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Water use efficiency and functional traits of a semiarid shrubland

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In semiarid climates, water is the fundamental factor determining ecosystem productivity and thereby the capacity for carbon sequestration. Increased water use efficiency (WUE), the ratio of carbon dioxide assimilation (canopy photosynthesis, P_c) to water transpired (canopy evaporation, E_c), is assumed to be an adaptive strategy for sclerophyll shrublands to improve productivity and stress resistance in water-limited environments. However, the real complexity of WUE lies in its dependence on both plant physiological traits (e.g. stomatal resistance, photosynthetic capacity, leaf chemical composition, structure) and on environmental conditions (e.g. atmospheric CO_2 concentration, vapour pressure deficit, temperature, light, soil water availability). We used a transient-state closed canopy-chamber to characterise CO_2 and water vapour exchanges at the whole plant scale under different environmental conditions and phenological stages. Diurnal and seasonal variations in P_c, E_c and WUE were explained by both physiological and environmental variables. All species showed symmetric patterns in both P_c and E_c when not water limited, but asymmetry during summer drought when leaf water potential was low. During drought, grasses (*Festuca* sp.) showed a marked decline in functioning (P_c and E_c), whereas shrubs (*Genista* sp., *Hormathophylla* sp.) maintained spring-like assimilation rates all morning until stomatal controls shut down gas exchanges. While grasses showed the highest WUE when not water limited, their near senescence during summer drought yielded the lowest WUE. Shrubs showed reduced WUE under moderate drought stress, in contradiction to the assumptions made in global ecosystem models. The importance of the appropriate time-scale for calculating WUE (daily versus hourly), together with water use strategies and ecological functions of individual species, will be further discussed.