Feeling Stressed? So is the Poplar -- But Hormone Suppression Could Help the Tree

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The plant at the left, with the most vigorous root system, is the one most deficient in a plant hormone known as gibberellin.

(PhysOrg.com) -- People aren't the only living things that suffer from stress. Trees must deal with stress too. It can come from a lack of water or too much water, from scarcity of a needed nutrient, from pollution or a changing climate. Helping trees and crops adapt to stress quickly and efficiently is a pressing goal of plant biologists worldwide.

Now research led by Michigan Technological University scientists has identified the molecular mechanism that Populus—the scientific name for common poplars, cottonwoods and aspens—uses to adapt to changing soil conditions, as well as some of the genes that turn the process off or on. They hope to apply what they've learned to find ways to use biotechnology or selective breeding to modify the trees to make them more stress-tolerant.

"Our hope is that by understanding how this works, we can manipulate the system so the plants can adapt faster and better to stressful conditions," explained Victor Busov, associate professor in Michigan Tech's School of Forest Resources and Environmental Science and senior author on a paper published in the March 2010 issue of the journal The *Plant Cell*.

Busov and colleagues at Michigan Tech, the University of Georgia, Oregon State University and the Beijing Forestry University in China analyzed thousands of genes in the Populus genome, the only tree genome that has been completely sequenced. They were searching for the mechanism that regulates the plant's decision to grow tall or to spread its roots out in an extensive underground exploration system that can sample the soil near and far until it finds what the rest of the plant needs.

The key players turned out to be a family of hormones called gibberellins, referred to by the scientists as GAs.

"GAs' role in root development is poorly understood," said Busov, "and the role of GAs in lateral root formation is almost completely unknown." Lateral roots are the tangle of tiny roots that branch out from the primary root of a plant. "They are the sponges," Busov explained, "the ones that go looking for nutrients, for water—the ones that do most of the work."

The researchers found that GAs interact with other plant hormones such as auxin to tell the plant whether to concentrate on reaching for the sky or on building a bigger, better network of roots under ground. "The GAs and auxin are definitely talking, molecularly," said Busov.

Growing poplar seedlings mutated to make them GA-deficient, the scientists compared their root and stem growth to others that contained moderate amounts of GAs and a control group of wild-type plants with normal GAs. They found that more GAs, the more a plant's stem flourished, but its roots remained spindly. When GA production was shut down, either by using mutants that lacked the necessary genes or by silencing the genes that form the molecular on-off switch, the resulting plants looked dwarfed, but their lateral roots grew luxuriant and full.

Application of GA to the GA-deficient dwarf plants rapidly reversed the process. The plants grew tall, but their lateral root systems shriveled.

"Clearly, lack of the hormone promotes growth below ground, while the hormone itself promotes growth above ground," said Busov. "This is a natural mechanism that we don't know much about. It's always a tradeoff between growth above ground and growth below ground. Normally there is a fine balance, and this balance is a little disturbed under stress."

In a commentary on the research published in the same issue of the journal, Kathleen Farquharson, science editor of The Plant Cell, wrote: "This study provides important insights into how plant hormones regulate lateral root development."

Provided by Michigan Technological University

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