to saline conditions in the field have not been closely investigated.

Salinity and water logging have for a long time plagued agro forestry management and have become a threat to the economy of Pakistan. Excellent agricultural land has been turned into unproductive salt-encrusted wastes due to these problems. Among the problems with which agro-forestry is confronted today, soil salinity occupies a very important position. In most cases agricultural crops cannot be grown in such areas, especially those crops affected by severe salinity levels. It might be possible to plant some tree species in these areas, with or without some site preparation. However for efficient propagation of plants, knowledge of the germination pattern of the seeds under different salinity conditions is of prime importance.

In order to find out whether seeds would germinate and grow under such saline conditions, a study was carried out with seeds of *Acacia arabica, Albizzia lebbek, Parkisonia aculeata, Prosopis spicigera, Robinia pseudoacacia and Zizyphus jujuba* with different levels of soil salinity.

Review of Literature. In spite of the realisation of the importance of providing a protective vegetation cover on salt affected areas, the effects of varied salt concentrations on the germination of seeds and the growth of seedlings of different tree species has not been studied in Pakistan.

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Tsing, Fang and Wang (8) studied the effect of different levels of sodium chloride in the soil on seed germination for twenty-three species of trees and shrubs. They found that *Melia azedarach* survived up to a salt concentration of 0.6%. For normal germination, survival and good growth, the salt limits for *Ailanthus altissima* were 0.5%, 0.3% and 0. 3% respectively. For *Sapium sebiferum* they were 0.6%, 0.5% and 0.2% but *Robinia pseudoacacia* was less tolerant. Karschon (2) observed that *Acacia spirocarpa* did not survive for more than two or three days in solutions greater than 0.05M NaCl (0.3%). However solutions of lower concentrations were observed to increase the vigour of the plants. Under nursery conditions *A. spirocarpa* tolerated a soluble salts level of 0.23% in the soil.

Both solution culture and field plots were used in a study of eight species of annuals and twenty-one species of trees and shrubs by Monk (4). He found that Black Locust and Honey Locust survived the highest salt concentrations of 1%, Golden Willow up to 0.8% and Eastern Red Cedar and Douglas Fir up to 0.6%. Monk and Peterson (5) used solutions of equal quantities of sodium and calcium chlorides at concentrations from 0.4% to 1% with twenty species. Tamarix and Green Ash showed good growth in all plots but some species did not survive the lowest treatment. In general, as the concentration increased there was a concomitant decrease in the vigour and growth of the plants. In a study by Sankaranarayanan, Verghese and Menon (7), coconut palms did not show any sign of lasting injury at levels up to 0.64% soluble salts (mostly sodium chloride) in the soil, whereas Areca, Mango and Cashew crops were ruined.

Carleton (1) grew *Pinus radiata, P. resinosa, P. taeda* and *P. thunbergii* in a sand culture automatically irrigated with salt solutions. These consisted of basal nutrients together with soluble salts in the proportions found in seawater. One treatment was equivalent to seawater, and others had respectively 80%, 20%, 10%, 5% and zero% of this level of salts. *P. taeda* was the most salt tolerant followed by *P. thunbergii*. The effects of solutions of sodium chloride, sodium bicarbonate, magnesium chloride, magnesium sulphate, calcium chloride and calcium sulphate on germination was examined by Lalymenko (3). Low concentrations stimulated germination of two *Haloxylon* species and two *Salsola* species. Higher concentrations inhibited germination but the critical concentration varied markedly with the particular salt and with the species.

From these studies it can be seen that the effects of salinity on germination and growth must be examined for each individual species having regard to the type of soluble salts occurring in the field and the conditions under which the plants will be growing. The experiment described below provides a guide to the tolerance of six species to saline conditions.

Materials and Methods. The experiment was conducted in pots at the Silvicultural Research Garden Pakistan Forest Institute Peshawar, with seeds of *Acacia arabica, Albizzia lebbek, Parkinsonia aculeata, Prosopis spicigera, Robinia pseudoacacia and Zizyphus jujuba.* Two thousand grams of silt, loam soil was added to each of the pots, which were lined with polyethylene sheets to prevent leaching. A few days prior to sowing the seeds, sodium chloride was added at the following rates on a soil weight basis: 0%, 0.05%, 0.10%, 0.20%, 0.40%, 0.80%.

Each treatment was replicated five times for each species and seeds were sown at the rate of ten or fifteen per pot, depending on their size. Soil moisture was maintained at a constant level throughout the period of investigation by the addition of water twice daily. The temperature, rainfall, humidity, number of seeds germinated or number of seedlings surviving were recorded daily. The particle size analysis of the soil was carried out using the hydrometer method of Piper (6).

The soil used was a silt-loam in texture with 11% clay, 42% silt and 47% sand. Such a soil has favourable physical conditions and with suitable nursery techniques favours successful plant propagation. During the period of the experiment the total rainfall for June was 0.1524 cm and for July 6.7056 cm. Average humidities for these months were 46% and 56% respectively.

Thirty-seven days were allowed for germination and survival of the seedlings was monitored for a period of four months.

Results. The mean values for percentage germination and percentage survival are given in Tables 1 and 2:

Table 1

Percentage germination of seeds as influenced by salinity levels.

	NaCl Concentration					
Species	0	0.05%	0.10%	0.20%	0.40%	0.80%
Acacia arabica	91	85	70	60	50	35
Albizzia lebbek	90	90	70	65	70	35
Parkinsonia aculeata	85	70	65	60	35	25
Prosopis spicigera	90	75	65	55	40	30
Robinia pseudoacacia	90	85	65	55	35	25
Zizyphus jujuba	88	87	63	50	50	38

Increasing salinity resulted in a decrease in both germination and survival in every case. The range in values is not as great as might have been expected from other work reported in the literature, and the species used in the experiment would all be severely affected by salinity in the field situation. However, *Zizyphus jujuba*, *Albizzia lebbek* and *Acacia arabica* appeared to cope with the salt concentrations better than the other three species, as shown by both higher germination percentages and higher survival rates. It is possible for a species to have different tolerances for salinity when assessed by germination and survival, as germination will be restricted principally by osmotic potential but survival will also be affected by interference with the uptake of nutrient ions. However in this study the same rank order of the species was found in both parts of the experiment.

In the field the plants will also be affected by the unfavourable physical condition of the saline soil and the trial reported here should be extended to a field situation to confirm these results.

Table 2

Percentage survival of seedlings as influenced by salinity level.

	NaCl Concentration					
Species	0	0.05%	0.10%	0.20%	0.40%	0.80%
Acacia arabica	83	75	66	53	40	28
Albizzia lebbek	83	80	64	56	43	29
Parkinsonia aculeata	70	65	60	58	23	20
Prosopis spicigera	84	70	59	47	35	25
Robinia pseudoacacia	70	60	55	40	29	19
Zizyphus jujuba	75	70	59	45	41	30

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