



University of Kentucky  
UKnowledge

---

International Grassland Congress Proceedings

22nd International Grassland Congress

---

## Salt Secretion Is Essential for Xero-Halophyte *Reaumuria soongorica* Responding to Osmotic Stress

Ai-Ke Bao  
*Lanzhou University, China*

Hang-Yu Zhou  
*Lanzhou University, China*

Suomin Wang  
*Lanzhou University, China*

Follow this and additional works at: <https://uknowledge.uky.edu/igc>



Part of the [Plant Sciences Commons](#), and the [Soil Science Commons](#)

This document is available at <https://uknowledge.uky.edu/igc/22/1/15>

The 22nd International Grassland Congress (Revitalising Grasslands to Sustain Our Communities) took place in Sydney, Australia from September 15 through September 19, 2013.

Proceedings Editors: David L. Michalk, Geoffrey D. Millar, Warwick B. Badgery, and Kim M.

Broadfoot

Publisher: New South Wales Department of Primary Industry, Kite St., Orange New South Wales, Australia

---

This Event is brought to you for free and open access by the Plant and Soil Sciences at UKnowledge. It has been accepted for inclusion in International Grassland Congress Proceedings by an authorized administrator of UKnowledge. For more information, please contact [UKnowledge@lsv.uky.edu](mailto:UKnowledge@lsv.uky.edu).

# Salt secretion is essential for xero-halophyte *Reaumuria soongorica* responding to osmotic stress

Bao Ai-Ke, Zhou Hang-Yu and Wang Suo-Min

State Key Laboratory of Grassland Agro-ecosystems, College of Pastoral Agriculture Science and Technology, Lanzhou University, Lanzhou 730020, People's Republic of China

Contact email: [baoaik@lzu.edu.cn](mailto:baoaik@lzu.edu.cn)

**Keywords:** Drought tolerance, physiological mechanism, desert steppe, Tamaricaceae.

## Introduction

*Reaumuria soongorica*, a xero-halophyte semi-shrub belonging to Tamaricaceae with excellent adaptability to adverse arid and salinity environments of northwest China, serves important ecological roles in the improvement of saline-alkali soil and dune stabilisation, and also is an attractive fodder shrub in desert steppe (Ma *et al.* 2011). Previous studies demonstrated that secreting salt via salt glands is an important strategy for *R. soongorica* adapting to high salinity environments (Zhou *et al.* 2012). However, very little is known about the role of salt secretion in the plant's responses to drought. Therefore, in the present work, *R. soongorica* seedlings were subjected to osmotic stress in the presence or absence of additional NaCl to determine the potential relationship between salt secretion and drought tolerance of *R. soongorica* seedlings.

## Methods

### Plant material and treatments

The *R. soongorica* seedlings were cultured in sand irrigated with modified 1/2 strength Hoagland nutrient solution. Six-week-old seedlings were divided into 3 groups: control (C), osmotic stress (D) and osmotic stress with additional salt (D+S). Plants of C group continued to be irrigated with the same nutrient solution during the experimental period. In the two treatment groups, plants were cultured with the same nutrient solution supplemented without (D) or with 50 mM NaCl (D+S) for 4 days, then were exposed to -0.5 MPa osmotic potential induced by sorbitol for 3 days.

### Physiological assays

Salt secretions and cation concentrations were determined as described by Wang *et al.* (2009). The shoot osmotic potential ( $\Psi_s$ ) and contributions of cations to  $\Psi_s$  were assayed as mentioned by Ma *et al.* (2012).

## Results

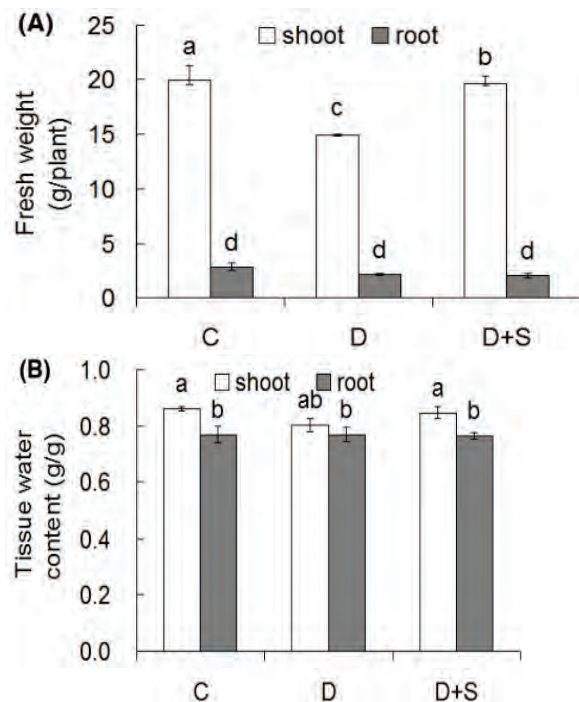
### Fresh weight and tissue water content of *R. soongorica*

In comparison with the control, shoot fresh weight (SFW) was significantly reduced by 25% when plants were subjected to osmotic stress (-0.5 MPa); however, a

significant increase in SFW by 32% was observed in plants grown in the presence compared with the absence of additional 50 mM NaCl under osmotic stress (Fig. 1A), suggesting the addition of 50 mM NaCl alleviated the deleterious impact of osmotic stress on growth of *R. soongorica*. Moreover, the tissue water contents showed no significant difference between the control and plants from osmotic stress treatments (Figure. 1B).

### The $\text{Na}^+$ , $\text{K}^+$ secretion from *R. soongorica*

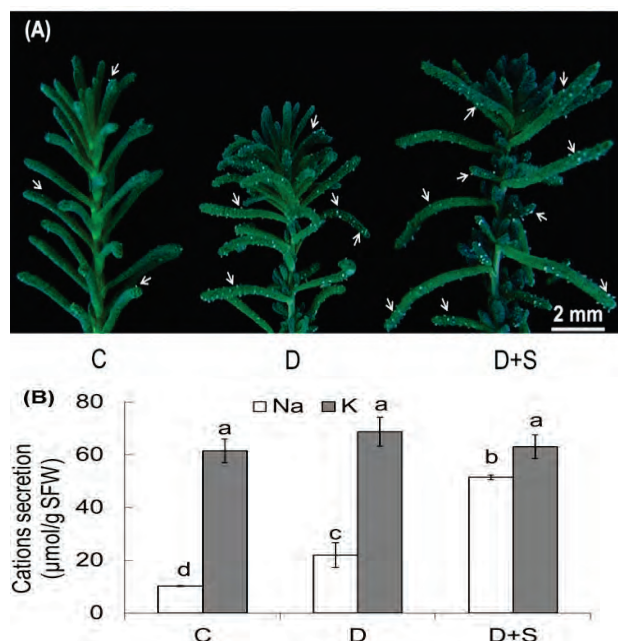
Only a small amount of salt crystallization was observed on leaf surfaces of control plants (Fig. 2A); however, osmotic stress significantly enhanced the amounts of salt crystallization, which showed an even greater increase in the presence of osmotic stress with additional 50 mM NaCl. Further analysis showed that osmotic stress triggered a significant increase in secretion of  $\text{Na}^+$  but not  $\text{K}^+$  (Fig. 2B), suggesting osmotic stress could induce  $\text{Na}^+$  secretion of *R. soongorica*.



**Figure 1.** Fresh weight and tissue water content of *R. soongorica* seedlings. C, control; D, -0.5 MPa osmotic stress; D+S, -0.5 MPa osmotic stress with 50 mM NaCl for 3 days.

**Table 1.** Shoot osmotic potential ( $\Psi_s$ ),  $\text{Na}^+$  and  $\text{K}^+$  concentrations, and the contributions of  $\text{Na}^+$  and  $\text{K}^+$  to osmotic potential ( $\Psi_s$ ) of *R. soongorica* seedlings. C, control; D, -0.5 MPa osmotic stress; D+S, -0.5 MPa osmotic stress with 50 mM NaCl for 3 days.

Treatments	$\Psi_s$ (MPa)	$\text{Na}^+$ concentration (mmol/g DW)	$\text{K}^+$ concentration (mmol/g DW)	Contribution of $\text{Na}^+$ to $\Psi_s$ (%)	Contribution of $\text{K}^+$ to $\Psi_s$ (%)
C	-2.3±0.03 c	0.75±0.03 b	0.99±0.08 a	13.0±0.5 a	7.1±0.2 a
D	-3.6±0.10 b	0.82±0.05 b	0.89±0.04 a	13.6±1.1 a	6.5±1.0 a
D+S	-4.0±0.07 a	1.09±0.11 a	0.84±0.10 a	11.7±0.4 b	3.8±0.3 b



**Figure 2.** Salt crystallization on leaf surface (A) and amount of  $\text{Na}^+$ ,  $\text{K}^+$  secretion (B) of *R. soongorica* seedlings. C, control; D, -0.5 MPa osmotic stress; D+S, -0.5 MPa osmotic stress with 50 mM NaCl for 3 days.

#### Shoot $\text{Na}^+$ and $\text{K}^+$ accumulation and their contribution to osmotic potential ( $\Psi_s$ ) of *R. soongorica*

Compared with the control, shoot  $\text{Na}^+$  concentration was unchanged under osmotic stress, and only slightly increased in the presence of an additional 50 mM NaCl and osmotic stress. On the other hand, shoot  $\text{K}^+$  concentration was unaffected by either osmotic stress or the addition of 50 mM NaCl and osmotic stress (Table 1). Further investigations indicated that osmotic stress decreased shoot  $\Psi_s$ , whether with or without additional 50 mM NaCl. It is interesting that the contribution of either  $\text{Na}^+$  or  $\text{K}^+$  to total osmotic potential showed no significant difference between the control and plants that

suffered osmotic stress, and even decreased in the presence of additional 50 mM NaCl and osmotic stress (Table 1). Combined with the data from Figure 1A, these results imply that secreting more  $\text{Na}^+$  may contribute to maintaining the water balance of *R. soongorica* under osmotic stress.

#### Conclusion

Our results demonstrated that 50 mM NaCl enhanced the osmotic tolerance of *R. soongorica*. This should be ascribed to the ability of *R. soongorica* to secrete more  $\text{Na}^+$ , which might contribute to maintaining the water balance and stability of shoot  $\text{K}^+$  concentration under osmotic stress. Therefore, it can be concluded that salt secretion plays important roles in xero-halophyte *R. soongorica* responding to osmotic stress.

#### Acknowledgments

This work was supported by the grants from National Science Foundation of China (31101750) and the Fundamental Research Funds for the Central Universities (lzujbky-2012-96).

#### References

- Ma HY, Tian CY, Feng G, Yuan JF (2011) Ability of multicellular salt glands in *Tamarix* species to secrete  $\text{Na}^+$  and  $\text{K}^+$  selectively. *Science China Life Science* **54**, 282-289.
- Ma Q, Yue LJ, Zhang JL, Wu GQ, Bao AK, Wang SM (2012) Sodium chloride improves photosynthesis and water status in the succulent xerophyte *Zygophyllum xanthoxylum*. *Tree Physiology* **32**, 4-13.
- Wang CM, Zhang JL, Liu XS, Li Z, Wu GQ, Cai JY, Flowers TJ, Wang SM (2009) *Puccinellia tenuiflora* maintains a low  $\text{Na}^+$  level under salinity by limiting unidirectional  $\text{Na}^+$  influx resulting in a high selectivity for  $\text{K}^+$  over  $\text{Na}^+$ . *Plant, Cell and Environment* **32**, 486-496.
- Zhou HY, Bao AK, Du BQ, Wang SM (2012) The physiological mechanisms underlying how eremophyte *Reaumuria soongorica* responding to severe NaCl stress. *Pratacultural Science* **29**, 71-75.