Hydraulic Lift through the Root Systems in *Zygophyllum xanthoxylum*

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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 $\triangle\psi_s$ ($\triangle\psi_s = \psi_{max} - \psi_{min}$) 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 H_2O m^{-2} s^{-1} to 1.72 mmol H_2O m^{-2} s^{-1} at 12 :00 , whereas it remained relatively constant for plants in the unshaded pots (Figure 2) .

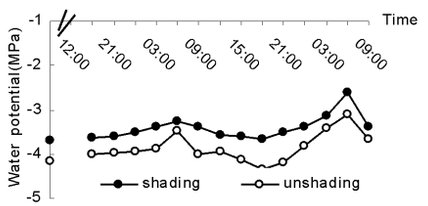

Figure 1 *Water potential in the top pots in different treatments .*

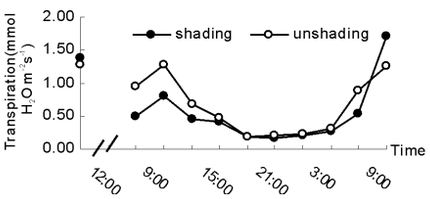

Figure 2 *Plant transpiration in different treatments .*

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 hydraulic lifted water by suppression of transpiration . Hydraulic lift may be a plant adaptation to arid environments .

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