Microbes And Plants Can Clean Up Toxic Spills

Superfund sites are infamous for their hazardous, stubborn chemical wastes, but one cleanup solution may be to put the right mix of plants and microbes together in the soil, according to a new University of Florida study.

The study examined the interaction between two of the likeliest candidates for cleanup duty — the loblolly pine and soil-dwelling, methane-eating bacteria.

The practice of planting chemically resilient trees and plants in contaminated sites to absorb harmful chemicals from the soil, known as phytoremediation, is highly appealing both to environmental cleanup agencies and to the communities near the hazardous sites. Phytoremediation is still in its infancy but has the potential to be relatively safe, sustainable and efficient — and the trees are aesthetically pleasing as well.

Microbes in the soil also play a key role. They help plants not only to absorb nutrients through their roots but also to soak up contaminants. However, the interaction between plants and microbes is not necessarily symbiotic, according to the study, which appeared in the January issue of the *Bulletin of Environmental Contamination and Toxicology*.

"We're trying to see what the role of the microbes is in the rhizosphere, the soil region around the plant roots," said Adriana Pacheco, a graduate student in UF's environmental engineering department and the lead author of the paper. "It seems to be one of the most important processes occurring."

Pacheco's research focused on methanotrophs, bacteria that consume methane in soils and in the process can also consume and break down a range of harmful organic compounds that may be present, such as the carcinogenic polychlorinated biphenyls, commonly known as PCBs, and trichloroethylenes, or TCEs.

However, not all trees work equally well with all kinds of microbes, and knowing how the different plant species affect the bacteria may be the key to effective and efficient cleanup, Pacheco said.

In her study, she focused on one tree species, the loblolly pine, a prime candidate for phytoremediation at a number of Superfund sites, particularly in the southeastern United States.

Loblolly pines are well known for supporting thriving populations of bacteria near their roots, possibly because of the piles of needles littering the soil and releasing a pungent group of chemicals called monoterpenes.

"These terpenes have been shown to inhibit bacteria," Pacheco said. "But methanotrophs can also be in really high concentrations in the rhizosphere of the pines, and they are degrading TCEs. So one of the questions is, are monoterpenes helping them in some way?"

To answer this question, Pacheco isolated several different species of methanotrophic bacteria, fed them methane and added monoterpenes as well as TCEs, and then measured the bacteria's response to the monoterpenes by observing how oxygen levels in the samples changed over time. She found that while some species of the bacteria thrived when the pine chemical was added, the chemical appeared to be toxic to others. That, she said, suggests environmental engineers will need to choose both plants and microbes carefully when planning phytoremediation-based cleanup.

Scientists also want to address what happens to the contaminants after they've passed through the microbe-plant system.

"It's a very aesthetic treatment," said Angela Lindner, a UF professor of environmental engineering and co-author of the paper. "Trees and plants are very resilient. They can accumulate the chemicals, and many times they will also transform the chemicals within the plant, and then the products as well as the chemical can volatilize through the leaves. But we need to know where the stuff is going."

For methanotrophic bacteria, at least, the fate of the chemicals is known. The bacteria produce an enzyme that breaks down harmful chlorinated compounds into harmless carbon dioxide, oxygen and water.

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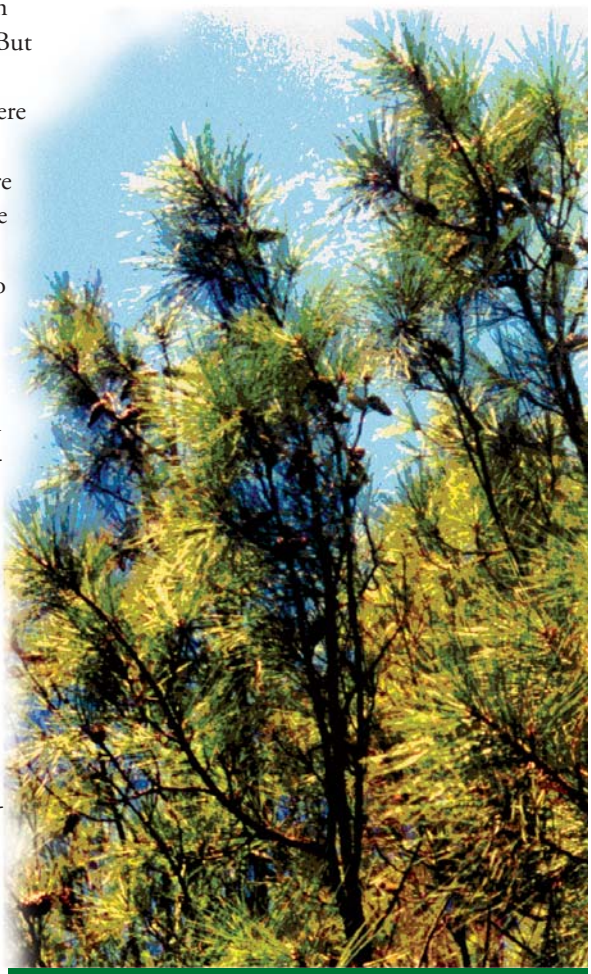

Loblolly Pine