Over-expression of poplar *Galacturonosyltransferase (GAUT)12* confirms key role in xylan synthesis and recalcitrance

Background

- A better understanding of plant cell wall structure and function is needed to elucidate the molecular mechanisms of biomass recalcitrance. Reduced expression *galacturonosyltransferase (GAUT)12* – a putative glycosyltransferase involved in secondary cell wall glucuronoxylan and pectin production – increased saccharification and growth in *Populus*.

Approach

- The *Populus GAUT12.1* gene was overexpressed. Greenhouse-grown transgenic and control lines were assessed for plant growth, biomass saccharification, and cell wall structure. Importantly, selected transgenic lines were also grown in a 2.8-year field trial to evaluate performance in the field.

Outcomes

- *Populus GAUT12.1*-overexpression (*PtGAUT12.1*-OE) lines had 12-13% decreased sugar release, as well as decreased plant height (6-54%), stem diameter (8-40%), and total aerial biomass yield (48-61%) compared to controls. The biomass saccharification, growth, and cell wall phenotypes of *PtGAUT12.1*-OE lines were completely opposite to those previously observed in *PdGAUT12.1*-knockdown lines. The data support the hypothesis that poplar GAUT12.1 is involved in the synthesis of a wall structure containing both pectic homogalacturonan and xylan, and that these glycans may be connected to each other by a base-sensitive covalent linkage.
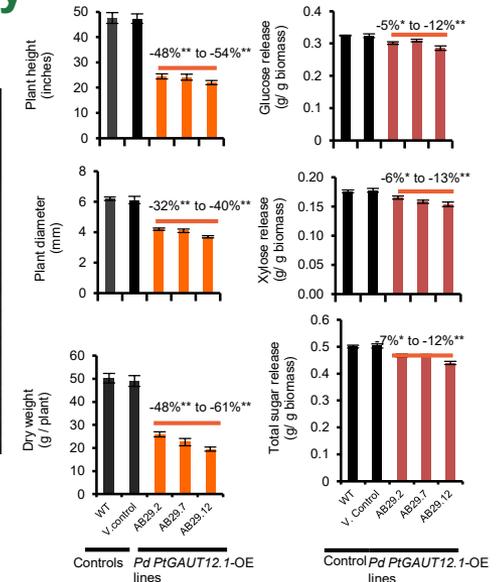
Significance

- The results establish *GAUT12.1* as a recalcitrance- and growth-associated gene ~~in poplar~~ and support the hypothesis that GAUT12.1 synthesizes either an HG-containing primer for xylan synthesis or an HG glycan required for xylan deposition, anchoring, and/or architecture in the wall.

Controls   *PtGAUT12.1*-OE line

Hypothetical structure	Supportive data	
	PdGAUT12.1-KD	*PdGAUT12.1*-OE
1. GalA in xylan reducing end sequence	+	+
2. HG primer for xylan	++	++
– HG in APAP1-like primer for xylan	-	-
– Unique HG glycan not covalently attached to xylan	++	++

+ mild agreement   – mild disagreement
++ strong agreement   – strong disagreement

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