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Adaptive strategies against drought stress of six plant species with different growth forms from karst habitats of southwestern China

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Frequent temporary drought in the rain season, as well as long-term drought in the dry season, is one of the most important factors limiting the survival and growth of plants in the harsh karst habitats of southwestern China. The morphological and physiological responses to drought stress of six native woody plant species were investigated under both temporary and prolonged drought stress. The six plant species included Pyracantha fortuneana (evergreen shrub), Rosa cymosa (deciduous shrub), Cinnamomum bodinieri (evergreen tree), and other three deciduous trees, Broussonetia papyrifera, Platycarya longipes and Pteroceltis tatarinowii. Under severe drought stress, the two shrubs with low leaf area ratio (LAR) maintained higher water status, higher photosynthetic capacity and larger percent biomass increase than the most of the trees, owing to their lower specific leaf area, higher intrinsic water use efficiency and thermal dissipation, and higher capacities of osmotic adjustment and antioxidant protection. The evergreen tree, C. bodinieri, exhibited small decrease of water potential and maintained higher leaf mass ratio (LMR) and LAR than the deciduous species under moderate drought stress, due to the high proline accumulation and high activities of antioxidant enzymes. However, it showed high levels of cellular damages, very low photosynthetic capacity, and sharp decreases of water potential and biomass under severe drought stress. After rewatering, C. bodinieri showed a lower ability to recover from severe drought with the successive repeats of severe drought event. The three deciduous trees developed high root mass ratio for maximizing water uptake, and showed higher LAR and biomass than the two shrubs under well-watered condition. However, drought stress resulted in sharp decreases of biomass in the three deciduous trees, which were attributed to the large drought-induced decreases of LMR, LAR and gas exchange. Under drought conditions, the deciduous trees minimized water loss by stomatal closure and by reducing transpiration leaf area and light harvesting through shedding leaves. This enabled them recover rapidly from severe drought events after rewatering, revealing enhanced photosynthetic capacity to compensate for the previous depression of photosynthesis. These results suggested that the two shrubs and C. bodinieri adopted tolerance strategies against drought stress with C. bodinieri having lower tolerance to severe drought, whereas the three deciduous trees were more sensitive to drought stress and employed avoidance strategies. Moreover, the repetition of drought events increased thermal dissipation and superoxide dismutase activity in many of the studied species. Increased intrinsic water use efficiency and high thermal dissipation were observed during the rewatering periods. These enhanced photosynthetic performance and photoprotection processes could be considered as acclimation mechanisms to successive intermittent drought events in karst habitats.