Development of Vegetative Oil Sorghum: From Lab-to-Field

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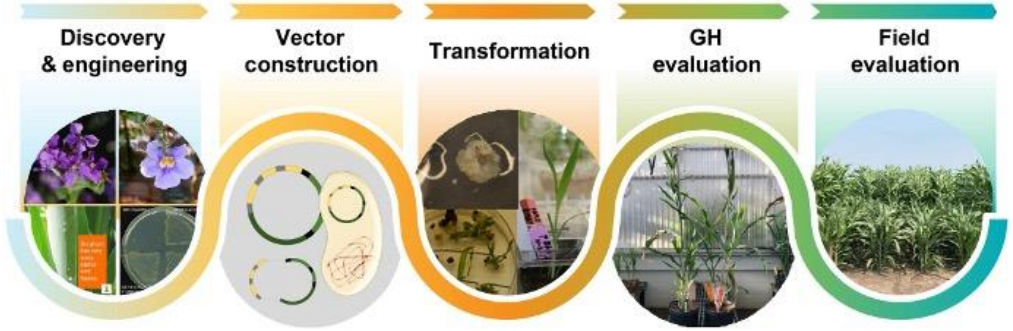
Background/Objective

- Biomass crops engineered to accumulate energy-dense triacylglycerols (TAG or 'vegetable oils') in their vegetative tissues have emerged as potential feedstocks to meet the growing demand for renewable diesel and sustainable aviation fuel (SAF). However, this potential is currently constrained by the inability of conventional C_4 grasses and other biomass crops to store TAG in vegetative tissues.
- In this study, we explored the feasibility of developing sorghum as a viable C_4 crop for field-scale production of vegetative oil.

Approach

We used grain (TX430) and sugar-accumulating 'sweet' (Ramada) genotypes of sorghum to accumulate TAG in leaves and stems. We compared transgene combinations for a "standard" 3P strategy ('push-pull-protect') using sorghum WRINKLED1 (WRI1), oleosin, and Arabidopsis diacylglycerol acyltransferase1 (DGAT1) transgenes to generate oils containing medium-chain length fatty acids.



Overview of lab-to-field pipeline.

Results

Engineered lines accumulated oleic acid-rich oil to amounts of up to 2.5% DW in leaves and 2.0% DW in stems in the greenhouse, 36-fold and 49-fold increases relative to wild-type (WT) plants, respectively. Under field conditions, the top-performing event accumulated TAG to amount to 5.5% DW in leaves and 3.5% DW in stems, 78-fold and 58-fold increases, respectively, relative to WT TX430. Transcriptomic and fluxomic analyses revealed potential bottlenecks for increased TAG accumulation.

Significance/Impacts

Overall, our study highlights the utility of a lab-to-field pipeline coupled with systems biology studies to deliver high vegetative oil sorghum for SAF and renewable diesel production. This strategy not only allows full agronomic and oil yield assessment of our lines, but also enables downstream functional evaluation of oil sorghum for applications such as SAF production.

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