Title: A new 15 acre field plantation for CBI harnessing the natural diversity of *Populus trichocarpa* and determining the genetic basis of drought tolerance

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Project Goals: *Populus* serves as a promising biomass feedstock for a suite of industrial applications including biofuels conversion. Drought is one of the most important factors limiting cost-effective production of *Populus* biomass. It is imperative to overcome this obstacle to achieve sustainable production of *Populus* biomass. However, drought response in *Populus* is a complex trait requiring the regulation and coordinated interactions of many genes, and identification of genetic networks regulating drought response remains unaccomplished and is urgently needed to inform genetic improvement of *Populus* feedstocks for sustainable biomass production. The goal of this research is to determine the genetic basis of drought tolerance in bioenergy *Populus* enabling tree improvement and the wide-scale deployment of *Populus* for bioenergy in marginal and droughted environments. Fast growing feedstock crops are required for a future bioeconomy where plant-based biofuels, chemicals and biomass for Bioenergy with Carbon Capture and Storage (BECCS) will be utilized as part of a more sustainable, energy secure economy.

Methods: This project has harnessed the natural genetic variation found in wild trees along the Pacific coast of North America. Originating from a range of naturally droughted and wet environments, the population possesses a number of unique genetic and genomic resources to help understand the trees response to water deficit.

Despite the hurdles of 2020, over 17,000 *P. trichocarpa* cuttings were planted in the greenhouse with a very high success rate for cutting survival. After two months growth the cuttings were transferred to a lath house in very close proximity to the field site. The flourishing cuttings were left to acclimate for eleven days before transplantation to the field.

Across a 5 acre drought site and 10 acre control site over 7000 *P. trichocarpa* trees were transplanted in early April 2020 and began to rapidly accumulate biomass. Daily field visits and maintenance were essential for the establishment of the site throughout the season. During this, the first growing season, 2020, trees were all kept “fully irrigated” and at the same time, two Eddy Covariance towers were deployed at the site, one each in “control” and future “drought” plots. These measurements will enable us, in the long-term to quantify the carbon balance of the site, including the potential of these trees for long-term carbon sequestration.

Objectives:

(i) To deploy a large-scale experimental drought trial for up to 1000 unique genotypes of *Populus* equipping the sites with controlled irrigation and drought treatments that are fully automated and monitored.

(ii) To test the hypothesis that a suite of traits identified for drought tolerance in *P. nigra* can be measured in drought and control treatments in the wide germplasm collection of *P. trichocarpa.*

Impacts and benefits: This research will deliver a new 15 acre common garden collection of the CBI *Populus trichocarpa*, that will be open for multiple collaborative opportunities. The replicated and blocked experiment, with a 5 acre plot of selected genotypes subjected to drought, and the addition of Eddy Covariance towers to quantify carbon flux and move towards assessing total carbon balance and carbon sequestration, should be a significant future value for multiple projects.

Publications

Taylor G., *et al* (2019). Sustainable bioenergy for climate mitigation: developing drought tolerant trees and grasses. Annals of Botany, 124: 513-520.

Muchero W. *e al* (2018). Association mapping, transcriptomics, and transient expression and transient expression identify candidate genes mediating plant-pathogen interactions in a tree. *Proc Natl Acad Sci USA* 115: 11573-11578.

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