Constitutive and Inducible Oleoresin System Share Genetic Architectures and Mechanisms in *Pinus taeda*

Background/Objective

The oleoresin system of loblolly pine (*Pinus taeda*) protects against insects and fungal pathogens and is an important source of terpene-based chemicals; however, the genetic mechanisms controlling oleoresin production are poorly understood.

Approach

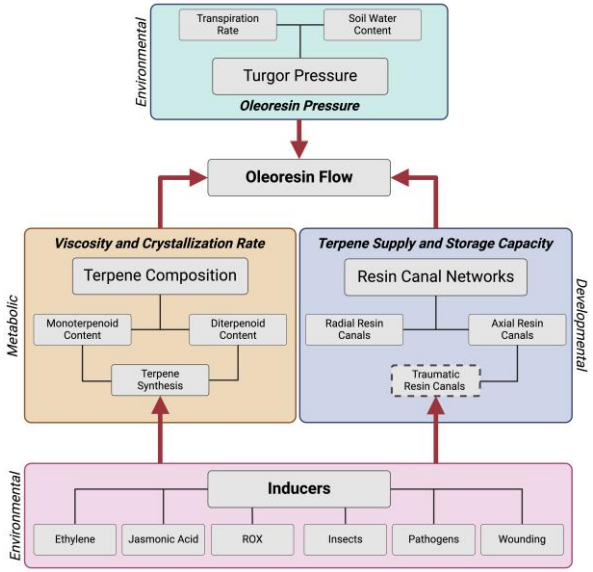
- We characterized the genetic architecture of stem wood oleoresin flow (constitutive and induced), resin canal number and density, and mono- and diterpenoid content in two clonal populations of loblolly pine.
- We used quantitative genetic analyses, genome-wide association studies (GWAS), multiplex network learning, and gene expression profiling to elucidate shared gene networks underlying oleoresin production and to identify high-quality candidates for breeding and engineering of loblolly pine for increased terpenes.

Results

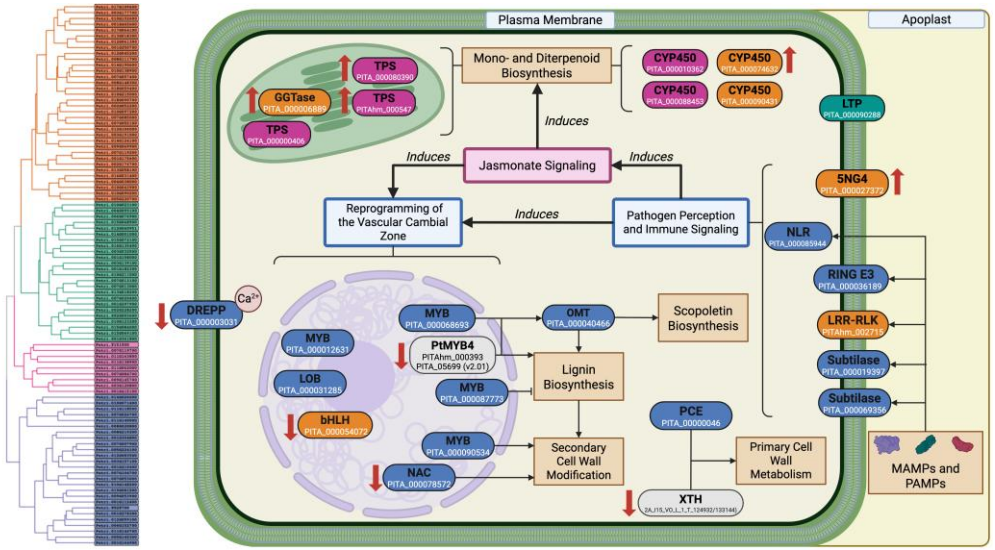
- Genetic analyses revealed polygenic inheritance and trait-to-trait correlations, providing strong evidence for shared genes regulating constitutive and induced oleoresin flow.
- Constitutive and induced flow were positively correlated with stem diameter, indicating that selecting for growth also increases oleoresin flow.
- GWAS identified 236 SNPs associated with oleoresin flow, resin canal number, and terpene composition, including candidate genes likely involved in terpene biosynthesis, cambial meristem reprogramming, pathogen perception and plant immunity signaling.
- Gene expression analyses provided independent evidence for 14 GWAS-implicated genes that are MeJA-responsive in tissues where resin canals form and terpene biosynthesis occurs.

Significance/Impacts

This integrated approach enabled prioritization of high-quality candidate genes and advances the development of loblolly pine as a source of valuable terpene-based chemicals.



Known genetic factors influencing oleoresin flow



Mechanistic model of candidate genes influencing/regulating oleoresin-related traits

Morgan *et al*. *New Phytologist* (2026). https://doi.org/10.1111/nph.71134