# Understanding deadly citrus disease

Researchers at the University of California, Riverside have made an important step in understanding the molecular mechanism of huanglongbing (HLB), a destructive disease that is a serious threat to the citrus industry worldwide.

HLB, also known as citrus greening disease, has devastated groves in Asia, South America, and the southern U.S., costing the Florida citrus industry billions of dollars since 2005. Since 2012, the disease has been spreading in California's residential areas, prompting serious concerns about the state's commercial citrus groves.

HLB is associated with a species of bacteria called Candidatus Liberibacter asiaticus (CLas), which is transmitted by a tiny insect called the Asian citrus psyllid (ACP). Infected trees show leaf mottling, deformed and discolored fruits, and premature fruit drop. There is no cure for the disease and once a tree is infected it typically dies within three to five years.

An important step to developing HLB-resistant citrus varieties is to better understand how the bacterium infects trees and causes disease.

"Citrus trees, like all plants, have complex immune systems to prevent pathogenic infection, so the question is 'how does the CLas pathogen evade that immunity so it can cause disease?' said Wenbo Ma, a professor of plant pathology in UCR's College of Natural & Agricultural Sciences.

In a paper published Monday in Nature Communications, a team led by Ma reported a significant breakthrough in understanding the disease mechanism of HLB. They discovered that the bacterium secretes a protein -- called Sec-delivered effector 1 (SDE1) -- that helps infect plants. SDE1 works by attacking specific proteases -- called papain-like cysteine proteases (PLCPs) -- that could otherwise help the citrus trees resist infection.

"In the diseased trees we studied, the protein levels of some PLCPs were increased, presumably attempting to combat the bacterial infection," Ma said. "However, the bacterium fights back, by inhibiting the enzymatic activity of PLCPs through SDE1."

Ma said since scientists cannot grow CLas in the laboratory, the team used a surrogate system comprising the model plant Arabidopsis thaliana and the bacterial pathogen Pseudomonas syringae that was genetically engineered to produce SDE1. Using this system, they show that SDE1 promotes

bacterial infection. This study is among the first to describe the molecular tactics employed by CLas to colonize citrus plants.

"This study represents an important step towards better understanding the HLB disease mechanism, which will help us develop novel approaches to control this unstoppable disease," Ma said.

The team is now investigating the molecular details of how SDE1 suppresses citrus PLCPs with the aim to use the CRISPR gene editing system to modify the proteases to become resistant to the inhibitory effects of SDE1.

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