LEAF AREA INDEX ACROSS EASTERN COTTONWOOD AND HYBRID POPLARS AND ITS RELATIONSHIP WITH PRODUCTIVITY AND WATER USE EFFICIENCY UNDER COPPICING AND NONCOPPICING MANAGEMENT IN THE SOUTHEASTERN UNITED STATES

Jiaxin Wang and Heidi J. Renninger

EXTENDED ABSTRACT

Populus is a promising genus for bioenergy production due to its fast growth. Using efficient and productive *Populus* genotypes is critical for sustainable bioenergy production. However, breeding and testing different genotypes can be costly and time consuming, and the results may vary based on environmental conditions. Therefore, using easily measurable leaf traits to predict *Populus* water use efficiency and productivity could lead to a faster and more accurate selection of top genotypes.

To estimate eastern cottonwood (*Populus deltoides*) and hybrid poplar growth performance, we planted 167 unique clones of *P. deltoides* and five interspecific hybrid taxa of *Populus* at two sites in the Southeastern United States. Leaf area index (LAI) of individual trees was measured across the growing season from April to November. Leaf gas exchange was measured during the middle of the growing season. Tree height and diameter at breast height were measured yearly at the end of the growing seasons. We used analysis of variance, linear regression, and machine learning models to explore the difference in LAI, photosynthetic capacity, intrinsic water use efficiency (iWUE), productivity (yearly added dry biomass), and the relationships between different taxa.

The sum of LAI of each tree (Sum_LAI) measured from April to November varied significantly across different taxa. *Populus deltoides* × *P. deltoides* (D×D) genotypes had significantly higher (10–150 percent higher) Sum_LAI than other taxa. *Populus deltoides* × *P. nigra* (D×N) genotypes had the lowest Sum_LAI (2.0 m^2 m^{-2}). *Populus trichocarpa* × *P. maximowiczii* (T×M) genotypes exhibited the highest iWUE (as high as 58 µmol mol^{-1}), and D×D

Jiaxin Wang, Graduate Student, Mississippi State University, Department of Forestry, Mississippi State, MS 39762

Heidi J. Renninger, Associate Professor, Mississippi State University, Department of Forestry, Mississippi State, MS 39762

exhibited the lowest iWUE (as low as 15 μmol mol^{-1}). D×D had the highest biomass (up to 9.0 kg/tree at age 3), and T×M genotypes had the lowest biomass (as low as 2.0 kg/tree at age 3).

Coppicing management (every 2 years after age 2) significantly reduced Sum_LAI, photosynthetic capacity, and productivity compared to noncoppiced management. Weighted linear regression models suggested that Sum_LAI, stomatal conductance, and photosynthetic rate explained >80 percent of the variance in productivity and >90 percent in iWUE under noncoppiced and coppiced management (different models were fitted for noncoppiced and coppiced management).

These findings can be used for future breeding and quicker phenotyping of seedlings for productivity and physiological traits to select *Populus* taxa and genotypes for efficient bioenergy production in the Southeastern United States.