How plants 'muscle up' against bacteria in the cold

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Credit: Michigan State University

Michigan State University scientists have furthered our understanding on how a plant protein, called CAMTA, helps plants strengthen themselves as they anticipate long periods of cold, such as three to four months of winter in the American midwest or northern Europe.

The long-term goal behind the research is to breed or create plants with higher tolerance to wild swings in temperature. The study is published in the journal *The Plant Cell*.

CAMTA proteins are universally found across plants, and they help turn on genes that communicate freezing tolerance to these plants. In the study, CAMTA proteins were observed to also control how plants defend against harmful bacteria under long-term cold conditions.

In the cold, plants generally build up high levels of salicylic acid, or SA, a compound that protects them against bacteria.

"At warm temperatures CAMTA proteins, specifically the N-terminus (the start of the proteins), block the system that produces SA," said Yong Sig Kim, a post-doctoral student in the lab of University Distinguished Professor and MSU Foundation Professor Michael Thomashow.

When it gets cold for a long enough period, an unknown signal is generated that modifies CAMTA to allow SA production to turn on. In that case, the C-terminus, or the bottom of an amino acid chain that is stopped by a free carboxyl group, detects the signal—possibly a rise in cellular calcium levels—that enables SA biosynthesis.

This observation reverses current accepted models, which proposed instead that the C-terminus blocked SA production.

Why does tolerance to the cold instigate bacterial defenses?

"SA doesn't protect the plant from the cold, per se. Instead, we think the plants enhance their immune systems in the cold as a general preemptive strategy," Kim said.

Although plants take measures to survive the cold, they still get injured,

and their structures are destabilized, which makes them more vulnerable to bacterial infection.

So, weakened plants keep their guard up as a precaution. It is similar to how humans take preventative measures to stay healthy – eat well, sleep eight hours, hydrate, etc.

This knowledge has long-term potential impact on agricultural production. For example, according to the EPA, in 2010 and 2012, high nighttime temperatures affected corn yields across the U.S. Corn Belt, and premature budding due to a warm winter caused $220 million in losses of Michigan cherries in 2012.

"The field of plant defense is gradually revealing how protection mechanisms against the elements and against other living beings are interrelated," Kim said.

More information: Yong Sig Kim et al. CAMTA-Mediated Regulation of Salicylic Acid Immunity Pathway Genes in Arabidopsis Exposed to Low Temperature and Pathogen Infection, *The Plant Cell* (2017). DOI: 10.1105/tpc.16.00865

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