Productivity and Ecosystem Services of Poplar in the Southeast: The Role of Functional and Taxonomic Diversity

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Short rotation woody crops (SRWC), such as Populus species and their hybrids, are important components of the bioenergy landscape. These trees grow quickly both above- and below-ground and have the potential to provide a range of ecosystem services, particularly those related to carbon storage and sequestration. Furthermore, various strategies to increase productivity could include deploying superior genotypes, applying treatments like endophytic bacteria, and/or implementing various planting schemes that increase taxonomic or functional diversity. To evaluate these strategies, we established monocultures and mixed clonal plantings of six Populus genotypes across three taxa (*Populus deltoides* Bartr. Ex Marsh. (D×D), hybrids of *P. deltoides* × *P. maximowiczii* A. Henry (D×M), and hybrids of *P. deltoides* × *P. trichocarpa* Torr. & Gray (D×T)) at two contrasting nitrogen use efficiencies, and with and without root endophyte inoculation at two research sites in central Mississippi. Here we present data on productivity, tree physiology, and ecosystem services after three years of growth, with trees coppiced after the second growing season.

For productivity, we found that functionally diverse planting mixtures over-yielded by producing more aboveground biomass than either of their constituent monocultures, while taxonomically diverse planting mixtures under-yielded, producing less above ground biomass than the average of their constituent monocultures. For physiology, planting diversity mainly impacted leaf nitrogen characteristics with functional diversity mixtures exhibiting higher leaf N concentrations than monocultures. For ecosystem services, all planting mixtures effectively reduced nitrate concentrations in shallow groundwater from agricultural runoff, with no trends associated with functional or taxonomic diversity. Soil carbon sequestration was weakly correlated with aboveground biomass production. When inoculated with endophytes, we found that trees had higher productivity, higher water use efficiency, lower leaf nitrogen concentrations, higher soil respiration, and higher soil carbon concentrations. Our findings provide preliminary evidence that functional and taxonomic diversity could be leveraged in SRWC cultural practices to improve both productivity and ecosystem services.