Comparative water use in short-rotation *Eucalyptus benthamii* and *Pinus taeda* plantations in the Southeastern United States

Chris A. Maier[1], Timothy J. Albaugh[2], Kurt H. Johnsen[3], John Johnson[4], Jim Vose[5]

[1] USDA Forest Service, RTP, NC (cmaier@fs.fed.us); [2] Virginia Tech, Blacksburg, VA; [3] USDA Forest Service, Asheville, NC; [4] Meadwestvaco, Ravenel, SC; [5] USDA Forest Service, Raleigh, NC

Short rotation eucalyptus plantations offer great potential for increasing wood-fiber production in the southeastern United States. Eucalyptus plantations can be highly productive (>35 m^3 ha^{-1} $year^{-1}$), but they may use more water than intensively managed pine (primarily *Pinus taeda*) plantations. This has raised concern about how expansion of eucalyptus plantations will affect water resources. Water consumption of short-rotation eucalyptus needs to be quantified in relation to intensively managed pine in order to develop management and silvicultural practices that maximize productivity and water use efficiency (WUE) without compromising water resources.

We compared tree water use, stem growth, and WUE (kg wood per m^3 water transpired) in adjacent eight-year-old *Eucalyptus benthamii* and *P. taeda* plantations with similar stand density and leaf area. Species differences in stem biomass, stem growth, transpiration per unit tree ($E_{t,tree}$, l day^{-1}), ground (E_t, mm day^{-1}), and leaf area (E_l, mmol m^{-2} s^{-1}), canopy stomatal conductance (G_s, mmol m^{-2} s^{-1}), leaf area index (LAI), and leaf to sapwood area ratio (A_L:A_S) were quantified. Transpiration was measured continuously over one year using thermal dissipation probes. Eucalyptus had higher mean daily $E_{t,tree}$ (39.8 l day^{-1}) and E_t (4.31 mm day^{-1}) than pine (15.9 l day^{-1}, 2.04 mm day^{-1}). Eucalyptus exhibited a seasonally bimodal pattern in daily E_t that did not occur in pine. Monthly E_t was 23-51% higher in eucalyptus and differences between species were greatest in the spring and fall. Annual E_t was 25% higher in eucalyptus (990 mm yr^{-1}) than pine (742 mm yr^{-1}) (P = 0.06). Annual stem biomass increment was greater in eucalyptus (eucalyptus: 22.9; pine: 11.8 Kg $tree^{-1}$ $year^{-1}$, se=0.03, P = 0.01), and eucalyptus had greater WUE (eucalyptus: 2.85; pine 1.86 kg biomass m^{-3} H_2O $year^{-1}$, se=0.24, P = 0.02). Average LAI was similar between species (eucalyptus: 2.66; pine: 2.87); however, pine exhibited a larger seasonal minimum and maximum LAI. At low LAI, there was no significant difference between species in E_l or G_s; however, at maximum LAI, eucalyptus E_l and G_s were 44 and 39% higher, respectively than pine. E_l and G_s were significantly correlated with atmospheric vapor pressure deficit (D). At a similar reference G_s ($G_{s,ref}$ at D = 1kPa), pine exhibited greater stomatal sensitivity to D. These results suggest that 1) eucalyptus had higher water use than pine, 2) eucalyptus had greater stem growth and WUE, and 3) species differences were in water use were driven primarily by differences in E_l and G_s.