Gene helps plants use less water without biomass loss

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(PhysOrg.com) -- Purdue University researchers have found a genetic mutation that allows a plant to better endure drought without losing biomass, a discovery that could reduce the amount of water required for growing plants and help plants survive and thrive in adverse conditions.

Plants can naturally control the opening and closing of stomata, pores that take in carbon dioxide and release water. During drought conditions, a plant might close its stomata to conserve water. By doing so, however, the plant also reduces the amount of carbon dioxide it can take in, which limits photosynthesis and growth.

Mike Mickelbart, an assistant professor of horticulture; Mike Hasegawa, a professor of horticulture; and Chal Yul Yoo, a horticulture graduate student, found that a genetic mutation in the research plant Arabidopsis thaliana reduces the number of stomata. But instead of limiting carbon dioxide intake, the gene creates a beneficial equilibrium.

"The plant can only fix so much carbon dioxide. The fewer stomata still allow for the same amount of carbon dioxide intake as a wild type while conserving water," said Mickelbart, whose results were published in the early online version of the journal *The Plant Cell*. "This shows there is potential to reduce transpiration without a yield penalty."

Mickelbart and Yoo used an infrared gas analyzer to determine the amount of carbon dioxide taken in and water lost in the *Arabidopsis* mutant. Carbon dioxide is pumped into a chamber with the plant and the

analyzer measures the amount left after a plant has started to take up the gas. A similar process measures water lost through transpiration, in which water is released from a plant's leaves.

Analysis showed that the plant, which has a mutant form of the gene *GTL1*, did not reduce carbon dioxide intake but did have a 20 percent reduction in transpiration. The plant had the same biomass as a wild type of Arabidopsis when its shoot dry weight was measured.

"The decrease in transpiration leads to increased drought tolerance in the mutant plants," Yoo said. "They will hold more water in their leaves during drought stress."

Of the 20 genes known to control stomata, *SDD1* was highly expressed in the mutant. *SDD1* is a gene that is responsible for regulating the number of stomata on leaves. In the mutant, with *GTL1* not functioning, *SDD1* is highly expressed, which results in the development of fewer stomata.

Mickelbart said the finding is important because it opens the possibility that there is a natural way to improve crop drought tolerance without decreasing biomass or yield. He said the next step in the research is to determine the role of *GTL1* in a crop plant.

More information: The Arabidopsis GTL1 Transcription Factor Regulates Water Use Efficiency and Drought Tolerance by Modulating Stomatal Density Via Transrepression of SDD1, Chan Yul Yoo, Heather E. Pence, Jing Bo Jin, Kenji Miura, Michael J. Gosney, Paul M. Hasegawa and Michael V. Mickelbart, *The Plant Cell*.

Provided by Purdue University