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Effect of salinity and temperature on germination, growth and ion relations of *Panicum turgidum* Forssk

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Abstract

Seed germination of *Panicum turgidum* was significantly affected by salinity levels, temperature and their interaction. Maximum germination was noted in the lowest saline media (25–50 mM) and distilled water at the temperature of 15–25 °C and 20–30 °C. Seeds germination was substantially delayed and reduced with an increase in NaCl to levels above 50 mM. This trend was much pronounced under high levels of NaCl and incubation temperature. Low levels of NaCl (25–50 mM) stimulated shoot and root dry weights of *P. turgidum* seedlings. However, the highest NaCl levels (>100 mM) resulted in a significant decrease in shoot, root and total dry weights of seedlings. Intermediate degrees of temperature, 15–25 and 20–30 °C, resulted in a significant increase in biomass accumulation. The Na^+ concentration in shoots and roots significantly increased as NaCl concentration increased. The K^+ concentration in roots and K/Na ratio in shoots and roots was significantly reduced as salinity concentration increased. The K/Na ratio was greatly affected by higher NaCl concentration and incubation temperatures.

Keywords: Germination; *Panicum turgidum*; Salinity; NaCl; Incubation temperature; Ion relations; K/Na ratio

1. Introduction

Panicum turgidum Forssk is a dominant perennial grass in the dry rangelands of Saudi Arabia. This grass species is distributed from the western coast through the lower mountains of Asir and Najd to eastern coast of Saudi Arabia (Chaudhary and Al-Jowaid, 1999). In these areas, the average annual rainfall is about 100 mm or less. Adult plants grow well under arid environments and even in saline areas with low to medium NaCl concentrations. *P. turgidum* is usually observed in association with *Haloxylon salicornicum*, *Plantago boisseri*, *Moltkiopsis ciliata* (Shaltout et al., 1997; Al-Khateeb et al., in press). It has the potential for domestication and for use as a forage crop (Al-Zaid et al., in press).

Seed germination and early seedling growth are critical stages for the establishment of plant populations under saline conditions (Perez et al., 1998; Khan and Gulzar, 2003a). Grasses differ in their upper limit of salinity tolerance and an increase in salinity concentration usually delays and reduces seed germination (Perez et al., 1998; Gulzar and Khan, 2001 and Khan and Gulzar, 2003b). Seed germination under saline conditions occurs after high precipitation where soil salinity is usually reduced due to leaching (Khan and Ungar, 1986). It was noted that grasses like *P. coloratum* (Perez et al., 1998) and *P. hemitimon* (Hester et al., 1998) germinate well in NaCl concentrations up to 200 mM, but seedling growth is significantly retarded, showing a lethal effect under high salt concentrations. However, halophytic grasses like *Sporobolus virginicus* (Breen et al., 1997), *Halopyrum mucronatum* (Khan and Ungar, 2001) and *Hordeum vulgare* (Badger and Ungar, 1989) germinated under salt concentration up to 350 mM, while seeds of

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extreme halophytic grasses like *Aeluropus lagopoides* (Gulzar and Khan, 2001) germinated at 500 mM NaCl concentrations or higher. Salt tolerance at germination seems to have no relation to the tolerance level during seedlings growth (Johnson, 1991). Reduced growth of plants subjected to gradual increase in salinity in the growth media could be due to an osmotic effect and/or ion toxicity (Gorham et al., 1985; Munns and Termaat, 1986; Munns, 1993).

Salinity and temperature have differential effects on seed germination (Badger and Ungar, 1989; Yu et al., 1999; Khan and Ungar, 1999, 2001; Khan and Gulzar, 2003b). El-Fawal and El-Nathlawy (1989) reported that seed germination and seedling growth decreased more with salinity at high temperatures.

This investigation was undertaken to study the effect of NaCl concentration and incubation temperature on germination, seedling growth and ion relations of *P. turgidum*.

2. Methods

Seeds of *P. turgidum* were collected during April, 2002, from naturally growing stands in the sandy soil near Al-Ogair on coast of the Arabian Gulf of Saudi Arabia. Seeds were separated from inflorescences and stored dry at 4 °C. During the first week of September 2002, stored seeds were sterilized with 0.5% sodium hypochlorite solution for 1 min. Thereafter, they were washed twice with distilled water. Twenty-five seeds were sown in 1.0 L plastic disposable containers with airtight lids and containing dry washed sand. Containers were incubated in a programmed, refrigerated incubator on 12 h light:12 h dark (2000 L × Sylvania cool-white florescent lamps) with four temperatures, namely 20:10, 25–15 °C , 30:20 and 35–25 °C (light:dark). The containers were irrigated to field capacity with one of six solutions; distilled water, 25, 50, 100, 200 and 400 mM NaCl. Salinity levels were maintained constant throughout the experiment period due to the use of airtight lid containers which ensure no evapotranspiration loss. Treatments were replicated 6 times in a factorial experiment laid out in a completely randomized design. Germination percentages were recorded every 3 days for 24 days after sowing.

Plants were harvested 45 days after treatment application, separated into roots and shoots, and their fresh weights were determined. Seedlings irrigated with 400 mM NaCl solutions died, therefore growth parameters were recorded only for salinity up to 200 mM NaCl. The shoots were washed twice in distilled water while ions were removed from the free space of roots by washing for one minute in sorbitol solutions isotonic with the treatments concentration in which the plants were grown. Shoots and roots were dried at 85 °C for 48 h to determine their dry weights.

For the analysis of K^+ and Na^+, three samples each of 100 mg of fresh material of both shoots and roots were homogenized using a pestle and morter and extracted, in 25 mL distilled water at 90 °C for 4 h. The K^+ and Na^+ measurements were undertaken using an Atomic Absorption Spectrophotometer. Analyses were not carried out for the 200 mM NaCl sample because not enough tissue was available.

Data were subjected to analysis of variance (ANOVA), according to Gomez and Gomez (1984). Averages of the main effects and their interactions were compared using the revised least significant difference test (LSD) at 0.05 level of probability (Waller and Duncan, 1969). Computations and statistical analysis were done using SAS (SAS, 2001).

3. Results

Seeds germination of *P. turgidum* was significantly affected ($P < 0.05$) by NaCl concentrations (Figs. 1 and 2). The highest germination percentage was found in distilled water, followed by 25 mM NaCl. The highest NaCl concentrations (200 and 400 mM NaCl) showed substantial reduction in seed germination (Fig. 1). Incubation temperature of 15–25 °C was suitable for germination of *P. turgidum* and was followed by 20–30 °C. Seed germination was significantly lower under extreme temperatures of 10–20 °C and 25–35 °C with

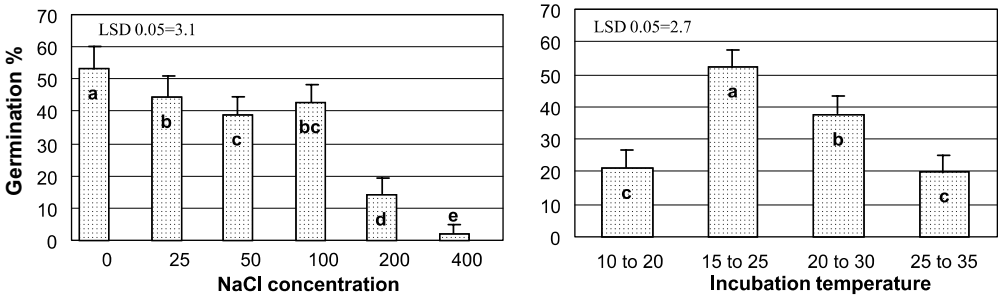

Fig. 1. Germination percentage of *P. turgidum* seeds as influenced by salinity concentrations and incubation temperatures. Values with the same superscript letters are not significantly different at $P > 0.05$. Lines over bars represent SE, $n = 6$.