High throughput phenotyping and quantitative genetics to understand productivity and drought traits in the model C4 grass Setaria

Ivan Baxter[1,3]*, Maximilian Feldman[1], Patrick Ellsworth[4], Asaph Cousins[4], Andrew D.B. Leakey[2], Darshi Banan[2], Rachel Paul[2], and **Thomas P. Brutnell[1]**

[1]Donald Danforth Plant Science Center, St Louis; [2]University of Illinois, Urbana-Champaign; , [3]USDA-ARS, St Louis, and [4]Washington State University.

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Genetically tractable model systems closely related to bioenergy grasses need to be developed to drive the crop improvement required for large scale, ecologically sustainable bioenergy production. *Setaria viridis* **is an ideal candidate C₄ panacoid grass.   The over-arching objectives of this large, collaborative project are to utilize genomic, computational and engineering tools to begin the genetic dissection of drought response in** *S. viridis***. This will be achieved through: 1) Quantitative trait and association genetics; 2) novel controlled environment and field phenotyping combined with molecular and chemical profiling; 3) development of metabolic and gene networks; 4) development of transformation technologies***;* **5) reverse genetic testing of candidate genes.**

Phenotyping has become the rate-limiting step in using large-scale genomic data to understand and improve agricultural crops. Our project has used the Bellwether Phenotyping platform for controlled-environment plant growth and automated, multimodal phenotyping to study how plant biomass traits change temporally in response to water availability and identify the genetic loci underlying those changes. We have analyzed two independent genetically structured populations of *Setaria* sp.: an interspecific *S. italica* x *S. viridis* recombinant inbred line population and to two grow outs of a *S. viridis* natural diversity panel. We developed Plant Computer Vision (PlantCV) as an open-source, platform independent quantitative image analysis community resource and have used it to quantify height, biomass, water-use efficiency, color, plant architecture, and near-infrared traits. We have identified QTLs for height, biomass and water use efficiency in both populations. We have also conducted elemental profiling and isotopic studies of the same plants to link biochemical and phenomic approaches to understanding the response of plants to water deficit.