Success with 'cisgenics' in forestry offers new tools for biotechnology

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Six weeks after being transplanted, genetically modified trees developed through the science of "cisgenics," at left, are growing substantially taller than a control group, at right. This research program at Oregon State University is moving genes from very similar or identical plant species, as an alternative to the more traditional "transgenic" approach to genetic modification. (Photo courtesy of Oregon State University)

Forestry scientists at Oregon State University have demonstrated for the first time that the growth rate and other characteristics of trees can be changed through "cisgenics" - a type of genetic engineering that is conceptually similar to traditional plant breeding.

Cisgenics uses genes from closely related species that usually are sexually compatible. If governments choose to regulate it similarly to conventional breeding, experts say, it could herald a new future for biotechnology, not only in forestry but crop agriculture and other areas.

In findings just published in *Plant Biotechnology Journal*, researchers used cisgenic manipulation to affect the actions of gibberellic acid, a plant hormone, in poplar trees. This had significant effects on the growth rate, morphology and wood properties of seedling trees.

The advance is important for forestry research, but perhaps even more significant in demonstrating the general value and success of cisgenics.

"Until now, most applications of biotechnology have been done with transgenics, in which you take genetic traits from one plant or animal and transfer them into an unrelated species," said Steven Strauss, a distinguished professor of forest biotechnology at OSU. "By contrast, cisgenics uses whole genes from the same plant or a very closely related species. We may be able to improve on the slow and uncertain process of plant breeding with greater speed and certainty of effect."

This is possible in part because of the growing knowledge about what specific genes do in plants and animals, and enormous increases in the speed of genome sequencing, or mapping them out in their entirety. Sequencing that used to take years can now be accomplished in days.

Modern plant breeding, in which related plant species are systematically interbred to create improved traits - such as faster growth, more desirable qualities, drought or disease resistance - dates back at least to the late 1800s. It's the basis of all varieties of plants that form the backbone of world agriculture. And the same basic mechanism is at work with cisgenics, except it's done with a much higher degree of genetic understanding, using genome and biotechnology techniques of which Charles Darwin and early plant breeders never would have dreamed.

Strauss believes that the more natural process and greater specificity of cisgenic biotechnology may help transcend some of the costly, time-consuming and cumbersome regulatory hurdles that have held back this science in forestry, agriculture and other fields.

"With cisgenics, you know exactly what gene you're picking, what you're putting in, and it's a process that is similar to what happens naturally during crop breeding and evolution," Strauss said. "Our genetic tools just make the process more precise, and we do it faster. We believe that this will help address some people's concerns, and that regulatory agencies may soon view this quite differently than the type of genetic modification done with conventional transgenics.

"We're not trying to insert genes from a fish into a strawberry here," Strauss said. "We're taking a gene from a poplar tree and putting it back into a poplar tree. That's easier for a lot of people to accept, and scientifically we believe such approaches should be exempt from the regulatory reviews required for most transgenic crops. "

Genetic analysis of natural variation in plant traits provide important clues for cisgenic approaches, Strauss said. In any group of plants, some might grow taller or better resist disease than others. So once researchers know what genes are controlling growth and disease resistance, they can take them from one plant and put them back into the same or closely related species, and amplify or attenuate the desired characteristic.

"That is conceptually the same thing we've been doing in conventional plant breeding for two centuries," said Strauss, a world leader in the application of biotechnology to forestry.

This research has been supported by the U.S. Department of Energy, and the Tree Biosafety and Genomics Research Cooperative based at OSU.

In the new study with poplar trees, the researchers were able to use cisgenic technology to change the growth rate of the trees - some grew faster and others slower, in a greenhouse setting. Both smaller and taller trees can be useful for different kinds of applications. There can actually be a wide range of variation possible with this approach, allowing scientists to create different characteristics and simply select the ones that have value after multiple gene insertions and field tests.

Desirable characteristics might relate to growth rate, height, drought or disease resistance, flowering time, seed production or other traits. A gene that gives plants more heat tolerance might be useful in helping plants to deal with a warming climate. Some ornamental trees might be developed for shorter height to use in compact urban areas.

Applications in bioenergy, such as for faster growth or modified biomass for processing into ethanol, are also possible. And tree pests and diseases are proliferating at an alarming rate, due to exotic pests and climate variation. The ability to insert resistance genes from related species could provide new tools to deal with some of these problems, and do it much faster than is possible with conventional tree breeding, which often takes many years.

The much heralded "green revolution," in fact, took decades, but produced such accomplishments as wheat plants with shorter stems that were sturdier and spent more of the plant's energy on seed production instead of stem growth.

In this study, Strauss showed that it is feasible to create similar changes with native cisgenes in one year.

Provided by Oregon State University

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