26. Rapid Hemispherical Photographic Phenotyping of Productivity and Canopy Dynamics in a Setaria RIL Population

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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.

Crop genetics and breeding is limited by the ability to accurately gather useful phenotypic information from large, diverse populations of crop genotypes. Most significantly, rapidly and non-destructively assessing the productivity and allometry of crop plants at high frequency during a growing season in the field remains a significant challenge. Hemispherical photography has proven utility in forestry research as a tool to evaluate the growth, structure, and light interception of a canopy. But, high resolution digital cameras with fish-eye lens have been large and relatively expensive. This study tested the use of a small digital camera (GoPro Hero3+) customized with a fully hemispherical lens and miniature self-leveling gimball to rapidly assess leaf area index, biomass production and radiation interception efficiency for quantitative trait loci (QTL) analysis in a diverse population of 186 recombinant inbred lines (RILs) generated by crossing Setaria viridis with S. italica. Plant area index estimated from hemispherical photographs correlated strongly with leaf area index ($r^2 = 0.85$), stem biomass ($r^2 = 0.76$) and total vegetative biomass ($r^2 = 0.84$) in an initial validation experiment where LAI varied over time and genotypes from 0.3 – 3.6. Using these trait regressions, canopy hemispherical photography was then analyzed from the full population of RILs. QTL analysis will be presented comparing loci identified from conventional biomass harvests and the rapid hemispherical photographic phenotyping.

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