Legume lessons: Reducing fertilizer use through beneficial microbe reactions

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The University of Delaware's Janine Sherrier is examining the relationships between legumes and beneficial microbes as part of a $6.8 million National Science Foundation grant. Credit: Kathy F. Atkinson/University of Delaware

Janine Sherrier, professor in the Department of Plant and Soil Sciences at the University of Delaware, is part of a team that has been awarded $6.8 million from the National Science Foundation (NSF) to study the legume *Medicago truncatula*.

Sherrier leads one of four research groups participating in this project, which represents a collaborative effort between researchers at the Noble Foundation, the Boyce Thompson Institute at Cornell University, the University of Delaware, and the University of North Texas.

"The aim of this large project is to generate resources for the U.S. and international research communities. We will generate resources to help accelerate the transfer of fundamental laboratory research results into useful applications for crop production," said Sherrier.

In past years, the NSF has supported projects to sequence the complete genomes of organisms, including *M. truncatula*. The resources generated by this new NSF grant will help researchers define the roles of all of the individual genes within the genome and to elucidate how they are important for legume growth.

"Legumes, such as beans and lentils, provide one third of the protein consumed as part of the human diet globally. Legumes also contribute fiber and micronutrients to the human diet and are utilized widely as forage crops for livestock," said Sherrier.

M. truncatula has been selected as a research model to study the symbiotic relationships that are characteristic of legumes. Unlike many species of plants, legumes rely on interactions with rhizobia (naturally-occurring beneficial microbes) to supply them with nitrogen. Many crop plants are supplemented with industrially produced nitrogen fertilizer, and the synthesis of the fertilizer is an energy-intensive process.

"As much as four percent of the world's natural gas is consumed in the production of nitrogen fertilizers, releasing carbon dioxide by-products into the atmosphere," said Sherrier.

When nitrogen is not present at sufficient levels in the soil to support plant growth, legumes create a home for beneficial bacteria in their roots. The plant develops a novel root organ where bacteria can grow, multiply and enter the plant cell, and within the plant cells the bacteria convert atmospheric nitrogen into a fertilizer for the plant. This greatly reduces the amount of fertilizer and energy necessary to produce a successful crop, lowers production costs for farmers and reduces runoff of fertilizers into the groundwater.

The focus of Sherrier's research program is on the protein-to-protein interactions that are necessary for such beneficial plant-bacteria relationships to occur.

"If the plant lacks a specific protein, then this can allow bacteria to enter the plant and simply take the sugar without producing anything in return. This would be detrimental for a crop," she explained.

As part of the NSF-funded project, Sherrier's team will also be developing and teaching a 4-H summer camp across Delaware to teach children about how different microbes are important for agriculture. Campers will participate in science-based activities, such as using microscopes and making yogurt. The camps will contribute to the development of future growers in all three counties.

Provided by University of Delaware