Scientists identify genetic mechanism that contributed to Irish Famine

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These are some soybean plants affected by *Phytophthora*. Credit: Ma Lab, UC Riverside.

When a pathogen attacks a plant, infection usually follows after the plant's immune system is compromised. A team of researchers at the University of California, Riverside focused on *Phytophthora*, the pathogen that triggered the Irish Famine of the 19th century by infecting potato plants, and deciphered how it succeeded in crippling the plant's immune system.

The genus *Phytophthora* contains many notorious pathogens of crops. *Phytophthora* pathogens cause worldwide losses of more than $6 billion each year on potato (*Phytophthora infestans*) and about $2 billion each year on soybean (*Phytophthora sojae*).

The researchers, led by Wenbo Ma, an associate professor of plant pathology and microbiology, focused their attention on a class of essential virulence proteins produced by a broad range of pathogens, including Phytophthora, called "effectors." The effectors are delivered to, and function only in, the cells of the host plants the pathogens attack. The researchers found that Phytophthora effectors blocked the RNA silencing pathways in their host plants (such as potato, tomato, and soybean), resulting first in a suppression of host immunity and thereafter in an increase in the plants' susceptibility to disease.

"*Phytophthora* has evolved a way to break the immunity of its host plants," Ma explained. "Its effectors are the first example of proteins produced by eukaryotic pathogens—nucleated single- or multi-cellular organisms—that promote infection by suppressing the host RNA silencing process. Our work shows that RNA silencing suppression is a common strategy used by a variety of pathogens—viruses, bacteria and *Phytophthora*—to cause disease, and shows, too, that RNA silencing is an important battleground during infection by pathogens across kingdoms."

Study results appeared online Feb. 3 in Nature Genetics.

What is RNA silencing and what is its significance? RNA is made from DNA. Many RNAs are used to make proteins. However, these RNAs can be regulated by "small RNA" (snippets of RNA) that bind to them.

The binding leads to suppression of gene expression. Known as RNA gene silencing, this suppression plays an important role in regulating plant growth and development. When RNA silencing is impaired by effectors, the plant is more susceptible to disease.

Basic RNA silencing processes are conserved in plant and mammalian systems. They serve as a major defense mechanism against viruses in plants and invertebrates. RNA silencing has also been implicated in anti-bacterial plant defense. The discovery by Ma's lab is the first to show that RNA silencing regulates plant defense against eukaryotic pathogens.

"*Phytophthora* effectors have a motif or signature—a specific protein code—that allows the proteins to be delivered into host cells," Ma said. "A similar motif is found in effectors of animal parasites, such as the malaria pathogen *Plasmodium*, suggesting an evolutionarily conserved means for delivering effectors that affect host immunity."

Next, her lab will work on extensively screening other pathogens and identifying their effectors' direct targets so that novel control strategies can be developed to manage the diseases the pathogens cause.

Ma was joined in the study by UC Riverside's Yongli Qiao, Lin Liu, Cristina Flores, James Wong, Jinxia Shi, Xianbing Wang, Xigang Liu, Qijun Xiang, Shushu Jiang, Howard S. Judelson and Xuemei Chen; Fuchun Zhang at Xinjiang University, China; and Qin Xiong and Yuanchao Wang at Nanjing Agricultural University, China.

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In 2011, UCR received a $9 million USDA grant to research late blight, caused by Phytophthora infestans, that mainly attacks potatoes and tomatoes. Last year, UCR released avocado rootstocks that can help control Phytophthora root rot, a disease that has eliminated commercial avocado production in many areas of the world.

Provided by University of California - Riverside