Acta Botanica Hungarica 44(1–2), pp. 67–74, 2002

SALT TOLERANCE VARIATION IN SOME COMMON TREES

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(Received 8 May 2001)

The reduction in seed germination and seedling growth varies with plant species, salinity level and ionic composition of the salts present in soil solutions. Seed germination of *Leucaena leucocephala* and *Prosopis juliflora* were affected in soil extract of all halophytic communities. Significant ($p < 0.05$) reduction in seed germination of *Thespesia populnea* was found in soil extract of *Cressa-Suaeda-Atriplex* and *Suaeda-Heliotropium-Tamarix* community. The root growth of *P. juliflora* was significantly reduced in soil extract of *Haloxylon-Suaeda-Atriplex* community. Significant inhibition in shoot growth of *L. leucocephala* and *P. juliflora* were found in soil extract of *Haloxylon-Suaeda-Atriplex* community. *L. leucocephala* and *T. populnea* showed low tolerance in soil extract of *Cressa-Suaeda-Atriplex* community. *P. juliflora* demonstrated low tolerance in soil extract of *Haloxylon-Suaeda-Atriplex* community.

The soil collected from different community showed variation for soil conductivity and cations. The highest sodium (11,500 µg/g) was observed in *Suaeda-Heliotropium-Tamarix* community. *Salsola-Fagonia-Zygophyllum* community exhibited the lowest concentration of sodium and potassium, 500 and 75 µg/g, respectively. It was found that sodium was directly proportional to the conductivity of the soil extract.

Key words: germination, salt tolerance, toxicity, trees

INTRODUCTION

According to an estimation one third of the world's land surface is arid and semi arid (4.8×10^9), out of which one half is estimated to be affected by salinity (Croughan and Rains 1982). Salinity is the most important problem especially in arid and semi arid regions of the world. Salinization is not only one of the leading cause of desertification, but is also one of the most frustrating results of man's attempt to expand cultivation into these regions. Salinity and sodicity are the two major problems of Pakistan. The extensive canal irrigation system is an important cause for both salinity and waterlogging. Unfortunately, nearly 1,000 acres of land is being affected by salinity and waterlogging every year (Hussain and Ilahi 1985). About 33% of the irrigated soils of Pakistan have been adversely affected by different types of salts (Aslam *et al.* 1979). Salt affected areas in Pakistan have continued to increase alarmingly during the past few years owing to a number of factors (Ahmed and Bano 1992). Salinity and sodicity are soil conditions which may cause reductions in growth of

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plants. The reduction in plant growth and yield varied with plant species, salinity level and ionic composition of the salts that contribute to salinity (Khan *et al.* 1998). Ansari *et al.* (1977) had reported reduction in germination of wheat seeds under salts stress. The seeds of sunflower exhibited poor and delayed germination in different concentration of various salts (Ilahi and Begum 1981, Hussain *et al.* 1990, Khan *et al.* 1994). Hussain and Ilahi (1992) have reported differential response of various cultivars of *Brassica* to salts.

In view of the destructive role of salt stress affecting the plants, an investigation had been carried out to determine their toxic effects on seed germination and seedling growth of some important trees.

MATERIAL AND METHODS

Soil samples were obtained from four halophytic communities, *Suaeda-Heliotropium-Tamarix, Suaeda-Heliotropium-Atriplex, Cressa-Suaeda-Atriplex* and *Haloxylon-Suaeda-Atriplex* and one from a non-halophytic community, *Salsola-Fagonia-Zygophyllum.* The soil samples were collected at 12 cm depth, dried and sieved through 2 mm sieve. Ten percent soil extract was made with distilled water. The healthy seeds of *Leucaena leucocephala* (Lam.) de Wit, *Thespesia populnea* (L.) Soland. ex Correa and *Prosopis juliflora* Swartz were collected from the natural habitat conditions of the university campus. The seeds were surface sterilized for one minute in 0.2% mercuric chloride solution to avoid any fungal contamination. The seeds were washed with distilled water and transferred to 97 mm diameter Petri dishes on Whatman No. 1 filter paper at room temperature. Ten seeds were kept in each respective Petri dish and allowed to germinate in 5 ml of soil solution for one week. Seed germination, shoot and root length was measured. There were three replicates for each treatment. Percentage of tolerance of species was determine by the following formulae: mean root length in saline soil extract / mean root length in non-saline soil extract × 100.

Sodium and potassium contents in soil were analysed by flame photometer (Model 410). Soil conductivity was determined by conductivity meter in milli simon per centimeter (mS/cm).

Analysis of variance (ANOVA) and Duncan’s multiple range test were also applied.

RESULTS

The effects of soil extract in terms of seed germination and seedling growth were found indifferent for all the tree species. Seed germination of *L. leucocephala* and *P. juliflora* was not significantly affected by any soil treatment (Figs 1–2). Significant ($p < 0.05$) reduction in seed germination of *T. populnea* was found in soil extract of *Cressa-Suaeda-Atriplex, Suaeda-Heliotropium-Tamarix, Suaeda-Heliotropium-Atriplex* and *Haloxylon-Suaeda-Atriplex* communities (Fig. 3). The root growth of *L. leucocephala* was reduced in soil extract of *Cressa-Suaeda-Atriplex* community. Root growth of *P. juliflora* was significantly ($p < 0.05$) reduced in soil extract of *Haloxylon-Suaeda-Atriplex* community (Fig. 2). Significant inhibition in shoot growth of *L. Ieucocephala* and *P. juliflora* were found in soil extract of *Haloxylon-Suaeda-Atriplex* community. Shoot growth of *T. populnea* was not found significantly affected by soil treatment of any community.

The seedlings of tree species were also tested for tolerance using soil extract of different halophytic communities (Fig. 4). *L. leucocephala* and *T. populnea* showed low percentage of tolerance in soil extract of *Cressa-Suaeda-Atriplex* community. The low percentage of tolerance for *P. juliflora* was found in soil extract of *Haloxylon-Suaeda-Atriplex* community.

The conductivity, sodium and potassium in soil extract of different communities showed variation in their levels (Table 1). The highest sodium (11,500

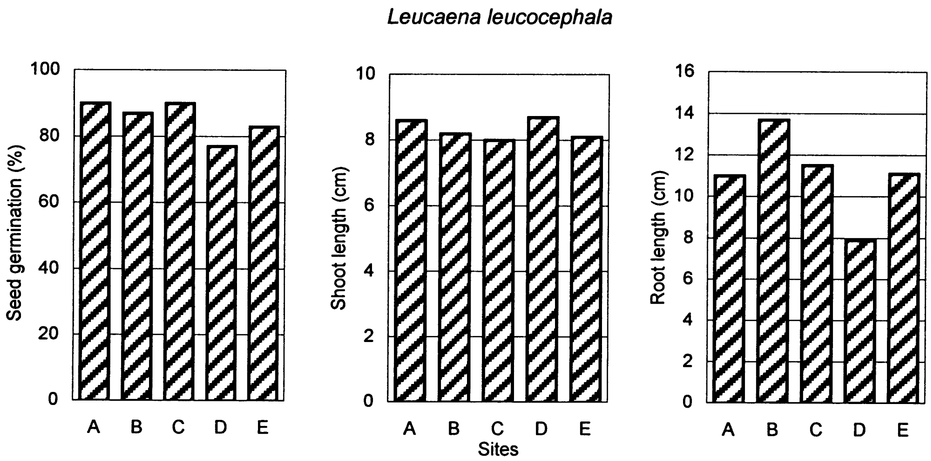

Fig. 1. Effects of soil extracts of different communities on germination and seedling growth of *L. leucocephala*. (A = *Salsola-Fagonia-Zygophyllum* (non-saline), B = *Suaeda-Heliotropium-Tamarix*, C = *Suaeda-Heliotropium-Atriplex*, D = *Cressa-Suaeda-Atriplex*, E = *Haloxylon-Suaeda-Atriplex*)

µg/g) was found in *Suaeda-Heliotropium-Tamarix* community, followed by *Suaeda-Heliotropium-Atriplex* (7,880 µg/g), *Cressa-Suaeda-Atriplex* (6,380 µg/g) and *Haloxylon-Suaeda-Atriplex* (3,880 µg/g) communities, respectively. *Salsola-Fagonia-Zygophyllum* community exhibited the lowest amount of sodium and potassium (500 and 75 µg/g). The highest amount of potassium (160 µg/g) was found in *Suaeda-Heliotropium-Atriplex* community. It was observed that sodium is directly proportional to the conductivity of the soil extract. The highest conductivity in soil was found in *Suaeda-Heliotropium-Tamarix* (11 mS/cm) followed by *Suaeda-Heliotropium-Atriplex* (9.1 mS/cm), *Cressa-Suaeda-Atriplex* (6.6 mS/cm), *Haloxylon-Suaeda-Atriplex* (4.6 mS/cm) and *Salsola-Fagonia-Zygophyllum* (3.3 mS/cm) communities.

DISCUSSION

Plants in saline environments are constrained by both osmotic and specific ion effects (Lauchli and Epstein 1990). The adaptation for a particular genotypes to a particular environment is determined by its response to heat, cold, drought and soil nutrients (Aslam *et al.* 1999). The seeds tested for germination and growth in this study responded differently. Low percentage of seed germination for *T. populnea* and *L. leucocephala* was found in soil extract of *Cressa-Suaeda-Atriplex* community. The soil of this community had high

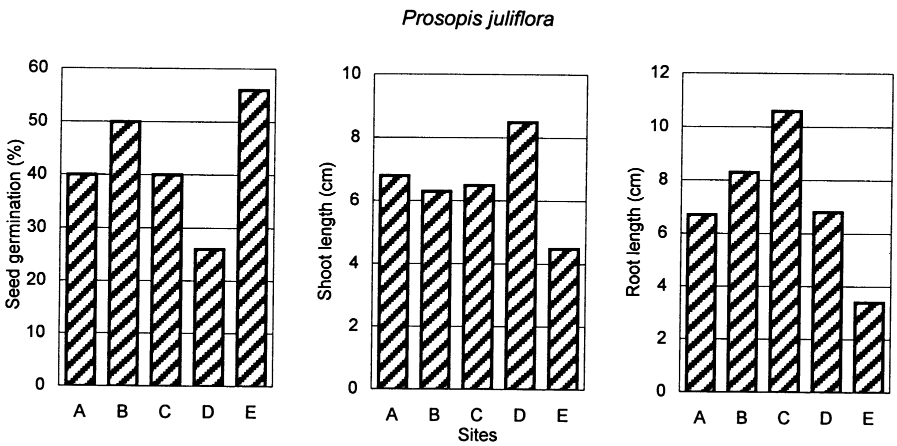

Fig. 2. Effects of soil extracts of different communities on germination and seedling growth of *Prosopis juliflora*. (A = *Salsola-Fagonia-Zygophyllum* (non-saline), B = *Suaeda-Heliotropium-Tamarix*, C = *Suaeda-Heliotropium-Atriplex*, D = *Cressa-Suaeda-Atriplex*, E = *Haloxylon-Suaeda-Atriplex*)

amount of sodium and potassium salts. Delayed seed germination in *Suaeda fruticosa* collected from indifferent habitats to salt stress was observed (Mohammad and Sen 1991). Our results indicated that the seed germination re-

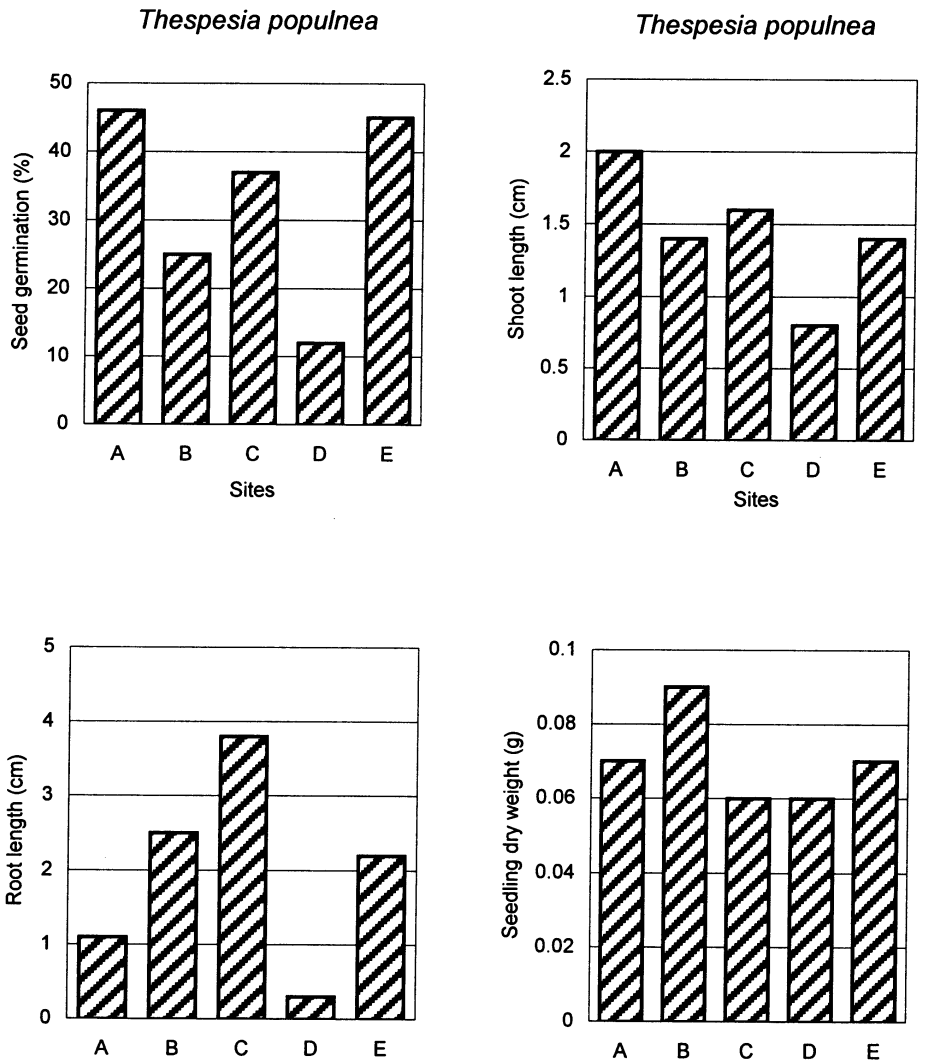

Fig. 3. Effects of soil extracts of different communities on germination and seedling growth of *Thespesia populnea*. (A = *Salsola-Fagonia-Zygophyllum* (non-saline), B = *Suaeda-Heliotropium-Tamarix*, C = *Suaeda-Heliotropium-Atriplex*, D = *Cressa-Suaeda-Atriplex*, E = *Haloxylon-Suaeda-Atriplex*)

Table 1
Determination of conductivity, sodium and potassium in soil extract of different communities

Communities	Sodium (μg/g^{-1})	Potassium (μg/g^{-1})	Conductivity (mS/cm)
Salsola-Fagonia-Zygophyllum	500	75	3.3
Suaeda-Heliotropium-Tamarix	11,500	120	11.0
Suaeda-Heliotropium-Atriplex	7,880	160	9.1
Cressa-Suaeda-Atriplex	6,380	130	6.6
Haloxylon-Suaeda-Atriplex	3,880	85	4.6

sponses of plant species appeared to be related to the intensity of their exposure to salinity levels. In *Cressa-Suaeda-Atriplex* soil treatment, the lowest seed germination rate for *P. juliflora* might be due to sodium and potassium salts content found in soil. Khan *et al.* (1987) also reported delay in germination of *Prosopis* sp. under saline conditions. Significant ($p < 0.05$) decrease in root growth of *P. juliflora* was observed in *Haloxylon-Suaeda-Atriplex* community soil treatment. In this community soil had an average amount of sodium (3,880 μg/g) and potassium (85 μg/g) content which could be the cause of reduction in root growth. The radicle length of *P. juliflora* was found reduced under various treatments, especially at high salinity level. Ansari *et al.* (1977) and Khan *et al.* (1998) observed that saline conditions reduced seedling growth and establishment. Soil treatment reduced the seedling growth of *P. juliflora* when

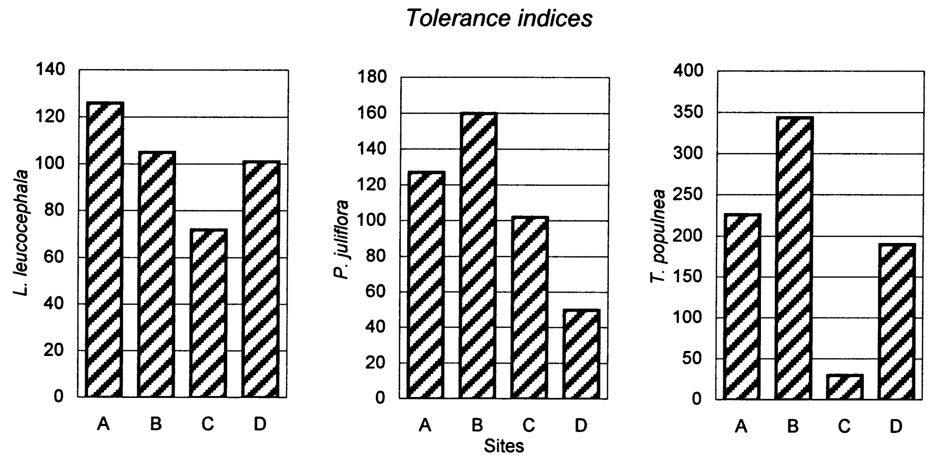

Fig. 4. Indices of tolerance for some trees (*L. leucocephala*, *Prosopis juliflora* and *Thespesia populnea*). (A = *Suaeda-Heliotropium-Tamarix*, B = *Suaeda-Heliotropium-Atriplex*, C = *Cressa-Suaeda-Atriplex*, D = *Haloxylon-Suaeda-Atriplex*)

treated with different community soil extracts. The treatment of *Haloxylon-Suaeda-Atriplex* community soil extract decreased the root growth of *L. leucocephala.* Soil treatment also reduced the seedling growth of *T. populnea* when treated with different community soil extract. The treatment of *Cressa-Suaeda-Atriplex* community soil extract decreased the root growth of *T. populnea*.

Lack of mineral nutrients and excess of salt content soon after germinations stunts growth of plants growing in any area. Too high level of mineral nutrient, which results in an accumulation of soluble salts, causes stunting or death depending on the quantity of salts in soils. Too little water just after seed germination causes water stress and stunting. These edaphic factors have been shown to have a considerable bearing on the pattern of compositional variation in arid or semi arid regions (Qadir *et al.* 1966, Ayyad and Ammar 1974, Shaukat *et al.* 1976). Mineral nutrients are very important for the normal growth of plants. The treatment in soil extract of solution seems responsible to affect growth of treated plants by changing the normal physiology of the treated plants. Presence of unbalanced nutrients in the soil can cause disturbance in the uptake of certain elements necessary for the growth. Sodium is usually needed by plants in small amounts (Niazi and Ahmed 1984). Excessive amounts of sodium salts present in the soil produced saline conditions and inhibit the growth of plants (Strogonov 1964, Tripathi and Ambasht 1981). Higher concentration of sodium, the strongest monovalent cation, upsets the composition of minerals in soil and thus may cause inhibition in growth of the plants. Among all the tested species, *L. leucocephala* showed the lowest percentage of tolerance in soil extract of *Cressa-Suaeda-Atriplex* community. *P. juliflora* and *T. populnea* showed low percentage of tolerance in soil extract of *Haloxylon-Suaeda-Atriplex* and *Cressa-Suaeda-Atriplex* communities, respectively. Low sodium, potassium and conductivity was observed in *Salsola-Fagonia-Zygophyllum* community soil extract which favoured the germination and growth of *L. leucocephala* as compared to other tree species. Besides other factors which are responsible for plant growth, physical properties of soil such as soil strength, bulk density, texture and structure influence greatly the root penetration, growth and yield of various crops (Gerard *et al.* 1982). In general, variation in germination and growth for *L. leucocephala* was less affected in soil extract of *Salsola-Fagonia-Zygophyllum* community. However, soil extract of *Suaeda-Heliotropium-Tamarix* community reduced the growth of *L. leucocephala.* Chemically, the level of sodium exhibited consistent relationship for the growth of *L. leucocephala*.

The results confirmed the finding that soil of *Salsola-Fagonia-Zygophyllum* community is suitable for growing plants. *L. leucocephala* and *P. juliflora* grew better than *T. populnea* in soil extract of halophytic community. High sodium salt content inhibited the seed germination and seedling growth of *T. populnea*.

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