Understanding the genetic basis of drought tolerance in *Populus trichocarpa*

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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 biofuels using CBP with cotreatment at high rates, titers and yield in combination with catalytic upgrading into drop-in hydrocarbon fuel blendstocks.

Populus trichocarpa is a fast-growing tree and a potential biofuel feedstock crop, but future large-scale crop production is likely to be required. In 2020 we initiated a new multi-environment multi-year field trial with over 1000 genotypes of *P. trichocarpa* on the UC Davis Farm, California, with the aim of discovering the genomic basis of phenotypic diversity and drought tolerance, enabling the development of tree breeding for water limited environments. We are focused on finding adaptive traits that enable poplar trees to maintain yield in water-limited conditions. We are identifying genetic loci and candidate genes linked to these traits and these will be tested and deployed in breeding pipelines, enabling the development of energy tree crops suited to marginal, low input sites. We established the site in 2020, planting multiple replicates of over 1,000 unique genotypes across 15 acres. In 2021, we implemented a controlled drought treatment across 5 of the 15 acres, throughout the growing season. We are deploying the latest molecular, leaf, proximal and remote sensing technologies for high through-put phenotyping. For example, 6 phenocams mounted at 80 feet high on three separate towers take images every 30 min of several hundred trees, every day of the year. This is producing valuable data on canopy phenology of relevance to yield and drought tolerance. We have identified a set of tree genotypes that are able to tolerate this drought and we are already identifying gene loci explaining traits of interest. We are currently characterizing the relationship between climate of origin and alleles contributing to the phenological and yield traits to address hypotheses about their role in local adaptation to climate. We have further identified loci contributing to performance traits (e.g., biomass estimates) under drought and well-watered conditions and tested for evidence of this variation reflecting historical selection across climate gradients of origin in *P. trichocarpa*. The loci identified are beginning to provide insights into the genetic and phenotypic basis of climate adaptation in *P. trichocarpa* with potential to facilitate genomic assisted breeding.

References/Publications

1. G Taylor IS Donnison, D Murphy-Bokern, M Morgante et al. (2019). Sustainable bioenergy for climate mitigation: developing drought-tolerant trees and grasses, Annals of Botany **124**, 513-520

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