Plant protein 'doorkeepers' block invading microbes, study finds

June 29 2009

A group of plant proteins that "shut the door" on bacteria that would otherwise infect the plant's leaves has been identified for the first time by a team of researchers in Denmark, at the University of California, Davis, and at UC Berkeley.

Findings from the study, which will appear June 29 in the online journal *Public Library of Science Biology*, provide a better understanding of plants' immune systems and will likely find application in better protecting agricultural crops and horticultural plants against diseases.

"The ability of a plant's immune system to recognize disease-causing microorganisms is critical to the plant's survival and productivity," said Gitta Coaker, a UC Davis plant pathologist and lead author on the study.

"In this study, we identified a complex of proteins in the common research plant Arabidopsis that appear to play important roles in the biochemical mechanisms that enable plants to recognize and block out invading bacteria," Coaker said.

She noted that, over the last 20 years, scientists have identified a number of proteins that are important for regulating the plant immune system but still do not have a good sense of what protein complexes these proteins belong to and how they signal to confer disease resistance.

"Our ability to purify an immune protein complex will serve as a starting point to understand how these proteins signal in the plant," Coaker said.

"A greater understanding of how these proteins function is fundamental knowledge that can be applied to prevent plant disease."

PLANT IMMUNITY

Plants are continually exposed to bacteria, viruses and other microorganisms, many of which have the ability to infect the plant and cause disease.

Animals have what are known as innate, or preformed, immune systems as well as adaptive immune systems that learn to recognize and defend against disease-causing microbes. Plants, however, only have innate immune systems. Rather than developing immunity as they are exposed to various microbes, plants make use of certain built-in cells and genetically programmed systems to protect themselves against microbial invasion and related diseases.

This type of innate immune system has two branches: one makes use of receptor proteins outside the cell to recognize specific molecular features of an invading microbe, while the other branch uses similar proteins within the cell to recognize an invading microbe during the infection process.

Up until now, scientists had identified only one protein, known as RIN4, which is able to regulate these two branches of the plant immune system in Arabidopsis. The protein is found in the permeable plasma membrane that encases the cell on the inside of the cell wall. It has been unclear exactly how the protein and the two branches of the immune system interact to trigger an immune response in the plant.

THE NEW FINDINGS

In studying the RIN4 protein, Coaker and her colleagues identified six previously uncharacterized proteins that can associate with RIN4 inside plant cells. One protein, called AHA1, was characterized in-depth and found to be key to the immune response in Arabidopsis plants.

AHA1 can act to regulate the opening and closing of tiny holes called stomata, found on the underside of the leaf. The stomata allow gases and water to pass in and out of the leaf. This is the same opening that allows bacteria and other invading microbes to gain entrance to the plant.

The stomata are each flanked by two guard cells, which control these vitally important portals to the leaf. When the guard cells swell, the stomata close. Conversely, when the water content of the guard cells decreases, the stomata open.

The six proteins identified in this study were found to be intricately involved with the biochemical processes that enable the plant to recognize and block out invading bacteria.
The researchers found that RIN4 can act to regulate AHA1 and that both proteins work together to control stomatal openings in response to a disease-causing microorganism.

"These findings highlight how important regulation of the stomata is in Arabidopsis immunity," Coaker said. "Further research is needed to determine if RIN4 and its associated proteins play the same role in other plant species."

Source: University of California - Davis