

WATER USE IN FOREST CANOPY BLACK CHERRY TREES AND ITS RELATIONSHIP TO LEAF GAS EXCHANGE AND ENVIRONMENT

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Models of canopy gas exchange are needed to connect leaf-level measurement to higher scales. Because of the correspondence between leaf gas exchange and water use, it may be possible to predict variation in leaf gas exchange at the canopy level by monitoring rates of branch water use. Rates of water use were determined in branches of forest canopy black cherry trees (ca. 25 m) using the stem heat balance method, as were relationships between water use, leaf gas exchange, and microenvironment. Maximum rates of water flow occurred between 1200 and 1300 HRS (EST), and declined steadily throughout the afternoon hours. Total daily water use was greatest for branches within the upper crown, however, the magnitude of difference between upper and lower crown branches was less for south-facing branches than for north-facing branches. At the entire tree level, measured water flow rate (F) was correlated with stomatal conductance (g_s) ($r = 0.66$), transpiration rate (E) ($r = 0.63$), and photosynthetically active radiation (PAR) measured at the leaf surface ($r = 0.79$). The degree of association between these variables increased with stratification by crown level and increased further with stratification by branch level. Both relative humidity (RH) and PAR measured at 1 m above the canopy contributed significantly ($P = 0.0001$ and 0.01137 respectively) to a model expressing water flow rate as a function of microenvironmental variables. However, variation in RH explained a greater proportion of the total variation in measured flow rate in the lower crown than in the upper crown ($r^2 = 0.94$ and 0.60 , respectively). These results suggest that (1) at the branch level, measured rates of water use can be used to estimate variation in g_s and E , (2) much of the temporal and spatial variation in flow rate is driven by variation in incident PAR, and (3) vapor pressure deficit is probably more important to the regulation of leaf gas exchange in the lower crown while canopy boundary layer resistance is probably more important to the regulation of leaf gas exchange in the upper crown.

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