ABSTRACT

Comparative field studies were conducted on Acacia tortilis (Forsk.) Hyne and Acacia xanthophloea Benth. trees growing in a semi-arid environment in Kibwezi, Kenya, to assess root access to soil water at varying soil depths and how this may affect the expression of morphological and physiological traits developed during drought. Measurements of soil water content, leaf growth, shoot elongation, sap flow in the xylem of stems and branches, leaf water potential, leaf transpiration and stomatal conductance were carried out. Further, water use efficiency (WUE) over long-term periods was examined via carbon isotope discrimination (δ13C) on leaves. Whole tree and leaf specific hydraulic conductance were determined from sap flux or leaf transpiration and the water potential gradient between soil (as predawn potential) and canopy, respectively. Leaf growth and shoot elongation depended on soil water availability (SWC) and plant tissue water status. A. xanthophloea showed greater (40 kg d−1) water use compared to A. tortilis trees of comparable sizes (20 kg d−1) during favorable conditions of SWC. Decline in SWC reduced water use and the onset and rate of decline in sap flux was determined by the rooting depth. A. xanthophloea showed earlier response (onset at SWC=0.24 m3 m−3) to water stress than A. tortilis (onset at SWC=0.14 m3 m−3). Midday depression in stomatal conductance and subsequent decline in transpiration during favorable SWC as observed in A. xanthophloea was attributed to increased hydraulic resistance and stomatal closure. Rooting patterns and root characteristics could account for the observed morphological and physiological differences between A. tortilis and A. xanthophloea as well as between small and large A. tortilis trees. However, seasonal responses were modified by species-inherent characteristics, which are expressed during drought. Access to deeper soil water resources and the abilities of trees to extract and efficiently transport water may explain differences in drought resistance among species and tree distribution in the arid savanna.