Overexpression of heterologous laccases and peroxidase leads to increased biomass yield and reduced recalcitrance in Populus

Background

- Laccases (LAC) and peroxidases (PRX) are the major phenyl-oxidases that play an important role during the polymerization of monolignols into lignin during secondary xylem development. The gene functions of various laccases and peroxidases in woody plants are poorly understood.

Approach

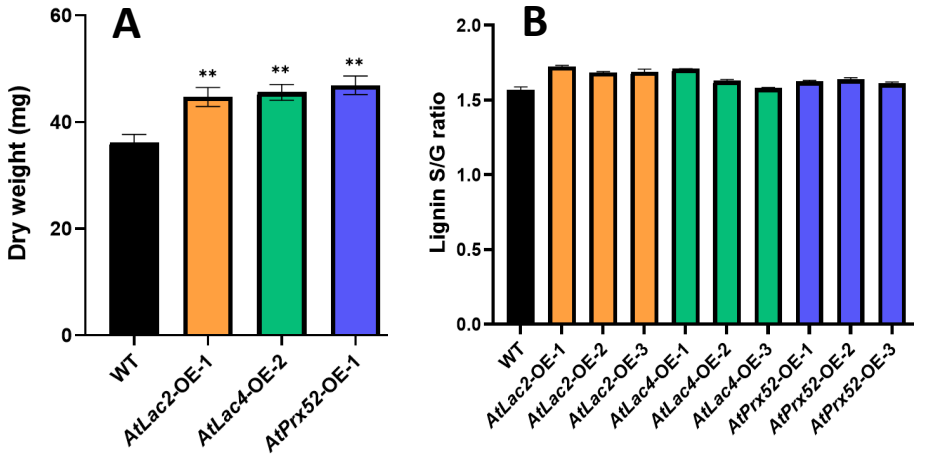
- The goal of this study is to understand the function of LAC and PRX in *Populus* (poplar) wood formation, plant growth, and biomass recalcitrance.
- We used the developing-xylem tissue-specific promoter DX15 to individually overexpress (OE) *Arabidopsis laccase2* (*AtLac2*), laccase4 (*AtLac4*), and peroxidase52 (*AtPrx52*) genes in poplar. Greenhouse-grown transgenics were assessed for growth phenotypes, gene expression, lignin analysis, and biomass saccharification efficiency.

Results

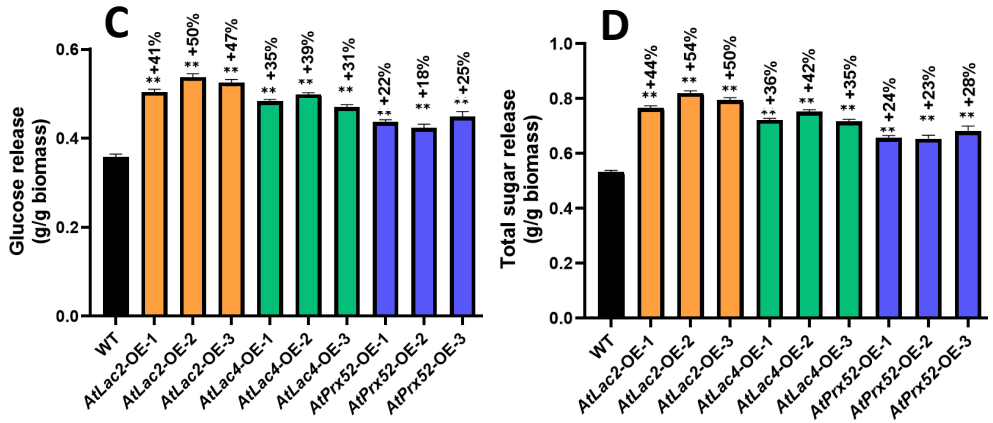
- Dry biomass yield increased by 24-30% across all OE transgenic lines compared to wildtype control (WT).
- No changes in lignin content were observed among the over expression lines, but all transgenic lines had higher lignin S/G than WT.
- Saccharification efficiency increased by 35–50%, 21–42%, and 8–39% in *AtLac2*-OE, *AtLac4*-OE, and *AtPrx52*-OE transgenic poplar lines, respectively, as compared to WT.
- Expression network analyses indicate that these laccases and peroxidases are important regulators in the biosynthesis of specific secondary cell wall components.

Significance

- Over-accumulation of LAC and PRX enzymes impacts plant cell wall structure and represents a promising strategy to improve ethanol production through improvement of saccharification efficiency in poplar bioenergy feedstocks.



Dry biomass (A) and S/G ratio (B) of wildtype control (WT) and transgenic poplar lines (OE).



Glucose (C) and total sugar (D) release from wildtype control (WT) and transgenic poplar lines (OE).

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