Blight-resistant American chestnut trees take root at SUNY-ESF

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A young American chestnut tree grows in a SUNY-ESF plot. ESF researchers are growing blight-resistant American chestnut trees. Credit: SUNY-ESF

Scientists at the SUNY College of Environmental Science and Forestry (ESF) are growing the first American chestnut trees that can withstand the blight that virtually eliminated the once-dominant tree from the eastern United States.

Members of the ESF research team recently published three peer-reviewed papers that, along with continuing research, support their conviction that their biotechnology work with a gene originating in wheat makes the American chestnut tree at least as blight resistant as the Chinese chestnut tree that can co-exist with blight with minimal ill effects.

"Our goal was to develop an American chestnut tree that has blight resistance equal to that of a Chinese chestnut and we are there. We've done it," said Dr. William Powell, an ESF professor who leads the research project along with Dr. Chuck Maynard. "The leaf assays show it, the small-stem assays show it," Powell said, referring to the analytical processes the researchers go through to determine the level of blight resistance. "These American chestnut trees are blight resistant."

"It is tremendously satisfying to reach this level of success. We have a lot of people to thank for this. It's been a long haul but we are happy with where we are," Maynard said. A significant milestone in the process, he said, was reached when the transgenic trees, inoculated with the blight during testing, remained essentially as healthy as control trees that had been inoculated with only water.

The tree was once prominent enough to have earned a place in American culture, with chestnuts roasting over open fires in the winter, and Chestnut Streets running through towns across the country. The wood of American chestnuts is rot-resistant, making it suitable for construction purposes, and its abundant nuts were once a dietary staple for wildlife.

The next step in its return is for the researchers to select one of the 14 lines of transgenic trees with blight resistance and submit a detailed application to the federal agencies that will conduct a rigorous review process. The U.S. Department of Agriculture, Environmental Protection Agency, and Food and Drug Administration must approve the trees before they are available to the public for planting. If all goes well, the process could take around five years.

This is the first time the approval process will be used for a tree that is ultimately destined to be planted in the wild. The process has been applied to many crops, orchard and plantation trees, but not to species that are native to U.S. forests.

In the meantime, Powell, a molecular plant biologist, and Maynard, a tree improvement specialist, will produce as many trees as possible, perhaps 10,000, so they are ready for planting if and when the approval process is complete. The ESF College Foundation, Inc., which supports the

college's educational mission, continues fundraising efforts to support the work.

"The team has accomplished a major goal, the generation of a blight-resistant American chestnut tree," said Dr. Timothy Tschaplinski, a scientist at Oak Ridge National Laboratory who does chemical analysis for the research team to determine if the tissue of transgenic trees differs from that of wild-type trees. "The results of the metabolite analyses indicate that the nuts produced from transgenic plants aren't appreciably different from those produced by wild-type plants and should be safe for consumption. The sum total of these efforts is a major step forward for the goal of restoration of American chestnut to the North American landscape."

Continuing research by ESF and collaborators from other institutions indicates that the transgenic trees do not affect the composition of leaf litter, the feeding habits of insects or the growth of ecologically important fungi.

"We're doing all these tests to be sure there are no ill effects because we are the first to develop a transgenic tree for an environmental restoration program," Powell said.

Powell said the fact that the gene used to enhance blight resistance is obtained from wheat should allay concerns about the genetic engineering that went into producing the new lines of trees. "We eat it all the time," he said. "If you had a bagel for breakfast, you ate it today. And this gene is gluten-free."

He said that in trees produced in the laboratory, only two genes—the wheat gene and a common selectable marker gene—did not originally occur in the American chestnut (which has about 40,000 genes). A selectable marker gene is one introduced to an organism to help researchers be sure the resistance-enhancing gene is present.

Many hybrid chestnuts made by crossing different chestnut species, such as the "Dunstan" chestnut and others commonly on the market today, mix tens of thousands of genes. Even backcross breeding results in trees that have approximately one-sixteenth Chinese genes, or some 2,500 genes introduced by humans. "Our transgenic American chestnuts are much, much closer to the original trees that were in our forests, and we got there by adding only a couple genes," Powell said.

The most recent study, published this week in the journal "*Plant Science*," shows that when American chestnuts acquire blight resistance in the laboratory, they pass it on to the next generation, so trees planted in the wild would have blight-resistant offspring. The two previous publications show that the level of blight resistance in an individual tree is linked to the presence of the resistance gene from wheat and that laboratory tests performed on leaves predict the level of blight resistance that is seen in field tests.

Powell and Maynard said the process shows the value of biotechnology in dealing with invasive species, such as the pathogenic fungus that arrived in New York City more than 100 years ago and virtually wiped out what was once the most abundant forest tree in the eastern United States.

"It's possible to enhance disease resistance in plants with genetic engineering. This is a powerful tool that can be added to all the other tools available to improve forest health. This technique can be used for many species of trees that are threatened by disease. It goes beyond the American chestnut," Powell said.

Initiating the approval process marks the latest step in a process that began about 25 years ago with the two professors' partnership.

Powell and his team were responsible for finding and testing genes that would protect the tree. His background research on the blight fungus led the way to the successful use of a wheat oxalate oxidase gene. This gene doesn't hurt the fungus, but instead detoxifies the acid used by the fungus to attack the tree, essentially changing the fungus from a pathogen to a saprophyte that lives on the bark of the tree without causing significant harm.

Meanwhile, Maynard and his team were developing a process to insert genes into embryo tissue of American chestnut and regenerate them into whole

plants. Maynard estimated that in the first five years alone, they extracted at least 10,000 embryos from nuts. The majority of these embryos died or just grew callus, but a handful survived for the next steps of the research process. Since 2006, about 2,000 transgenic American chestnut trees have been planted in field trials.

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