Scientists Identify Bacteria That Increase Plant Growth

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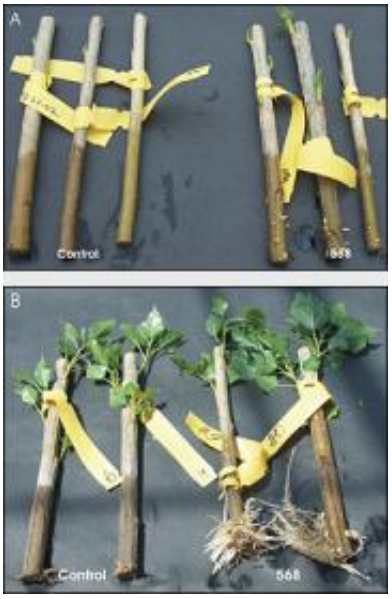

Poplar plants at 1 (A) and 10 (B) weeks after being treated with endophytic bacteria (strain S. proteamaculans 568) compared with control plants. The inoculated plants show increased root and shoot formation, particularly after 10 weeks.

(PhysOrg.com) -- Through work originally designed to remove contaminants from soil, scientists at the U.S. Department of Energy's Brookhaven National Laboratory and their Belgium colleagues at Hasselt University have identified plant-associated microbes that can improve plant growth on marginal land. The findings, published in the February 1, 2009 issue of *Applied and Environmental Microbiology*, may help

scientists design strategies for sustainable biofuel production that do not use food crops or agricultural land.

"Biofuels are receiving increased attention as one strategy for addressing the dwindling supplies, high costs, and environmental consequences of fossil fuels," said Brookhaven biologist and lead author Daniel (Niels) van der Lelie, who leads the Lab's biofuels research program. "But competition with agricultural resources is an important socioeconomic concern."

Ethanol produced by fermenting corn, for example, diverts an important food source — and the land it's grown on — for fuel production. A better approach would be to use non-food plants, ideally ones grown on non-agricultural land, for biofuel production.

Van der Lelie's team has experience with plants growing on extremely marginal soil — soil contaminated with heavy metals and other industrial chemicals. In prior research, his group has incorporated the molecular "machinery" used by bacteria that degrade such contaminants into microbes that normally colonize poplar trees, and used the trees to clean up the soil. An added benefit, the scientists observed, was that the microbe-supplemented trees grew faster — even when no contaminants were present.

"This work led to our current search for bacteria and the metabolic pathways within them that increase biomass and carbon sequestration in poplar trees growing on marginal soils, with the goal of further improving poplar for biofuel production on non-agricultural lands," said co-author Safiyh Taghavi. In the current study, the scientists isolated bacteria normally resident in poplar and willow roots, which are known as endophytic bacteria, and tested selected strains' abilities to increase poplar growth in a controlled greenhouse environment. They also sequenced the genes from four selected bacterial species and screened

them for the production of plant-growth promoting enzymes, hormones, and other metabolic factors that might help explain how the bacteria improve plant growth.

"Understanding such microbial-plant interactions may yield ways to further increase biomass," van der Lelie said.

The plants were first washed and surface-sterilized to eliminate the presence of soil bacteria so the scientists could study only the bacteria that lived within the plant tissues - true endophytic bacteria. The plant material was then ground up so the bacterial species could be isolated. Individual strains were then supplemented with a gene for a protein that "glows" under ultraviolet light, and inoculated into the roots of fresh poplar cuttings that had been developing new roots in water. The presence of the endophytic bacteria was confirmed by searching for the glowing protein. Some bacterial species were also tested for their ability to increase the production of roots in the poplar cuttings by being introduced during the rooting process rather than afterward.

The results

The scientists identified 78 bacterial endophytes from poplar and willow. Some species had beneficial effects on plant growth, others had no effect, and some resulted in decreased growth. In particular, poplar cuttings inoculated with Enterobacter sp. 638 and Burkholderia cepacia BU72 repeatedly showed the highest increase in biomass production — up to 50 percent — as compared with non-inoculated control plants. Though no other endophyte species showed such dramatic effects, some were effective in promoting growth in particular cultivars of poplar.

In the studies specifically looking at root formation, non-inoculated plants formed roots very slowly. In contrast, plant cuttings that were

allowed to root in the presence of selected endophytes grew roots and shoots more quickly.

The analysis of genes and metabolically important gene products from endophytes resulted in the identification of many possible mechanisms that could help these microbes thrive within a plant environment, and potentially affect the growth and development of their plant host. These include the production of plant-growth-promoting hormones by the endophytic bacteria that stimulate the growth of poplar on marginal soils.

The scientists plan to conduct additional studies to further elucidate these mechanisms. "These mechanisms are of prime importance for the use of plants as feedstocks for biofuels and for carbon sequestration through biomass production," van der Lelie said.

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