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Genetically Modified Poplar Trees Emit Fewer Hydrocarbons And Are Just As Hardy

Jeff Kart Contributor

In situ studies of isoprene emission in an experimental poplar plantation near Tucson, Arizona. DAVID J.P. MOORE, UNIVERSITY OF ARIZONA

Trees don't just emit oxygen as part of photosynthesis. Some, like the poplar tree, also emit gases which can harm air quality. But before you start clear-cutting, know this: Field trials in Oregon and Arizona show that poplars, which emit trace amounts of isoprene gas, can be genetically modified without stunting their growth.

That's according to a research collaboration led by scientists as the University of Arizona, along with the Helmholtz Research Center in Munich, Portland State University and Oregon State University.

A lot of trees also emit isoprene and other gases. If you've ever smelled a pie forest, you're smelling a group of complex organic molecules called terpenes, which are stored in the needles to ward off insects.

Isoprene is bad because it worsens people's respiratory health and warms the atmosphere. It's a hydrocarbon that reacts with gases produced by tailpipe pollution to produce ozone, a greenhouse gas. Isoprene also causes higher levels of atmospheric aerosol production, reducing the amount of direct

sunlight reaching the earth, and (to a larger extent) increases the global warming potential of methane in the atmosphere.

The research team genetically modified poplars to not produce isoprene, then tested them in three- and four-year trials at plantations in Oregon and Arizona, according to Russell Monson, professor of ecology and evolutionary biology at the University of Arizona and the study's lead author.

Another photo from the experimental plantation near Tucson
DAVID J.P. MOORE, UNIVERSITY OF ARIZONA

But isoprene isn't all bad. It helps trees tolerate climate stresses, such as high temperature and drought. And the genetically modified poplars figured a way around that.

"The trees appear to be clever," Monson says. "They have access to alternative pathways that replace the protective influences of isoprene, and thus they are able to continue growing and producing wood at the same rates as trees with the isoprene trait."

Researchers found that the trees were able to adjust to the loss of isoprene because most plantation growth takes place during cooler and wetter times of the year.

The findings were published the journal Proceedings of the National Academy of Sciences.

"What we are saying in this paper is that the growth and wood production of the trees is not affected by the trait of isoprene emission," Monson says.

Can the research be used to curb harmful emissions from other trees?

Yes, Monson says, especially for species like palm (used for palm oil production) and eucalyptus (used for wood and biomass production in tropical and subtropical areas).

"Many of the tree species that produce isoprene, like poplar, palm and eucalyptus are also used for cellulose and biomass production in agroforestry—mainly in plantations," he explains.

"Thus, when plantations are located in the vicinity of urban or suburban areas, the isoprene can react with (nitrogen oxides) from the cars and produce ozone at relatively high rates. This is how trees produce air pollution."

Why study poplars?

Well, poplar plantations cover 9.4 million hectares (more than 36,000 square miles) globally, including in the Pacific Northwest and Midwest in the United States. And worldwide, that's more than double the land used 15 years ago. The trees grow fast and are a source of biofuel and other products including paper, pallets, plywood and furniture frames.

A poplar plantation
UNIVERSAL IMAGES GROUP VIA GETTY IMAGES

Meanwhile, millions of metric tons of isoprene leak into the atmosphere each year, according to University of Arizona officials. And climate warming will make the situation worse by increasing the rate of isoprene emissions, Monson says.

So what difference can genetically modified poplars make?

"A good estimate of the fraction of global isoprene emissions that come from agroforestry plantations is difficult, because the global databases on forest plantation coverage are not updated very well," he explains.

"I would estimate that the percentage of emissions due to plantations is modest at the present time, but it is increasing rapidly due primarily to the increased global demand for palm oil and the interest in producing second-generation biofuels (those from cellulose production rather than fructose production) from poplar and eucalyptus."

Pine plantations also are expanding, especially in the southeastern U.S., and the terpenes associated with that smell of pine also are hydrocarbons that can react with nitrogen oxides to produce ozone.

Scientists from Portland State University; the University of California, Riverside; NASA's Goddard Space Flight Center; and the Institute for Microbiology in Greifswald, Germany, also collaborated on the study. Funding was provided in part by the National Science Foundation, U.S Department of Agriculture and the German Ministry of Education and Research.

It's not clear how long it will be before modified poplars are helping clean up the air on a wider scale.

Monson says the use of modified poplars will likely be followed up by Steven Strauss, a co-author on the paper from Oregon State University.

Richard P. Vlosky, Ph.D.
Director, Louisiana Forest Products Development Center
Crosby Land & Resources Endowed Professor of Forest Sector Business Development
Room 227, School of Renewable Natural Resources
Louisiana State University, Baton Rouge, LA 70803
Phone (office): (225) 578-4527; Fax: (225) 578-4251; Mobile Phone: (225) 223-1931
Web Site: www.LFPDC.lsu.edu