УНИВЕРЗИТЕТ У НОВОМ САДУ
UNIVERSITY OF NOVI SAD

TOP ACHIEVEMENTS 2022

INSTITUTE FOR LOWLAND FORESTRY AND ENVIRONMENT

Water use efficiency of poplars grown for biomass production in the Midwestern United States. Scientific work of category M21

Global Change Biology – Bioenergy 14(3): 287-306.
https://doi.org/10.1111/gcbb.12887

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Water availability and other site conditions influence poplar biomass productivity and affect clonal performance due to genotype × environment interactions. It is important to select genotypes with high water use efficiency (WUE) that maximizes yield with available amounts of water at sites, while avoiding drought stress and growth impacts to the trees. During drought, stomatal closure induces increased accumulation of δ13C carbon isotope in tree tissues, which is strongly correlated with WUE of trees and usually expressed through carbon isotope discrimination (Δ). Our primary objectives were to evaluate differences in WUE among poplar genotypes grown in the Midwestern United States, and to identify genotypes with high WUE for future deployment on water-limited sites in the region. Sites included 10-year-old biomass plantations in Escanaba, Michigan; Waseca, Minnesota; and Ames, Iowa established from 2000 to 2001 with seven poplar genotypes' three genomic groups. Following harvest, height, diameter, and biomass were determined. Wood samples were collected from individual growth rings to assess annual ring width and WUE through δ13C and Δ. Aboveground dry biomass varied among sites ($p = .0007$), clones ($p < .0001$), and their interactions ($p = .0134$), ranging from 3.1 to 14.0 Mg ha−1 year−1. Δ varied among sites (Δ = 18.9–19.7‰; $p < .0001$) and clones (Δ = 18.6–19.9‰; $p < .0001$), indicating effects of site conditions on WUE of tested genotypes. Clones varied in their water-conserving strategies. Some clones were characterized as water consumers with high growth and high WUE ("C916000"; "C916400"), while other genotypes were water conservers using lower amounts of water with moderate biomass production ("NC13624"; "NC13649"; "NM2" to a certain extent). Although δ13C carbon isotope accumulation correlates with WUE, Δ should only be used for selection when it is integrated with other parameters such as productivity, soils information, and climate data.