Using systems approaches to improve photosynthesis and water use efficiency in sorghum

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Project Goals:

1. Engineer photosynthesis for improved performance under water stress.
2. Optimize water relations to enhance drought tolerance and water use efficiency.
3. Develop a comparative GWAS pipeline for sorghum and Setaria.
4. Use metabolic network modeling to guide biomass engineering.
5. Manipulate plant gene expression through precision engineering.
6. Develop methods to improve transformation efficiencies in sorghum and establish a regulatory framework for deployment of engineered organisms.

Abstract:

The success of a bioenergy economy will depend on the development of second generation biofuel crops that can be grown in suboptimal conditions (e.g., hot, dry, marginal soil) and thus not compete with the food or feed markets. Sorghum is a naturally drought-tolerant, heat-resistant, low-cost crop, currently grown globally in Asia, Africa, Australia, and the Americas. To maximize the potential of sorghum as a biofuel crop, a new systems-oriented blueprint and re-design of sorghum is needed. Using both sorghum and the model grass green foxtail (*Setaria viridis*), this project will build a synthetic biology toolkit to accelerate development of elite energy sorghum varieties for production under marginal environments. This will involve the convergence of precision bioengineering technologies, genome-scale modeling, genome sequencing, and high-throughput analyses in laboratory and field settings. Using those computational and engineering tools, this research will enhance photosynthesis in sorghum to increase plant growth and biomass accumulation, while minimizing irrigation requirements by improving water acquisition through a redesigned root system and by reducing plant transpiration. With this multidisciplinary approach, this project will deliver stress-tolerant sorghum lines, addressing DOE's mission in the generation of renewable energy resources.

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