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Differential water uptake patterns and physiological regulations in response to groundwater fluctuations for two desert riparian species in hyper-arid areas of Northwest China

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Frequent variations in hydrological environment present challenges to riparian plants to maintain water status. To explore the differences in water-use strategies of two desert riparian species (Populus. euphratica and Tamarix. ramosissima) in response to the increase of the groundwater depth (GWD) during the growing season, we conducted field observations in two typical desert riparian ecosystems in downstream Heihe River Basin, northwest China. Stable isotope composition in plant xylem water, soil water and groundwater were analyzed concurrently with physiological measurements. We found that as the increase of GWD, both species suffered from drought stress indicated by significantly decreased leaf water potential. P. euphratica was more severe affected by the subtle increase of GWD, evidenced by decreased leaf water potential beyond the safety margin for xylem cavitation, decreased maximum stomatal conductance and maximum photosynthetic rate. P. euphratica and T. ramosissima exhibited contrast water use strategie to increasing GWD. Both two species switched to extract greater ratio of groundwater, the magnitude was up to 92.4% for P. euphratica and 93.6% for T. ramosissima. T. ramosissima shifted its water sources to groundwater at the onset of the growing season, while P. euphratica did not extract higher proportion of groundwater until the end of the growing season. The rapidly switch of water sources of T. ramosissima may be resulted from faster functional roots elongation. P. euphratica showed more tight stomatal control than T. ramosissima. Shifts in water sources were associated with reduced stomatal conductance and photosynthesis for P. euphratica, indicating that the switch of water sources was insufficient to compensate for the negative impact of increasing GWD on gas exchange.