Physiological responses of *Populus trichocarpa* genotypes to drought

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Project goals: The Center for Bioenergy Innovation (CBI) vision is *to accelerate domestication of bioenergy-relevant, non-model plants and microbes to enable high-impact innovations at multiple points in the bioenergy supply chain.* CBI addresses strategic barriers to the current bioeconomy in the areas of 1) high-yielding, robust feedstocks, 2) lower capital and processing costs via consolidated bioprocessing (CBP) to specialty biofuels, and 3) methods to create valuable byproducts from the lignin. CBI will identify and utilize key plant genes for growth, composition and sustainability phenotypes as a means of achieving lower feedstock costs, focusing on poplar and switchgrass. We will convert these feedstocks to specialty biofuels (C4 alcohols, C6 esters and hydrocarbons) using CBP at high rates, titers and yield in combination with cotreatment, pretreatment or catalytic upgrading. CBI will maximize product value by *in planta* modifications and biological funneling of lignin to value-added chemicals.

Abstract: *Populus trichocarpa* (black cottonwood) is a species commonly used as a plantation crop for biofuel production. Although extensive variation exists in growth in response to water limitation, the physiological underpinnings of this variation remain largely unknown. We established two studies to investigate water-limitation physiology in *P. trichocarpa*: a common garden study in Boardman, OR where 60 genotypes (ranked as either high or low performers based on growth data between droughted and well-watered groups) were analyzed; and a greenhouse study in Morgantown, WV where a subset of 20 of the genotypes were evaluated. In Boardman, osmolality ($p=0.0018$), stem water potential ($p<0.0001$), and specific leaf area ($p=0.0047$) differed between droughted and well-watered groups, and there was genotypic variation in osmolality ($p=0.0002$), SPAD ($p<0.0001$), stomatal conductance ($p=0.0045$), and specific leaf area ($p=0.0131$). There were no differences, however, between the high and low performing ranked groups. In Morgantown, stem water potential ($p<0.0001$), stomatal conductance ($p<0.0001$), photosynthesis ($p<0.0001$), and water use efficiency ($p<0.0001$) all changed during the dry-down period, and there were genotypic differences in SPAD ($p<0.0001$), stem water potential ($p=0.0102$), stomatal conductance ($p=0.0005$), photosynthesis ($p<.0001$), and water use efficiency ($p=0.0002$). The high performers had higher SPAD values ($p=0.0207$), more negative stem water potentials ($p=0.0327$), lower stomatal conductance ($p=0.0262$), and reduced photosynthesis ($p<0.0001$) compared to low performers. Thus, the physiological factors that appear to establish the field performance rankings are those that allow the tree to uptake and retain as much water as possible. This means that those genotypes that can more efficiently use water when available, and minimize loss when water is limiting, will be more successful as a plantation crop species.

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