Inside a Plant’s Immune System

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Could you picture a rose bush sneezing or a daisy with a runny nose? Have you heard a marigold cough? Plants, like humans, must fight off illness. Though they may not take two Advil and call their doctors in the morning, the process of defending against diseases may be more similar than we thought.

If bacteria invade our bodies, our immune system primarily uses cells to attack the foreign body. Plants, however, employ chemicals to combat their invaders, such as bacteria and fungi, to inhibit their growth. One way plants do this is through recognition of microbial-associated molecular patterns (MAMPs).

MAMPs are located on the surface of plant-disease-causing fungi or bacteria and are conserved over generations. Conservation of MAMPs allows components on the surface of immune cells, such as toll-like receptors to recognize foreign bodies and protect the host organism against potential infections. Dr. Nicole Clay, Assistant Professor of Molecular, Cellular, and Developmental Biology at Yale University, is attempting to elucidate this mechanism. “Once you figure out the details of how plants defend themselves, you can, in theory, design genetically modified plants that can defend themselves,” says Stacey Lawrence, a doctoral student in the Clay lab.

A plant’s innate immune system is of particular interest because it is the main line of defense after the waxy coating on the plants’ leaves. If plants could recognize pathogens as soon as they enter the plant’s body, they might stay healthy and thus reduce or eliminate the need for pesticides. Pesticides are commonly used to protect plants from bacteria and other pathogens. However, these can be harmful to humans and animals.

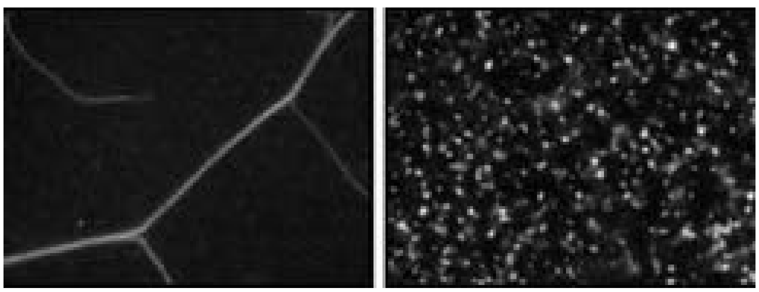
Stacey Lawrence’s research in the Clay lab focuses on a specific component of the immune system, G-proteins. G-proteins are important because they take signals from receptors, located on the outside of the cell, and translate them into other signals that activate appropriate defense responses for a perceived threat. Clay’s lab knows G-proteins bind in the innate immune system but they do not understand the G-proteins' role.

To study G-proteins, Arabidopsis (rockcress) is used. “One advantage of the plant is it has a very simplified form of G-protein,” says Lawrence. G-proteins are made up of an alpha, beta and gamma subunit. In humans, the G-protein has 40 subunits. The G-protein in Arabidopsis is much simpler, and contains only 5 subunits. This allows Clay’s lab to trace the role of G-proteins in the innate immune system through manipulation of the subunits.

The Clay Lab has shown that a particular mutation in the beta subunit of the G-protein has a negative effect on the immune system. To prove this they exposed Arabidopsis to bacteria or fungi then counted, under a microscope, the number of calloses containing antimicrobial agents. The number of calloses is representative of the plant's immune response to the foreign body. Normal plants responded with higher levels of antimicrobial agents than the plants containing a mutated beta subunit. This finding indicates that a plant with a normal G-protein could fight infections more readily.

People increasingly want fresh, locally produced products. After all, isn't "healthy" food—in the most literal sense— appealing to everyone?

Photo of Arabidopsis
Credit: Nicole Clay, PhD



Left: Arabidopsis exposed to water. Right: Callose activated by MAMPs
Credit: Nicole Clay, PhD