Throughout the southern US, past forest management practices have replaced large areas of native forests with loblolly pine plantations and have resulted in changes in forest response to extreme weather conditions. However, uncertainty remains about the response of plantation versus natural species to drought across the geographical range of these forests. Taking advantage of a cluster of unmanaged stands (85-130 year-old hardwoods) and managed plantations (17-20 year-old loblolly pine) in coastal and Piedmont areas of North Carolina, tree water use, cavitation resistance, whole-tree hydraulic (K_{tree}) and stomatal (G_{s}) conductances were measured in four sites covering representative forests growing in the region. We also used a hydraulic model to calculate natural versus plantation transpiration and the resilience to extreme soil drying. Our objectives were to determine: (1) if K_{tree} and stomatal regulation in response to atmospheric and soil droughts differ between species and sites; (2) how ecosystem type, through tree water use, resistance to cavitation and rooting profiles, affects the water uptake limit that can be reached under drought; and (3) the influence of stand species composition on critical transpiration that sets a functional water uptake limit under drought conditions. The results show that across sites, water stress affected the coordination between K_{tree} and G_{s}. As soil water content dropped below 20% relative extractable water, K_{tree} declined faster and thus explained the decrease in G_{s} and in its sensitivity to vapor pressure deficit. Compared to branches, the capability of roots to resist high xylem tension has a great impact on tree-level water use and ultimately had important implications for pine plantations resistance to future summer droughts. Model simulations revealed that the decline in K_{tree} due to xylem cavitation aggravated the effects of soil drying on tree transpiration. The critical transpiration rate (E_{crit}), which corresponds to the maximum rate at which transpiration begins to level off to prevent irreversible hydraulic failure, was higher in managed forest plantations than in their unmanaged counterparts. However, even with this higher E_{crit}, the pine plantations operated very close to their critical leaf water potentials (i.e. to their permissible water potentials without total hydraulic failure), suggesting that intensively managed plantations are more drought-sensitive than unmanaged stands.

Key words: cavitation, drought, natural stands, pine, plantations, transpiration