Grains in the rain: New study opens the door to flood resistant crops

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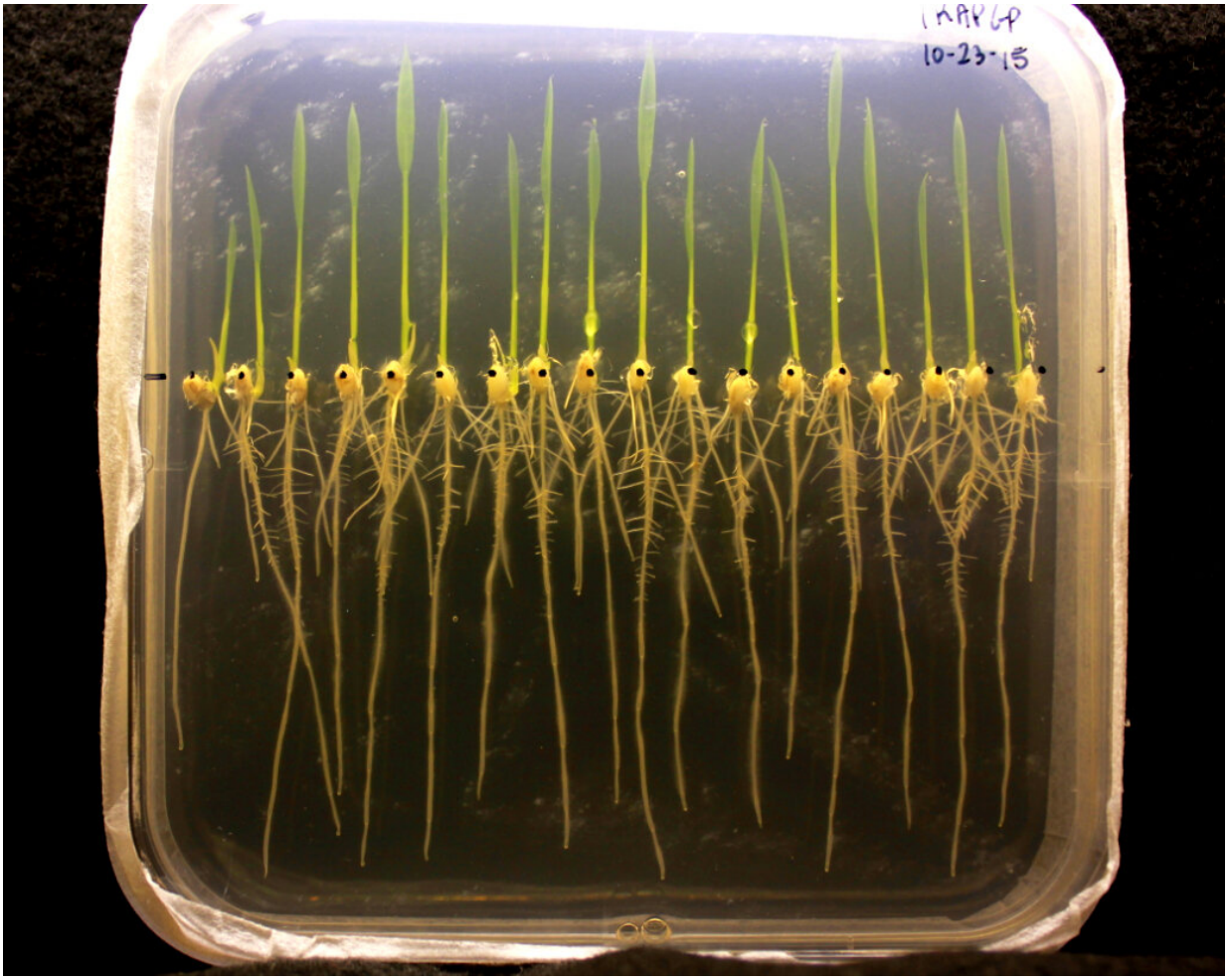

Rice seedlings, which are the first responders to a flood, react to complete submergence. Credit: Germain Pauluzzi / UCR

Of the major food crops, only rice is currently able to survive flooding. Thanks to new research, that could soon change—good news for a world in which rains are increasing in both frequency and intensity.

The research, newly published in *Science*, studied how other crops compare to rice when submerged in water. It found that the plants—a wild-growing tomato, a tomato used for farming and a plant similar to alfalfa—all share at least 68 families of genes in common that are activated in response to flooding.

Rice was domesticated from wild species that grew in tropical regions, where it adapted to endure monsoons and waterlogging. Some of the genes involved in that adaptation exist in the other plants but have not evolved to switch on when the roots are being flooded.

"We hope to take advantage of what we learned about rice in order to help activate the genes in other plants that could help them survive waterlogging," said study lead Julia Bailey-Serres, a UC Riverside professor of genetics.

In the study, the team examined cells that reside at the tips of roots of the plant, as roots are the first responders to a flood. Root tips and shoot buds are also where a plant's prime growing potential resides. These regions contain cells that can help a plant become more resilient to flooding.

Drilling down even further, the team looked at the genes in these root tip cells, to understand whether and how their genes were activated when covered with water and deprived of oxygen.

"We looked at the way that DNA instructs a cell to create particular stress response in a level of unprecedented detail," said one of the lead researchers, UC Riverside's Mauricio Reynoso.

"This is the first time that a flooding response has been looked at in a way that was this comprehensive, across evolutionarily different species," added study co-author Siobhan Brady, an associate professor of plant biology at UC Davis.

The genes involved in flooding adaptations are called submergence up-regulated families (SURFs). "Since evolution separated the ancestors of rice and these other species as many as 180 million years ago, we did not expect to find 68 SURFs in common," said co-author Neelima Sinha, professor of plant biology at UC Davis.

The study was an international collaboration funded by the National Science Foundation's Plant Genome Research Program. Researchers from UC Davis, as well as Emory, Argentina's National University of La Plata and Netherland's Utrecht University participated.

While UC Riverside researchers conducted flooding experiments and analysis of rice plant genomes, scientists at Davis did the same with the tomato species while the alfalfa-type plant work was done at Emory.

Though the SURFs were activated in all the plants during the flooding experiments, their genetic responses weren't as effective as in rice. The wild tomato species that grows in desert soil withered and died when flooded.

Climate change also produces periods of excessive drought, and separate efforts are under way to examine crop resilience to those conditions as well. However, Bailey-Serres said flooding responses are understudied compared to drought, making this work all the more important.

The group is now planning additional studies to improve the survival rates of the plants that currently die and rot from excess water.

This year is not the first in which excessive rains have kept farmers from being able to plant crops like corn, soybeans and alfalfa. Floods have also damaged the quality of the crops they were able to grow. As the climate continues to change, this trend is likely to continue. Without efforts to ensure our crops adapt, the security of the world's food supply is at risk.

"Imagine a world where kids do not have enough calories to develop," said Bailey-Serres. "We as scientists have an urgency to help plants withstand floods, to ensure food security for the future."

More information: "Evolutionary flexibility in flooding response circuitry in angiosperms" *Science* (2019). science.sciencemag.org/cgi/doi … 1126/science.aax8862

Provided by University of California - Riverside

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