Drought and Bioenergy Grasses: Effects of Drought on Biomass Composition and Effect of Biomass Composition on Drought Tolerance

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Project Goals: To determine the impact of drought on bioenergy crops and biofuel production.

Lignocellulosic biomass can be used to produce biofuels, bioproducts or biopower and presents a renewable energy resource that has the capacity to lower the global carbon footprint. However, shifting climates leading to an increase in arid lands and limits on water available for irrigation make it imperative to understand how the water deficit these bioenergy crops face may impact their biomass and bioenergy characteristics. In collaboration with the EpiCon project, we are reporting the results from the first trial comparing well-watered RT430 sorghum lines with RT430 lines that have been subjected to drought. Our results indicate that while there are differences in biomass characteristics of sorghum vegetative tissue in response to post-flowering drought stress, these changes are relatively small in comparison to total sugar composition. Notable changes appear in pectic monosaccharides (rhamnose, arabinose, galactose, galacturonic acid) of newly expanding tissues, in addition to hemicellulosic changes in older tissues (glucose, mannose, glucuronic acid). Consistent with the relatively small monosaccharide changes, the saccharification efficiencies of biomass differed only little between plants with and without post-flowering drought. In general, the results suggesting that post-flowering drought stress has little impact on biomass characteristics.

Another aspect of biomass and drought is the situation where biomass has been deliberately changed by breeding or engineering. How would such changes influence drought tolerance and water use efficiency? We have engineered Arabidopsis plants with low lignin content and/or low xylan content in fiber cells. Vessels were not impacted in these plants in order to ensure good growth properties, and all the engineered plants are indistinguishable from control plants during optimal growth conditions. Upon exposing these engineered Arabidopsis plants to severe drought, we observed better survival rates in those with low lignin and/or low xylan content compared to those in wild-type plants (1). In comparison, increased pectic galactan content had no effect on drought tolerance. The plants with low lignin were obtained by expressing QsuB, a bacterial dehydroshikimate dehydratase. The same gene has been expressed in switchgrass. Data will be reported on the drought response of the low lignin switchgrass plants. The mechanism for the increased drought tolerance in the engineered plants is still under investigation. Nevertheless, the drought tolerance is an important finding because it demonstrates that modification of secondary cell walls does not necessarily render the plants less robust in the environment, and it shows that substantial changes in biomass composition can be achieved without compromising plant resilience.

References

1. Yan J, Aznar A, Chalvin C, Birdseye DS, Baidoo EEK, Eudes A, Shih PM, Loque D, Zhang A, Scheller HV: **Increased drought tolerance in plants engineered for low lignin and low xylan content**. *Biotechnol Biofuels* 2018, **11**:195.

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