

Towards Oilcane: Engineering Hyperaccumulation of Triacylglycerol into Sugarcane Stems

Background/objective

Metabolic engineering to divert carbon flux from sucrose to oil in high-biomass crops like sugarcane is an emerging strategy to boost lipid yields per hectare for biodiesel production. Accumulation of triacylglycerol (TAG) in leaf tissues has been successful in model plants and high biomass crops, but leaf tissues represent only a minor fraction of the biomass of tall C4 grasses. Therefore, accumulation of TAG in stem tissues is highly desirable. This study¹ describes a step change in TAG accumulation in sugarcane stems compared to our previous report² by multi-gene engineering.

Approach

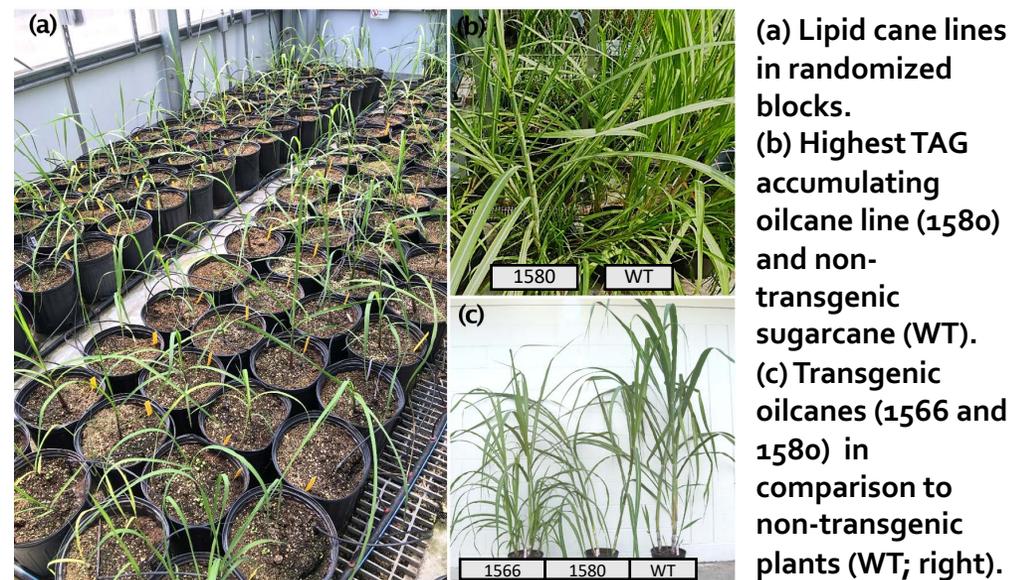
- ❖ Transgenic sugarcane co-expressing WRI1, DGAT1-2 and OLE1 and/or suppressing SDP1 and/or TGD1 was generated.
- ❖ Eight transgenic, lipid-accumulating sugarcane lines were compared with non-transgenic sugarcane under controlled greenhouse conditions in a randomized block design with eight replicates.

Results

- ❖ A step change in TAG accumulation in stem tissue of sugarcane was demonstrated, achieving an average of 4.3% of dry weight in a replicated greenhouse experiment.
- ❖ The TAG content in leaf tissue was also elevated by more than 400-fold compared to non-engineered sugarcane to reach an average of 8.0% of the dry weight and the amount of total fatty acids (FA) reached 13% of dry weight.

Significance

- ❖ The results may lay the foundation for commercial production of biodiesel and other FA derivatives from high-biomass accumulating crops.
- ❖ Further research will incorporate the stacking of additional factors that may result in even higher levels of TAG accumulation while minimizing the negative consequences of the accumulation of free fatty acids on biomass production.



TAG lines growing in replicated greenhouse trial.

¹ Parajuli, S. et al. 2020. "Towards Oilcane: Engineering Hyperaccumulation of Triacylglycerol into Sugarcane Stems". *GCB Bioenergy*. DOI: 10.1111/gcbb.12684

² Zale, J. et al. 2016 "Metabolic Engineering of Sugarcane to Accumulate Energy-Dense Triacylglycerols in Vegetative Biomass." *Plant Biotechnology Journal*, 14, 661–669. DOI: 10.1111/pbi.12411