WATER STATUS OF *Lygeum spartum* L. SEEDLINGS SUBJECTED TO SALT STRESS

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Abstract: *Lygeum spartum* L. (Poaceae) is a perennial rhizomatous grass, which is widely distributed in the Algerian steppes. This species can tolerate extreme conditions of aridity and high temperatures and it has been used as raw material for manufacturing paper. The seeds of *L. spartum* were collected from the area of *Aïn Maâbed* in the province of *Djelfa* (Algeria). The objective of the present work was to analyse plant water relations of this species in the presence of NaCl at different concentrations in order to evaluate the tolerance of the plant to salt stress. *L. spartum* seedlings were grown in hydroponic culture with Hoagland nutrient solution. After 13 days of growth, plants were treated with 0, 50 and 100 mM NaCl. The effect of NaCl on water relation parameters were measured after 7 days of the treatments. NaCl exposure of *L. spartum* produced a decrease in root hydraulic conductivity (L_0), with the highest NaCl concentration (100mM NaCl) causing 79% decrease of L_0. Transpiration was reduced by about 22% and 48% as compared to control plants, respectively, at 50 and 100mM NaCl. No change was observed in the turgor potential (Ψτ). Based upon these results, the ability to tolerate moderate saltinity renders this species a promising pasture plant for increasing forage production in salt-affected soils.

Key words: *Lygeum spartum* L., steppe, salinity, root hydraulic conductivity, turgor potential, transpiration.

SATATUT HYDRIQUE DU *Lygeum spartum* L. SOUS STRESS SALIN

Résumé : Le sparte (*Lygeum spa*rtum L.) fait partie des espèces graminées pérennes des steppes semi arides algériennes. Dotée d'une biomasse aérienne et racinaire assez importante, il constitue un outil efficace et relativement peu coûteux dans la lutte contre la désertification et dans la réhabilitation des terres dégradées. En Afrique du Nord, il constitue une ressources importantes en fibres pour l'industrie papetière. Des plantules de *L. spartum* ont été cultivées en condition hydroponique pour étudier l'effet de l'addition du NaCl dans la solution nutritive sur le statut hydrique de cette espèce. Les traitements utilisés sont 0, 50 et 100 mM NaCl. Les résultats obtenus ont montré que le NaCl entraîne une réduction de la conductivité hydraulique des racines (L_0) de l'ordre de 79% par rapport au témoin pour la concentration la plus stressante (100mM NaCl). La transpiration se trouve sévèrement diminuée en présence de NaCl dans le milieu de culture. Cette diminution peut atteindre jusqu'à 22% et 48% par rapport au témoin respectivement pour 50 et 100 mM NaCl. Alors que pour le potentiel de turgescence (Ψτ) une certaine stabilité a été enregistrée. Cette espèce peut être employée localement pour le repeuplement des terres affectées par la salinité, en vue de leur réhabilitation, notamment en tant que parcours.

Mots clefs : *Lygeum spartum* L., steppe, salinité, transpiration, conductivité hydraulique des racines, potentiel de turgescence, transpiration.

Introduction

Salinity, one of the major factors limiting crop production, may reduce plant growth by water deficit, ion toxicity, ion imbalance or a combination of these factors [1]. Some plants are able to tolerate salinity stresses by reducing the cellular osmotic potential as a consequence of a net increase in solute accumulation [2].

Lygeum spartum L. (Poaceae) is one of the most abundant and widespread perennial rhizomatous grasses found in the Algerian steppes. This species can tolerate extreme conditions of aridity and high temperatures, the maximal temperatures growth ranging between 40 and 45 °C [3,4]. Its extensive root system plays a significant role in preventing desertification, by stabilising the sand. It has been used as a fodder for domestic livestock and for rehabilitation of degraded lands.

In North Africa, it has been used as raw material for manufacturing paper [3]. However, as far as we know, there is little published information pertaining to the effect of salinity on *L. spartum*, in regard to the possibility of using it in arid zones [5,6]. Therefore, the objective of the present work was to evaluate the water status of *L. spartum* seedlings in the presence of NaCl.

1. Materials and methods

1.1. Plant material and growth conditions

The seeds of *L. spartum* were collected from the area of *Aïn Maâbed* in the province of *Djelfa* (Algeria) (2°39'E longitude, 34°50'N latitude and 934 m elevation). Seeds were pre-hydrated with de-ionised water for 12 h and germinated in vermiculite, at 28°C in an incubator, for 2 days. They were then transferred to a controlled-environment chamber with a 16h light – 8h dark cycle and air temperatures of 25 and 20 °C, respectively. The relative humidity (RH) was 60% (in day) and 80% (at night) and photosynthetically-active radiation (PAR) was 400 μmol m^{-2} s^{-1}, provided by fluorescent tubes.

After 7 days, the seedlings were placed in 15 Liters containers with modified, continuously-aerated Hoagland nutrient solution [7]: $Ca(NO_3)_2$ (2 mMole), K_2HPO_4 (0.5 mMole), $MgSO_4$ (0.5 mMole), H_3BO_3 (25 μMole), $MnSO_4$ (2 μMole), $ZnSO_4$ (2 μMole), $CuSO_4$ (0.5 μMole), $(NH_4)_6Mo_7O_{24}$ (0.5 μMole) and Fe-EDDHA [ethylendiamino-di(o-hydroxyphenylacetic) acid] (20 μMole).

The solution was replaced completely every week. After 13 days (when plants were 20 days-old).

Plants were treated with 0, 50 and 100 mM NaCl, the concentration of NaCl used in this experiment was similar to the level that can be found on Algerian saline steppes [8].

Transpiration, turgor potential (Ψτ) and root hydraulic conductance (L_o) were measured after 7 days of the treatments.

1.2. Measurements

The hydraulic conductance (L_0) of roots was measured by pressurising the roots using the Scholander chamber [9].

For transpiration, each pot containing one plant was covered with a plastic bag, secured around the stem base. The water transpired was estimated under controlled light from the weight loss over a 6-h period (10:00–16:00 h). The mean transpiration rate (per g fresh weight) was calculated based on the amount of transpired water and total fresh weight at the sampling time.

Turgor potential (Ψτ) was calculated as the difference between leaf water potential and osmotic potential.

1.3. Data analysis

The experiment was set up as a completely randomised design, with five replications of each treatment. Data were analysed statistically, using the SPSS 7.5 software package, by ANOVA and by Tukey´s multiple range test, to determine differences between means.

2. Results and discussion

After 30 days of treatment, all plants remained alive until the end of the experiment. The root hydraulic conductance (L_0) was measured from 11 to 13 h, when transpiration was maximal. Compared with the control, root hydraulic conductivity ($P<0.01$) in *L. spartum* seedlings declined significantly with the increase of salinity (figure 1).

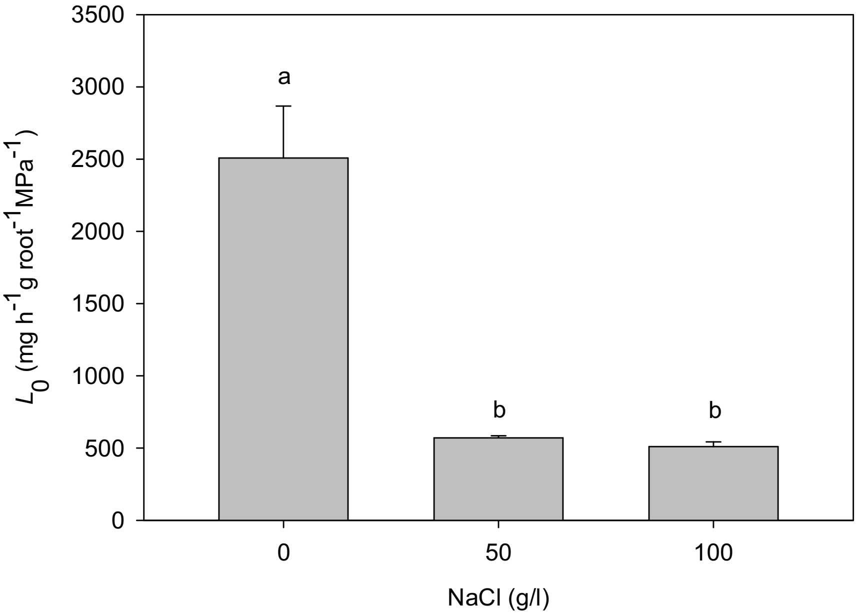

Figure 1: Root hydraulic conductance (L_0) of *Lygeum spartum* seedlings grown under different treatments of NaCl. Data are means ± SE (n = 5). Columns with the same letters are not significantly different ($P < 0.05$, Tukey´s test

A significant reduction of transpiration ($P<0.01$) occurred in plants treated with NaCl, both sodium chloride treatments decreased this parameter, the reduction being greater at 100 mM NaCl (figure 2).

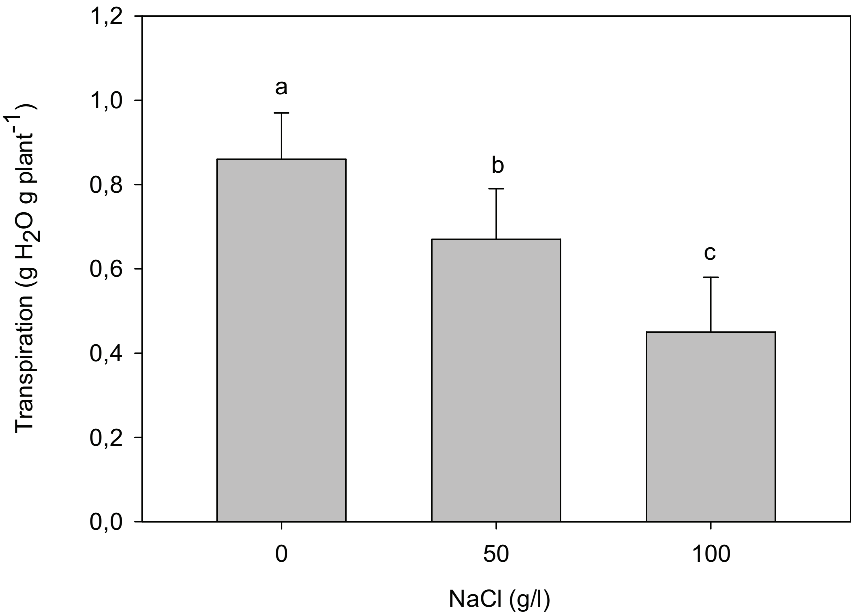

Figure 2: Transpiration of *Lygeum spartum* seedlings grown under different treatments of NaCl. Data are means ± SE (n = 5). Columns with the same letters are not significantly different ($P < 0.05$, Tukey´s test).

There were no significant differences ($P>0.05$) between the turgor potential (Ψτ) values of the control and treated plants (figure 3).

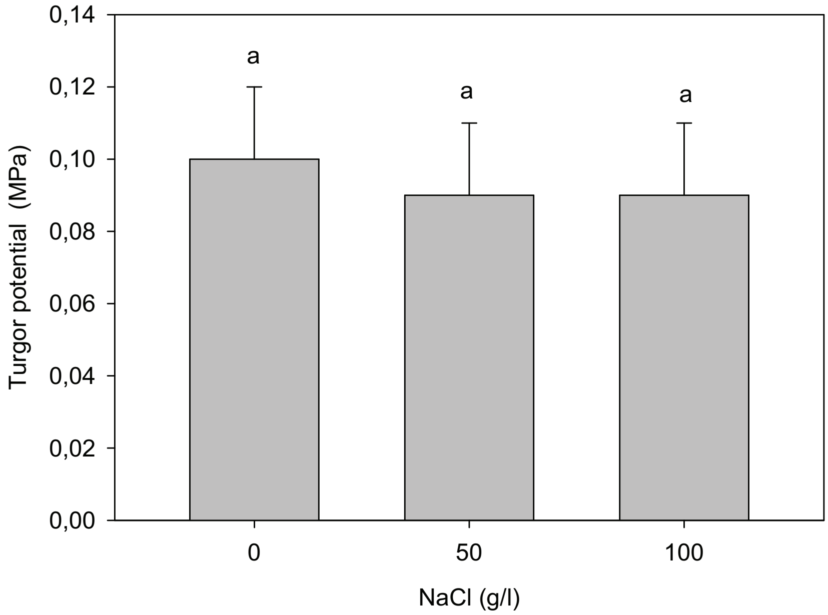

Figure 3: Turgor potential (Ψτ) of *Lygeum spartum* seedlings grown under different treatments of NaCl. Data are means ± SE (n = 5). Columns with the same letters are not significantly different ($P < 0.05$, Tukey´s test).

The effects of increased salinity on L_0 have been widely reported and it has been suggested [2,10] that they are due to the high concentrations of Na^+ and Cl^- in the cytoplasm, that reduce water transport through the plasma membrane aquaporins [11]. Our experiments showed a strong decrease of L_0 in roots of *L. spartum* plants when NaCl was applied (figure 1).

The large reductions in root hydraulic conductance for salinized plants were related closely to the decrease in the activity or concentration of aquaporins in the root plasma membrane [6,10], this effect being due mainly to the specific toxicity of Na^+ and Cl^- [12].

The transpiration rates of our plants seemed to reflect the effects observed for L_0. This may be due to the possibility that lowered water potentials in the roots can trigger a signal from root to shoot. This signal might be hydrostatic [13] or involve organic molecules such as ABA, as previous authors have claimed [14].

Osmotic adjustment involves the net accumulation of solutes in cells in response to a fall in the water potential of their environment. As a consequence of this net accumulation, the cell osmotic potential is lowered and turgor pressure tends to be maintained. The fact that there were no changes in turgor in the plants, in response to the treatments of our experiment, indicates a certain level of osmotic adjustment [1].

Conclusion

In summary, salinity significantly decreased transpiration and root hydraulic conductance in *L. spartum* plants. However, turgor potential was not significantly changed by salinity. These results indicate the possibility of introducing this plant as a source of fodder or forage in moderate salt-affected soils which are inadequate for traditional agricultural uses.

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