Study reveals mechanisms of drought response in plants

June 29 2015, by Scott Schrage

(L to R) Heriberto Cerutti, Zhen Wang, Jean-Jack Riethoven and Chi Zhang. Wang is holding a tray of the plant species (Arabidopsis thaliana) studied by the researchers. Credit: Craig Chandler

UNL biologists have published a new study that lays bare several roots of how plants respond to drought.

The researchers have shown that mutations in two genes of the plant species Arabidopsis thaliana can stifle its development and disrupt the defense mechanisms that protect it against drought-like conditions.

As reported June 22 in the journal *Proceedings of the National Academy of Sciences*, the UNL team bred a "double mutant" variant of Arabidopsis to explore the collective roles of two genes whose mutations effectively deactivated them.

The authors discovered that the mutations substantially stunted the growth and compromised the functioning of plant organs. The double mutant also showed much greater susceptibility to drought, wilting faster and dying more often than plants with either one or no defective genes.

"In the long term, we'd like to understand whether we can (produce) the opposite effects – plants that might be more tolerant to challenging environmental conditions," said lead author Heriberto Cerutti, professor of biological sciences. "I think this basic research is a necessary step toward that."

Cerutti's team traced the detrimental changes in the double mutant to the absence of interactions that typically occur in cellular proteins called histones, which act as space-saving spools that the spiral ladder of DNA coils around.

Biologists believe that histones help dictate when the genetic instructions encoded in DNA get transcribed and expressed in an organism. Recent research has also suggested that histone modifications – including phosphorylation, the addition of a phosphate molecule – may help optimize plant responses to environmental cues.

The stunted development of the double mutant plant (far right) compared with those with either one or no mutated genes. Credit: UNL

Cerutti and his colleagues found that normal Arabidopsis produced higher levels of phosphorylated histones when exposed to a simulated drought. However, this phosphorylation process requires a catalyst, called a kinase, to connect a phosphate donor with the histone set to receive it.

The UNL researchers determined that the double mutant lacked two of these matchmaking kinases, leading to lower levels of phosphorylated histones and, they believe, the dysfunctional growth and drought responses they observed.

"If you don't have those two genes and those two kinases, the consequences for the plant are pretty dramatic," Cerutti said. "We have to understand how the machinery (of plants) works if we ever hope to be able to modify it to our advantage. Given what's happening in the world related to climate change, we think that research in this area will be pretty relevant in the future."

More information: Osmotic stress induces phosphorylation of histone H3 at threonine 3 in pericentromeric regions of Arabidopsis thaliana, Zhen Wang, DOI: 10.1073/pnas.1423325112

Provided by University of Nebraska-Lincoln