27. Screening for Water-Use Efficiency with Stable Isotopes in the Model C4 Grass Setaria viridis

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http://sviridis.org/ http://foxmillet.org/

Project Goals: "A Systems-Level Analysis of Drought and Density Response in the Model C4 Grass Setaria viridis". The specific aims of the proposal are to: 1) Identify QTL for the effect of drought and density on biomass and seed yield components of Setaria. 2) Conduct in–depth physiological profiles in roots and leaves of a subset of selected lines 3) Integrate datasets and develop metabolic and gene networks for Setaria 4) Develop transformation technologies for Setaria viridis 5) Functionally examine the role of candidate genes deduced by network models; and 6) Develop protocols and best practices for monitoring gene flow in transgenic Setaria. To achieve these aims we will produce one of the most extensive molecular characterizations of plant growth in the field to date, generating several million data points that will be collected from physiological and molecular genetic studies. We will develop novel informatics models and network tools that will guide future molecular characterization in S. viridis and guide breeding efforts in major feedstock targets.

We screened recombinant inbred lines (RILs) of Setaria viridis x S. italica from the 2013 density and drought field season for water use efficiency (WUE) using leaf carbon and oxygen isotopic signatures (δ13Cleaf and δ18Oleaf, respectively) and total aboveground biomass. Values of δ13C in C4 plants are related to stomatal conductance, so that screening for both δ13C and total aboveground biomass takes into account both WUE and biomass production. Alternatively, the isotopic signature of source water and rates of transpiration determine δ18Oleaf. Across the RILs and the density/drought experiments, several QTLs were associated with WUE as determined by δ18Oleaf, δ13Cleaf, and δ13Cleaf/biomass. Additionally, some of the QTLs associated with δ13Cleaf were found across both the density and drought experiments suggesting that these QTLs for δ13Cleaf are independent of growth conditions. We also found several RILs that scored high in δ13Cleaf or δ13Cleaf/biomass rankings and have common genetic components. These RILs are being tested further for differences in leaf level physiological measurements such as photosynthetic efficiency, stomatal conductance and rates of transpiration. Gas exchange measurements of leaf CO2 assimilation showed that RILs with high δ13Cleaf values had higher photosynthetic capacity than RILs with low δ13Cleaf values. Presently we are conducting in-depth physiological studies to better understand the mechanisms controlling δ13Cleaf in these C4 plants, such as stomatal conductance, respiration, and the efficiency of the CO2 concentrating mechanism. The goal is to identify further physiological traits conferring differences in WUE across the RILs and to link them to particular genetic components.

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