

MORPHOLOGICAL CHANGES IN *Portulaca oleracea* L. UNDER SALT STRESS

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ABSTRACT: Halophyte plants are known to tolerate environments with high salt concentrations, although there are intraspecific differences in the level of tolerance borne by these plants. *Portulaca oleracea* L., commonly known as Purslane, is mentioned in the literature as a halophyte species that shows tolerance to salinity, but this tolerance is genotype-dependent. The present study aimed to evaluate if a Purslane access (B1) is highly tolerant to salinity, to be used in future studies on the mechanism(s) promoting this tolerance. For that, morphological changes the B1 access were evaluated once submitting it to saline stress at concentrations of 0.0; 0.2; 0.4; 0.6; 0.8; 1.0; 1.2; 1.4; 1.6; 1.8 and 2.0 g of NaCl / 100 g of substrate. Seeds were germinated in culture medium (MS ½ strength, Phytigel 0.2%, and pH 5.8) and then transferred to 200 mL plastic cups with 100 g of substrate. After 35 days, saline solutions containing different amounts of salts were added to the substrate in order to subject the plants to the different levels of salts above mentioned. The experiment was conducted in a plant growth chamber in which temperature was set at $25 \pm 2^\circ\text{C}$, $65 \pm 5\%$ of air relative humidity and $500 \pm 20 \mu\text{mol}/\text{m}^2/\text{s}^{-1}$ of PAR, and a photoperiod of 16/8 h (light/dark). The most common morphological characteristics (shoot growth, leaf area and number, stem succulence, leaf color and stem color) were monitored for a period of up to 12 days, after the onset of saline stress. The experimental design was completely randomized with three replicates per treatment. Purslane plants showed practically no changes in the variables evaluated up to 1.2 g of salt. Even in the highest concentrations, the plants remained alive.

KEYWORDS: Abiotic stress, salt tolerance, Purslane.

ALTERAÇÕES MORFOLÓGICAS EM *Portulaca oleracea* L. SOB ESTRESSE SALINO

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RESUMO: Plantas halófitas são conhecidas por tolerar ambientes com altas concentrações de sal, embora existam diferenças intraespecífica no nível de tolerância suportado por estas plantas. *Portulaca oleracea* L., conhecida popularmente como Beldroega, é citada na literatura como uma espécie halófito que apresenta tolerância a salinidade, mas esta tolerância é dependente do genótipo. O presente estudo objetivou avaliar o nível de um acesso de Beldroega (B1) é altamente tolerante à salinidade, para ser usado em estudos futuros sobre o (s) mecanismo (s) que promovem essa tolerância. Para isso, alterações morfológicas do acesso B1 foram avaliadas submetendo-as a estresse salino em concentrações de 0,0; 0,2; 0,4; 0,6; 0,8; 1,0; 1,2; 1,4; 1,6; 1,8 e 2,0 g de NaCl/100 g de substrato. As sementes de Beldroega foram semeadas em meio de cultura (MS ½ força, Phytigel 0,2%, e pH 5,8) e depois transferidas para recipientes plásticos de 200 mL com 100 g de substrato. Após 35 dias, foram adicionadas as soluções salinas, contendo as diferentes quantidades de sais, ao substrato para submeter as plantas aos diferentes níveis de sais mencionados acima. O experimento foi conduzido em câmara de crescimento nas seguintes condições $500 \pm 20 \mu\text{mol m}^{-2} \text{s}^{-1}$ PAR ao nível da planta, $25 \pm 2^\circ\text{C}$ de temperatura, $65 \pm 5\%$ de umidade relativa e fotoperíodo de 16 h luz/8 h escuro, das 06:00 às 22:00. As características morfológicas mais comuns (crescimento, área foliar, número de folhas, suculência do caule, cor da folha e cor do caule) foram monitorados por um período de 12 dias, após o início do estresse salino. O delineamento experimental foi inteiramente casualizado com três repetições por tratamento. As plantas de Beldroega não mostraram alterações nas variáveis analisadas até 1,2 g de sal. E, mesmo com concentrações mais altas de sal, elas sobreviveram.

PALAVRAS-CHAVE: Estresse abiótico, tolerância à salinidade, Beldroega.

INTRODUCTION

Salinity stress is considered an abiotic factor that limits the productivity of crops, causing reductions of 15-69%, depending on the plant species, type of soil, stress level and water quality used for irrigation (Qadir et al., 2014). The exposure of plants to high salinity can cause both reductions in biomass and crop yield, as well as plant death, as fundamental processes such as photosynthesis, protein synthesis, energy metabolism and lipid metabolism are compromised (Parida and Das, 2005), and changes in metabolic profile and nutritional potential are also observed (Macedo, 2012).

Saline stress can primarily reduce the plant ability to absorb water, decrease evapotranspiration, promote disturbances in mineral nutrition, hormonal imbalance, formation of reactive oxygen species, and, alteration in anatomical characteristics (Maksimovic and Ilin, 2012). Depending on the time of exposure to the stress, a significant reduction in the growth rate can be observed (Munns, 2002).

Plants can be classified either as glycophytes (they do not support saline environments), or halophytes (support saline environments), depending on its tolerance to salinity (Gupta and Huang, 2014). Among the halophytes, there are intraspecific differences in the level of tolerance supported by these plants. *Portulaca oleracea* L., also known as purslane, is cited in the literature as a halophyte species that shows salinity tolerance, but this tolerance is genotype dependent. This species presents nutritional potential for human and animal consumption (Teixeira and Carvalho, 2009), medicinal properties for a wide spectrum of diseases (Iranshahy et al., 2017), its seeds are sources of oil production (Teixeira and Carvalho, 2009), and due to its characteristic of supporting saline environments can be considered an important genetic source for saline tolerance (Slama et al., 2015).

The development of research aimed at elucidating the physiological, biochemical and genetic tolerance of halophyte plants can provide a promising basis for further studies on the understanding of how this tolerance is achieved by this plant, and how it can be transferred to a glycophyte. Thus, the present study aimed to evaluate the level of tolerance to salinity of the B1 access of *P. oleracea*, subjecting it to increasing levels of saline stress.

MATERIAL & METHODS

Seeds from *Portulaca* B1 access were disinfected by soaking in 2% sodium hypochlorite and Tween® 20, then washed with sterile water and dried on autoclaved filter paper. Then, they were seeded on culture medium (MS ½ strength, Phytigel 0.2%, and pH 5.8) (Murashige e Skoog, 1962), and kept in a growth chamber ($150 \mu\text{mol m}^{-2} \text{s}^{-1}$ at $30 \text{ }^\circ\text{C}$) for germination. After 20 days, the seedlings were transferred to 200 ml plastic cups containing 100 g of the substrate, which was prepared in the following ratio 2:1:1 (v; v; v) of sterilized soil, vermiculite, and a commercial substrate, respectively. The seedlings were transferred to a plant growth chamber in which temperature was set at $25 \pm 2^\circ\text{C}$, $65 \pm 5\%$ of air relative humidity and $500 \pm 20 \mu\text{mol/m}^2/\text{s}^{-1}$ of PAR, and a photoperiod of 16/8 h (light/dark). Plantlets were kept in acclimatization trays for 7 days.

After 35 days of the transfer of plants to the soil, different amounts of NaCl (0.0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8 and 2.0 g / 100 g of substrate) were applied to the substrate by means of a saline solution with a standard volume. It corresponded to the maximum water absorption capacity of the substrate (commonly referred to as field capacity). The experimental design was completely randomized with three replicates. The plants were monitored during 12 days after the onset of saline stress. Morphological evaluations (shoot growth, leaf area and number, stem succulence, and leaf color) of the symptoms were performed.

RESULTS AND DISCUSSION

Purslane plants tolerated levels of up to 1.2 g NaCl / 100 g of substrate, without significant changes in their morphological characteristics. Even when changes occurred in morphological variables, at salt concentrations above that value, the plants were able to complete their life cycle. Thus, doses of 0.2 to 1.0 g of NaCl did not present changes in the morphological characteristics (leaf number, stem succulence, leaf color and stem color) analyzed, however, doses from 1.2 up to 2.0 g of NaCl promoted changes in morphological characteristics, such as reduction in leaf number, change in leaf color (yellowing), change in stem color (rosy) and loss of stem succulence (Figure 1). These characteristics were more pronounced with increasing doses, but they did not make it impossible to produce seeds of this material at the end of the life cycle.

The visual effect of saline stress begins with the loss of leaves, reduction of leaf area, loss of green color, the absence of flowering, and, in cases of long exposure to salt, the stem changes its coloration to reddish or pink tonality. *Portulaca* is considered a moderate to high salinity tolerant species, producing a satisfactory amount of dry mass in saline environments; however, this should be elucidated for each genotype (Alam et al., 2014).

What was important to determine the level of tolerance of the B1 access, and to classify this material as tolerant. This classification of salinity tolerance was performed in another study to select 13 accessions of *Portulaca*, based on the best growth performance submitted to different salinity levels (0.0, 10, 20, 30 and 40 dS m⁻¹). These materials were classified as susceptible, moderately susceptible, tolerant and moderately tolerant by parameters such as leaf number, plant height and dry mass production (Alam et al., 2014).

The results obtained in this study promoted a promising basis for further studies on how this high tolerance is achieved and for a detailed description of the physiological, biochemical and genetic behavior of this access to salinity.

CONCLUSION

The B1 access of Purslane plants tolerated levels of NaCl up to 1.2 g / 100 g of the substrate without significant changes in morphological characteristics. Even when submitted to higher concentrations of salt (up to 2.0 g NaCl), the plants survived and completed their life cycle. Based on these results and taking into account the classification of the plants regarding the tolerance to the salts, the B1 access of *Portulaca oleracea* can be classified as a salinity-tolerant genotype.

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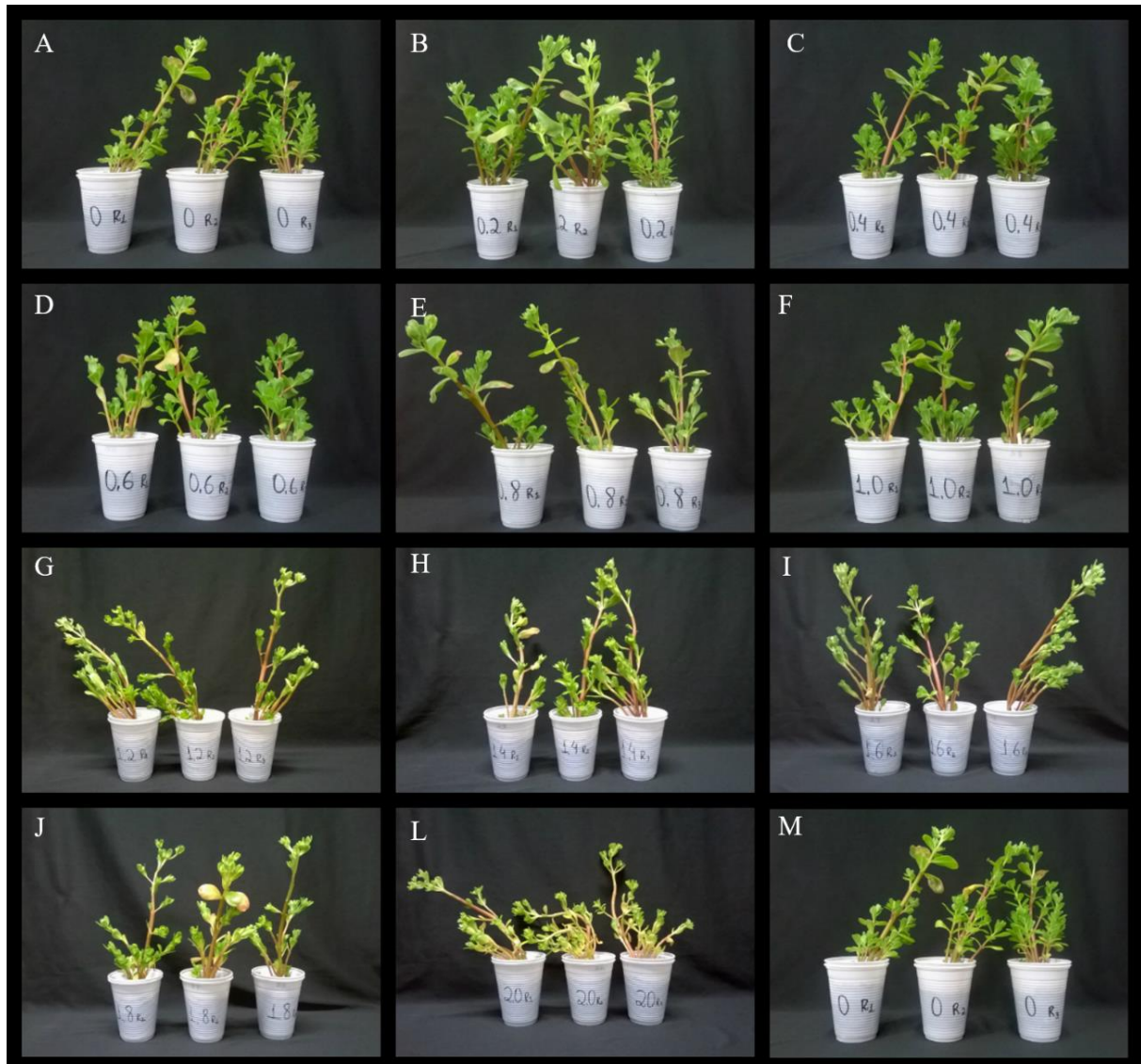


Figure 1 - Visual assessments (Pictures) of Purslane access B1 under different saline concentrations. (A) 0,0 g of NaCl/100 g of the substrate, (B) 0,2 g of NaCl/100 g of the substrate, (C) 0,4 g of NaCl/100 g of the substrate, (D) 0,6 g of NaCl/100 g of the substrate, (E) 0,8 g of NaCl/100 g of the substrate, (F) 1,0 g of NaCl/100 g of the substrate, (G) 1,2 g of NaCl/100 g of the substrate, (H) 1,4 g of NaCl/100 g of the substrate, (I) 1,6 g of NaCl/100 g of the substrate, (J) 1,8 g of NaCl/100 g of the substrate, (L) 2,0 g of NaCl/100 g of the substrate, (M) 0,0 g of NaCl/100 g of the substrate.