Atomic-level defense secrets revealed

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Just as nations around the globe carefully guard their defense secrets, so do plants.

New research in the current issue of *Nature*, however, has revealed the molecular secrets of plants' defense mechanisms at the atomic level. The study, led by Michigan State University and Van Andel Research Institute, focuses on the plant hormone jasmonate and its interaction with three key proteins. The findings could help scientists develop dream crops that are better equipped to fend off pests, diseases and future challenges created by fluctuating climate.

"Our study focused on three plant proteins, MYC, JAZ and MED25, which are key regulators of jasmonate signaling," said Sheng Yang He, a Howard Hughes Medical Institute-Gordon and Betty Moore Foundation Plant Biology Investigator, and an MSU Distinguished Professor in the MSU-Department of Energy Plant Research Laboratory. "A thorough understanding of how plants grow and defend themselves could lead to the design of a new generation of crops that have increased tolerance to diverse stresses and produce higher yields."

Jasmonate plays a crucial role in regulating defenses when plants come under attacks from pests or pathogens. However, producing and activating jasmonate to ward off these onslaughts takes significant energy and requires plants to strike a delicate balance between defense and energy conservation. If a plant constantly has its defenses activated, its growth can be severely affected.

Globally, about one-third of food is lost or wasted across the entire production chain, according to the Food and Agriculture Organization of the United Nations. With a growing global population and threats from plant pathogens and pests, understanding how plants defend themselves against these attacks is more important than ever before.

For the last decade, scientists have attempted to unravel the mystery of the sophisticated ways plants maintain their defenses while protecting their ability to grow. By revealing the structures of the jasmonate signaling complexes, researchers can now see how this crucial hormone pathway is governed, said He, who led the study with Karsten Melcher and Eric Xu of Van Andel Research Institute.

Understanding interactions among this trio of proteins not only has implications for global crop production, but also offers additional insights into other molecular mechanisms that play a role in human diseases. This study shows for the first time how a protein can serve as both a repressor and a receptor, two key roles that are vital for gene expression. In the presence of jasmonate, JAZ repressor becomes a component of the jasmonate receptor complex by changing its shape.

"How the same protein functions as a repressor in the absence of a hormone and a component of a receptor complex in the presence of hormone was a big mystery," Xu said. "We found that the JAZ protein undergoes a dramatic change in its shape in order to carry out its two different functions based on the presence or absence of jasmonate."

Answering these basic questions allows scientists to better understand the mechanisms that underlie the most vital biological functions, such as how genes are turned on and off, which are similar across plants, animals and humans.

"The MYC proteins utilized in jasmonate signaling collaborate with large activating and repressing protein machines that are also found in humans and have important roles in human disease, including cancer," Melcher said.

More information: Structural basis of JAZ repression of MYC transcription factors in jasmonate signalling, *Nature* (2015) DOI: 10.1038/nature14661

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