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Salinity stress tolerance evaluation of a native shrub (Nitraria schoberi) for use in urban landscape

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Salinity Stress Tolerance Evaluation of a Native Shrub (*Nitraria schoberi*) for Use in Urban Landscape

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Abstract
The use of native plants in urban landscape, especially in areas with saline and poor soils, plays a key role in water resources management and also in reduction of municipal landscape maintenance costs. In order to assess the effect of salinity stress on *Nitraria schoberi* as a native Iranian shrub, potted plants were irrigated with different levels of saline water (0, 20, 40, 60, 80 and 100 mM NaCl). Results showed that chlorophyll and sugar contents were not adversely affected by the salinity level. Proline content also was accumulated as a response to salt stress compared to control plants. Different salinity levels didn't significantly affect relative water content. Proline content did not increase significantly by salinity stress compared to control plants. The findings suggest that *Nitraria schoberi* is a really tolerant plant of salinity and it can be used as an ornamental plant in landscaping of semi-arid areas.

Keywords: Arid lanscape, Chlorphyll content, Proline content, Urban landscape

Evaluation of salt tolerance in a native shrub (*Nitraria schoberi*) for use in urban landscapes

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Abstract

The use of native plants in the urban landscape, especially in areas with saline and poor soils, plays a key role in water resource management and also in reduction of municipal costs. In order to assess the effect of salt stress on *Nitraria schoberi*, a native shrub from Iran, potted plants were irrigated with salt water (0, 20, 40, 60, 80 and 100 mM NaCl). The results showed that chlorophyll, sugar and relative water contents were not adversely affected by the salinity level. Proline content was also not increased significantly by salinity compared with control plants. The findings suggest that *Nitraria schoberi* is a tolerant plant to salinity that can be used as an ornamental plant in the landscaping of arid areas.

Keywords: arid areas, salinity, urban landscape

INTRODUCTION

Salt stress is a major abiotic stress worldwide, especially in arid and semi-arid regions. The most important symptoms of plants damaged by salinity include growth inhibition, accelerated development and senescence. If the plant is exposed to prolonged salt stress, severe salinity can eventually lead to plant death (Duncan et al., 2009; Nadeem et al., 2012). Some previous studies have indicated that most ornamental plants are more sensitive than other plants under salt stress, and they are usually damaged by low or moderate salinity in the irrigation water (Ma and Yamaji, 2006). Based on mixed salt salinity tolerance, ornamental plants are classified in several groups. For example, *Dahlia* spp., *Lilium* spp. and *Rosa* spp. were found to be most sensitive to salt stress (up to 2 dS m^{-1}) while *Chrysanthemum* spp. and *Dianthus caryophyllus* proved to be salinity tolerant (up to 6 dS m^{-1}) (Ivanova et al., 1999). One of the effective factors in selecting plants for landscaping is resistance or tolerance to salinity. In addition to morphological, physiological and biological traits, salt stress can affect biochemical parameters such as proline content, relative water content, and chlorophyll content. Some studies have indicated that proline content is raised significantly in many plants, and that it is positively correlated with the level of salt tolerance (Mademba-Sy et al., 2003). Salinity can also affect chlorophyll (Stępień and Kłbus, 2006) and relative water content (Ghoulam et al., 2002).

Nitraria schoberi L. (family *Zygophyllaceae*) is an evergreen shrub. It is widely distributed all over the Middle East, and also in arid and semi-arid areas of Iran (Naseri, 2014). The aim of the present study was to evaluate the tolerance response to irrigation with salt water in *N. schoberi* for evaluation of its use in arid and semi-arid urban landscape.

MATERIALS AND METHODS

This study was conducted in a greenhouse at Ferdowi University of Mashhad, Iran, from 20 February to 20 April 2016. After germination, seeds of *N. schoberi* were transferred to plastic containers filled with a soil, texture of which was sand clay. The plants were treated with solutions containing 0, 20, 40, 60, 80 or 100 mM NaCl. After 1 month of salt irrigation, parameters including relative water content (RWC), proline and chlorophyll

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content and also total carbohydrates were measured and calculated.

To calculate RWC, leaf samples were weighed (fresh weight; FW) and placed in distilled water at 4°C in the dark for 24 h to rehydrate, and the turgid weight (TW) measured. The samples were then put in an oven at 75°C for 24 h and the dry weight (DW) was determined. Finally, RWC was calculated by following formula: RWC = (FW-DW)/(TW-DW) × 100 (Silveira et al., 2003). In order to calculate chlorophyll content, fresh leaves were extracted in 80% acetone and centrifuged. Absorbance was determined on a spectrophotometer at 663 and 645 nm for chlorophyll *a* and *b*, respectively (Arnon, 1949). Free proline was measured by the following method: 100 mg fresh leaf material was homogenized in 2 mL 40% methanol, and then heated in a water bath at 85°C for 60 min. The absorbance was then measured at 528 nm by using a spectrophotometer (Troll and Lindsley, 1955). Total carbohydrates were measured in 100 mg powder of dried leaves, which was soaked in 80% (v/v) ethanol for 24 h, by the method of Shields and Burnett (1960). The absorbance was measured at 585 nm in a spectrophotometer.

The experiment was laid out in a complete randomized design with five replicates. All data obtained were subjected to statistical analysis. This analysis was performed using Minitab 17 and mean values were grouped with Tukey's multiple range test ($P<0.05$).

RESULTS AND DISCUSSION

As can be seen from Table 1, none of the salinity treatments significantly affected RWC, sugars, total chlorophyll or proline content in *N. schoberi*. The results indicated that, although the differences were not significant, proline and sugar content tended to increase, while RWC tended to decrease with increased the salinity level (except 60 mM). Total chlorophyll content was comparable in all plants treated with different salinity levels and also in control plants.

Table 1. Results of analysis of variance with mean square testing the effects of salinity levels on relative water content (RWC), proline, chlorophyll (Chl) and sugar content in *N. schoberi*. d.f., Degrees of freedom; SS, sum of squares; MS, mean square; ns, not significant.

Source	d.f.	Adjusted SS	Adjusted MS	F value	P value
Salinity treatments					
RWC (%)	5	133.6	26.71	0.35	0.874^{ns}
Sugar (mg g^{-1} FW)	5	241.8	48.36	0.81	0.553^{ns}
Total Chl (mg g^{-1} FW)	5	0.027	0.005	0.56	0.732^{ns}
Proline (mg g^{-1} FW)	5	1056	211.2	1.65	0.184^{ns}
Error					
RWC (%)	24	1808.2	75.34	-	-
Sugar (mg g^{-1} FW)	24	1431.3	59.64	-	-
Total Chl (mg g^{-1} FW)	24	0.2377	0.009	-	-
Proline (mg g^{-1} FW)	24	3065	127.7	-	-
Total					
RWC (%)	29	1941.8	-	-	-
Sugar (mg g^{-1} FW)	29	1673.1	-	-	-
Total Chl (mg g^{-1} FW)	29	0.2653	-	-	-
Proline (mg g^{-1} FW)	29	4121	-	-	-

Ornamental plants in general demonstrate wide variability in their reaction to salt stress (Ivanova et al., 1999). Previous studies reported that various plants can increase (Sabet Teimouri et al., 2007) or decrease (James et al., 2002) RWC under salt stress. The results of the present study indicated that, although the difference of RWC between the NaCl treatments was not statistically significant, plants grown under salt stress tended to have a lower RWC. This could be due to abnormal water uptake by leaves with a high solute content when floated on distilled water, which caused leakage of cytoplasmic solution into the apoplast (Volkmar et al., 1998). Our findings showed that proline and sugar concentration were raised in plants under salt stress (no significant difference). In many plants, proline content increases with increasing salt concentration as a response to metabolic salt stress, and it plays a key role in osmotic adjustment (Mademba-Sy et al., 2003). Under environmental stress, many plant species accumulate sugar in their tissues on order to adjust the osmosis system. In most plants exposed to salinity, chlorophyll content decreases. The reduction in chlorophyll content under salinity can lead to a decrease in photosynthetic rate (Francois and Maas, 1993).

In our study, no symptoms of sensitivity to salinity in *N. schoberi* were observed by measuring most common plant factors under salt stress, such as RWC, proline, sugar and chlorophyll content. Plants irrigated with different salt levels (low-moderate to relatively high) behaved nearly the same as control plants in terms of the above-mentioned biochemical parameters. Based on this, it can be said that *N. schoberi* is a plant with relatively high tolerance to salinity.

CONCLUSIONS

According to our findings, it seems that *N. schoberi* is a salt-tolerant plant. The results suggest that the plant may be a candidate species for planting in urban areas where salinity levels in the soil or water cannot be altered.

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