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Multisite Field Evaluation of Oil Accumulation and Agronomic Performance in Grain and Sweet Sorghums Engineered for Lipid Hyperaccumulation

Background/Objective

Current domestic supply of plant-based oils is not adequate to meet the projected increase in domestic biofuel demand, including for sustainable aviation fuel (SAF). In this context, engineered oil sorghum (OS) is being developed as a novel bioenergy crop which accumulates triacylglycerol (TAG) in its vegetative tissues. Field-testing of new engineered OS lines is a key step in the development of an ideal OS hybrid for SAF production. This work assessed the physiological and agronomic performance of four OS lines across a range of environmental conditions in the potential growing region for OS.

Approach

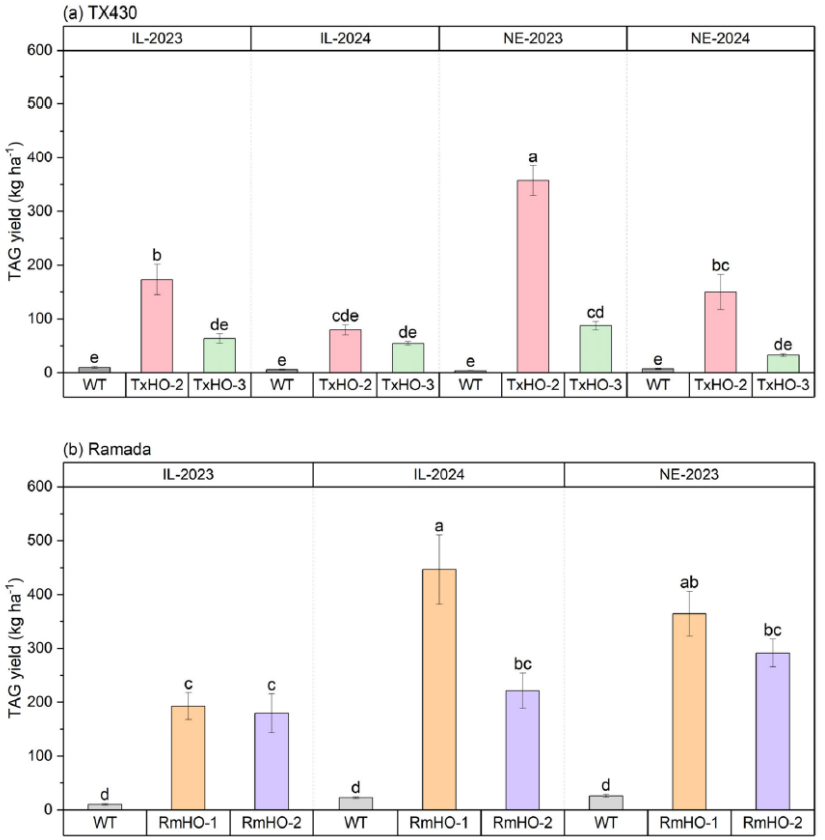
Four engineered OS lines derived from TX430 grain (TxHO-2, TxHO-3) and Ramada sweet (RmHO-1, RmHO-2) sorghum genetic backgrounds were grown alongside wildtype (WT) lines in Nebraska (NE) and Illinois (IL) over two years (2023-2024) to quantify genotype x environment effects on agronomic performance and TAG accumulation.

Results

TX430 OS lines averaged 15.0 g kg^{-1} TAG in leaves and 12.3 g kg^{-1} in stems, representing 25- and 13-fold increases over WT, respectively. Ramada OS lines averaged 26.1 g kg^{-1} TAG in leaves and 12.3 g kg^{-1} in stems, 25- and 13-fold increases over WT, respectively. TX430 lines exhibited an average 18% reduction in biomass overall relative to WT. However, the line with the highest cumulative TAG (TxHO-2) did not differ significantly from WT. Ramada OS biomass yield was similar to WT. TAG yield was greatest in TxHO-2 (190 kg ha^{-1}) and RmHO-1 (335 kg ha^{-1}), with biomass yield differences rather than TAG concentration driving the difference between the two lines. Nutrient removal (N, P, and K) increased in TX430 OS lines but not in Ramada lines, while structural carbohydrates and ash concentrations were unaffected.

Significance/Impacts

This work confirms vegetative lipid accumulation as a viable strategy for high-biomass sorghum, supporting its potential as a SAF feedstock. Future work is needed to optimize agronomy practices.



TAG yield* for WT and OS lines from (a) TX430 and (b) Ramada backgrounds under four environmental conditions.

*Values were calculated from TAG concentration measured in tissue analysis and corresponding biomass yield.

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