Tree growth model assists breeding for more wood

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A meeting in a forest between a biologist and a mathematician could lead to thicker, faster growing trees.

"Mathematicians like translating biological processes into numbers," said Andrei Smertenko, assistant professor in Washington State University's Institute of Biological Chemistry. "I'm a biologist, and I want to help grow stronger, better trees."

Breeding trees is a time-consuming and imprecise field, with breeders relying on a few genetic markers and what they can see. It takes years before they see the traits they're looking for in a young tree.

To help speed things up, Smertenko and his WSU Department of Mathematics colleagues Vladyslav Oles and Alexander Panchenko have developed a new model that could help make tree breeding much easier.

How hormones, genes impact growth

The group met three years ago at a party in a forest and started talking about trees, Smertenko's interest. That chance meeting eventually led to the model, which was recently published in the journal *PLOS* One under the title "Modeling hormonal control of cambium proliferation."

"Radial growth, or thickness, is known to be controlled by many hormones," Smertenko said. "But how each hormone contributes to the radial growth remains poorly understood. So the model simulates how interactions between hormones and key genes would impact radial growth."

Calculations require systematic evaluation of millions of different situations in the cells, he said. Basically, the model runs billions of simulations of genetic interactions to predict which trees are likely to make more or less wood as they grow.

Model focuses on cambium

The model focuses on understanding molecular processes in cambium, a type of stem cell that can sense availability of nutrients in soil and photosynthetic activity in shoots. Cambium integrates these signals with plant height to produce the required amount of wood each growth season, Smertenko said.

"Wood is very expensive for a tree to produce, from a resource perspective," he said. "Allocating too many resources to wood production would ultimately limit plant reproduction potential. And we can't currently measure or study cambium in a living plant because it stops working as soon as we do anything to the plant.

"So if we can't observe the tissue directly, then making a mathematical model is the best solution we have so far," he said.

Cambium controls tree growth and, during the active season, it divides quickly. If you look at annual rings of a tree, the light part reflects higher cambium activity, as in spring, and the darker rings are periods of slow growth, as in winter.

Model identifies breeding lines

In a genetically diverse population of trees, breeders can use the information from the model to see which trees are more likely to generate more wood.

"Some breeders may want skinnier trees, or thicker trees," Smertenko said. "From a science point of view, our model can be used to identify different breeding lines with higher or lower wood production."

So far, the model only works on deciduous trees, like oak or poplar, and not on coniferous trees, like pine or fir, because the growth process is better understood in deciduous trees, Smertenko said.

More information: Vladyslav Oles et al, Modeling hormonal control of cambium proliferation, *PLOS ONE* (2017). DOI: 10.1371/journal.pone.0171927

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