Silencing *folylpolyglutamate synthetase1* (*FPGS1*) in switchgrass (*Panicum virgatum* L.) improves lignocellulosic biofuel production

U.S. DEPARTMENT OF ENERGY | Office of Science

Background

Switchgrass is a lignocellulosic perennial grass with great potential for use as a bioenergy feedstock. Such feedstocks are resistant to cell wall deconstruction for efficient conversion into biofuels. The one-carbon (C1) pathway is critical for polymer methylation, including that of lignin and hemicelluloses in cell walls. Folylpolyglutamate synthetase (FPGS) catalyzes a biochemical reaction that leads to the formation of folylpolyglutamate, an important cofactor for many enzymes in the C1 pathway.

Approach

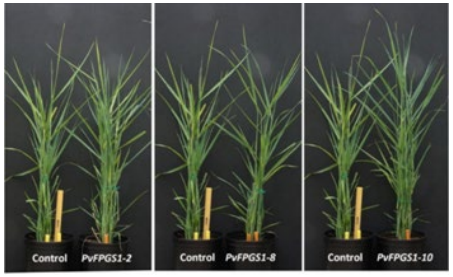
- We examined the functional role of a novel switchgrass *PvFPGS1* gene in cell wall composition and biofuel production by RNAi knockdown technology.
- We analyzed the *PvFPGS1*-downregulated plants in the field over three growing seasons.

Outcome

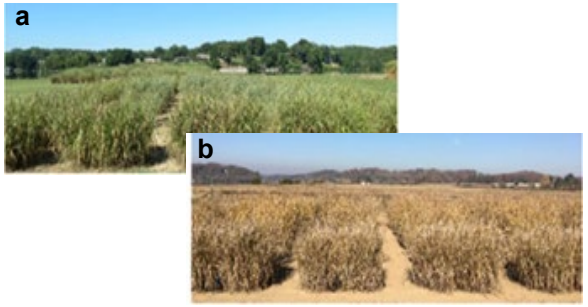
- Transgenic plants with the highest reduction in *PvFPGS1* expression grew slower and produced lower end-of-season biomass. Transgenic plants with low-to-moderate reduction in *PvFPGS1* expression produced equivalent biomass as controls.
- Transgenic plants produced up to 18% more ethanol than controls over the course of three field seasons while maintaining congruent growth and biomass as controls.
- Severity of rust disease among transgenic and control lines were not different during the time course of the field experiments.

Significance

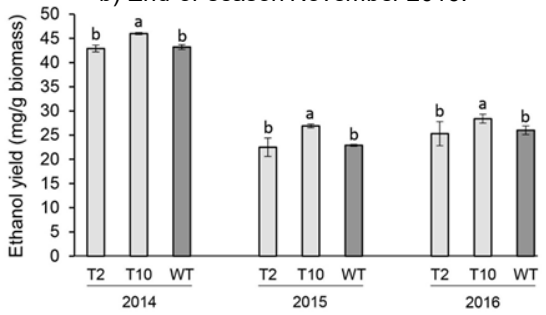
The present study provides insights into the effect of knockdown expression of *PvFPGS1* on improving biofuel production in switchgrass without negatively impacting plant growth and biomass yield or increased susceptibility to rust in feedstock. It further provides information on potential strategies to enhance productivity in bioenergy crops. This information enhances our understanding of the factors associated with reducing recalcitrance without decreasing biomass production.



Representative *PvFPGS1*-RNAi transgenic and control lines at 3 months old grown in greenhouse



FPGS1-downregulated switchgrass in the field (third year: 2016). a) Mid-season August 2016, b) End-of-season November 2016.



Ethanol yields of *FPGS1*-downregulated switchgrass in the first (2014), second (2015), and third (2016) growing seasons. There are three biological replicates for each transgenic line (T2 and T10) and wild-type control (WT).

Mazarei, M., Baxter, H.L., Srivastava, A., Li, G., Xie, H., Dumitrache, A., Rodriguez, M. Jr., Natzke, J.M., Zhang, J.-Y., Turner, G.B., Sykes, R.W., Davis, M.F., Udvardi, M.K., Wang, Z.-Y., Davison, B.H., Blancaflor, E.B., Tang, Y., Stewart, C.N. Jr. (2020). Silencing *folylpolyglutamate synthetase1* (*FPGS1*) in switchgrass (*Panicum virgatum* L.) improves lignocellulosic biofuel production. *Front Plant Sci,* doi: 10.3389/fpls.2020.00843).

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