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Hydraulic lift through the root systems in *Zygophyllum xanthoxylum*

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Key words : arid ecosystem, desert plant, hydraulic lift, water potential, transpiration

Introduction Water is the primary factor limiting plant growth in arid ecosystems. Hydraulic lift may be important in desert ecosystems because this phenomenon may enhance or prolong uptake of water and nutrients through roots during periods of water stress. During hydraulic lift, at night, water absorbed through deep roots in moist soil depths and transported into dry soils in upper portions of the profile, may increase the amount of water available to shallow roots. However, hydraulic lift may not occur in all plants. Our study was designed to investigate the phenomenon of hydraulic lift in *Zygophyllum xanthoxylum* and evaluate the effect of hydraulically lift on plant water transpiration.

Materials and methods The desert shrub *Z. xanthoxylum* were evaluated and two treatments (shaded, unshaded) were applied. Plants were transplanted into a top and bottom split-root apparatus in August 2004. The soil was the mixture of 70% fine sandy loam soil + 30% potting soil. Both top and bottom pots were irrigated regularly. On 2th June 2007, the top pots were irrigated at 25% VWC (volumetric soil water content) and then allowed to dry with the bottom pots continuing to receive water to attain a VWC of 18% (TDR, Germany). The pots were irrigated at 18:30 each day. Thus, when the VWC in top pots was lower than that in bottom pots, soil water potential in the top pots was monitored every 3 hours (PSψPRO, America). Then one treatment was shaded from 18:00 on 7th June to 9:00 on 9th June, the other was not shaded. Meanwhile the top pots were covered with plastic to prevent soil evaporation. Additionally, plant transpiration was measured at 12:00 on 7th June, and from 9:00 on 8th June to 12:00 on 9th June (LI-6400). Shading was provided by four layers of black nylon mesh which reduced solar irradiance by 80%.

Results Hydraulic lift was detected at the top pots for both treatments (Figure 1). Hydraulic lift occurred at night from 21:00 to 9:00 at the next day, hydraulically lifted water remains in the top pots until the transpiration reinstated from 9:00 to 21:00. For unshaded pots, water potential $\Delta\psi_s$ ($\Delta\psi_s = \psi_{\max} - \psi_{\min}$) was 1.24 MPa, and 1.05 MPa in the shaded pots, significantly smaller than that in unshaded treatment ($P < 0.05$). Before shading and after the shading were removed, the plant transpiration rate increased from 1.39 mmol H₂O m⁻² s⁻¹ to 1.72 mmol H₂O m⁻² s⁻¹ at 12:00, whereas it remained relatively constant for plants in the unshaded pots (Figure 2).

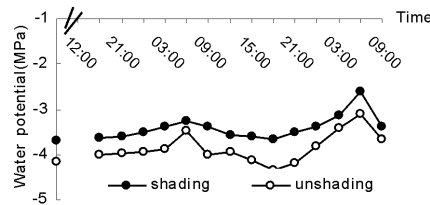


Figure 1 Water potential in the top pots in different treatments.

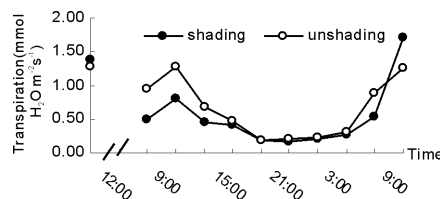


Figure 2 Plant transpiration in different treatments.

Conclusions Our results suggest that hydraulic lift was occurring in the desert shrub *Z. xanthoxylum*. The greater plant transpiration after remove of shading treatment may attribute to large hydraulically lifted water by suppression of transpiration. Hydraulic lift may be a plant adaptation to arid environments.

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