Using systems approaches to improve water use efficiency in sorghum by engineering root architecture

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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:
Grass species develop the majority of their root system through the adventious initiation of crown roots from the base of the shoot. Our recent work has shown that crown roots are particularly sensitive to the local availability of water at the soil surface in a response that is widely conserved across the Poaceae. Our data highlight the importance of crown root suppression in reducing the flux of water through the plant, which preserves soil water in a strategy known as water banking. While water banking may be a useful strategy for plants in natural environments, this strategy may have other negative consequences in an agricultural context including smaller root system size, reduced nutrient uptake and reduced carbon assimilation. For example, while Setaria viridis exhibits a severe reduction in crown root growth under drought, maize and sorghum inbreds show wide variation in this response with some inbreds able to maintain crown root growth under drought. Such variation suggests that breeding may have inadvertently "tuned" crown root responsiveness to drought to suit particular soil conditions and precipitation patterns. Understanding the relationship between environmental inputs (water, light, temperature) and crown-root response strategies will allow ideotypes appropriate to particular genotype-environment-management interactions. By modulating the growth of crown roots, we will change the rate at which water is taken up by the plant. This work will test the hypothesis that plants tend to exhibit responses that are more conservative than necessary due to their origins as wild species.

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