Forestry geneticists develop tree biomass crop to grow on marginal lands

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Amy Brunner

Two Virginia Tech researchers have received a $1.4 million grant to investigate the genetic regulatory networks that will allow an important

bioenergy crop to be bred so it will grow in less than ideal soils and climate.

Populus, a genus of fast-growing trees commonly known as cottonwoods and aspens, is being grown for bioenergy because it produces a significant amount of biomass in two years and will re-grow robustly when cut at just above ground level. Woody biomass can be converted to liquid fuels, such as ethanol.

"The goal is to develop the species so it will not become dormant in conditions that would stress other crops, such as high temperature, drought, or marginal soil nutrients," said Amy Brunner, associate professor of molecular genetics in the College of Natural Resources and Environment and an affiliate of the Fralin Life Science Institute. "It is important that bioenergy crops not require prime agricultural land."

"We don't want biomass production to compete with food production," she continued. "The aim is to minimize inputs, develop varieties that grow in different environments, and maximize biomass production."

Brunner and Jason Holliday, assistant professor of forest genetics and biotechnology in the college and a fellow Fralin Life Science Institute affiliate, received the grant from the U.S. Department of Agriculture National Institute of Food and Agriculture and the U.S. Department of Energy Office of Biological and Environmental Research. Their project is one of 10 grants awarded as part of the national strategy of sustainable biofuels production.

"The college made the decision to enter into the specialized and highly competitive research arena of molecular genetics, and Drs. Brunner and Holliday are making important contributions to the body of molecular genetics science of tree species," said Paul Winistorfer, dean of the college. "Developing alternative approaches to biofuel crops and their

adaptation and success to a changing climate is a strategic and important contribution to our future energy needs."

Brunner and Holliday are experimenting with the FT2 gene, which regulates vegetative growth. "In addition to seasonal dormancy, which happens when days get shorter, a common response to stress by woody plants is to stop growing and wait for things to get better, which is important to natural populations' ability to survive adverse conditions," said Brunner.

Jason Holliday

"Jason and I are melding our expertise to understand growth and dormancy transitions," she continued. "We will identify specific control

points that can be manipulated to maximize growth in different environments."

The FT2 gene integrates signals regarding environmental conditions, such as day length and drought, to control shoot growth or regrowth after harvest.

"If we understand the network, such as what genes are sending the signal regarding nutrient level or day length, then we can use that in a breeding program for optimal biomass production in specific climates and on marginal lands," said Brunner.

"This is also relevant to how to manage the health of this species' natural populations in light of climate change, since, for instance, temperature also impacts seasonal dormancy," she added.

After identifying components of the response networks to day length and nutrient level that act through FT2, five to six genes will be selected for functional analysis to validate their utility for enhancing plant growth and yield under different environmental conditions.

"Dr. Brunner has made important contributions to understanding the development of this species," said Professor Janaki Alavalapati, head of the Department of Forest Resources and Conservation. "This grant will take that work to the next level, toward the national goal of growing biofuel crops on marginal lands."

Brunner has 20 years' experience studying the regulation of Populus growth and development at the genetic level. She was a member of a team that received $1.2 million in 2007 and $1.5 million in 2011 from the U.S. Departments of Agriculture and Energy to identify genes and their regulatory networks specifically associated with wood formation. By 2011, that grant resulted in 400 such genes having been identified.

Work to identify the interactions of their encoded proteins and functions is continuing.

She and colleagues also identified genetic controls associated with tree growth and response to the environment. That work, funded by the National Science Foundation, was published in the *Proceedings of the National Academies of Science* and the *Plant Journal*. This new project builds on that previous work.

Holliday has extensive experience with all aspects of next generation sequencing and is presently doing sequence capture research funded by the National Science Foundation, as well as other funded research.

Brunner and Harold Burkhart, University Distinguished Professor and the Thomas M. Brooks Professor of Forestry at Virginia Tech, have field trials underway at Virginia Tech's Reynolds Homestead Forest Resources Research Center and in the Appomattox-Buckingham State Forest to identify Populus clones that will do well in southern and central Virginia.

"Populus is grown for biomass in the Pacific Northwest, the lower Mississippi valley, and the Great Lakes area. There has not been a market for it in the southeastern U.S., but there could be," said Brunner. "It could also be a resource for power, pulp, and paper."

More information: Chuan-Yu Hsu, Joshua P. Adams, Hyejin Kim, Kyoungok No, Caiping Ma, Steven H. Strauss, Jenny Drnevich, Lindsay Vandervelde, Jeffrey D. Ellis, Brandon M. Rice, Norman Wickett, Lee E. Gunter, Gerald A. Tuskan, Amy M. Brunner, Grier P. Page, Abdelali Barakat, John E. Carlson, Claude W. dePamphilis, Dawn S. Luthe, and Cetin Yuceer. "FLOWERING LOCUS T duplication coordinates reproductive and vegetative growth in perennial poplar." *PNAS* 2011 108 (26) 10756-10761; published ahead of print June 8, 2011, DOI:

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