Drought response identified in potential biofuel plant

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Drought resistance is the key to large-scale production of *Jatropha*, a potential biofuel plant—and an international group of scientists has identified the first step toward engineering a hardier variety.

Jatropha has seeds with high oil content. But the oil's potential as a biofuel is limited because, for large-scale production, this shrub-like plant needs the same amount of care and resources as crop plants.

"It is thought that *Jatropha*'s future lies in further improvement of *Jatropha* for large-scale production on marginal, non-food croplands through breeding and/or biotechnology," said John E. Carlson, professor of molecular genetics at Penn State. "The more that is known about the genetic basis of *Jatropha*'s key attributes such as drought tolerance, the more readily *Jatropha* improvement will progress."

According to Carlson, *Jatropha* currently grows best in tropical countries and is already being cultivated as a biofuel on a small scale in India, Southeast Asia and Africa. Breeding a strain that could do well in arid, barren conditions could enable mass cultivation, but large-scale production may still be decades away.

Researchers looked at a little known gene—JcPIP1—because a similar gene in the model plant Arabidopsis is known to play a role in drought response. They also examined JcPIP2, a potential drought response gene in *Jatropha* identified in 2007 by researchers at Sichuan University. They reported their findings today (July 15) in the *Journal of Plant*

Physiology.

The JcPIP genes code for membrane channels called aquaporins, which are responsible for transporting and balancing water throughout the plant, though exactly how each gene affects aquaporin behavior under environmental stress remains unclear. However, researchers have found that JcPIP1 and JcPIP2 are expressed at different times during a stressful situation, which hints at what roles they play in response and recovery.

By growing unmodified *Jatropha* samples in conditions simulating high soil salinity and low water availability, the researchers showed that *Jatropha* was normally more vulnerable and slower to recover from high salinity than from drought conditions.

Using a tobacco mosaic virus to transiently transform *Jatropha*, the researchers created plants in which JcPIP2 or JcPIP1 was temporarily disabled. They subjected the modified samples to six days of stress and six days of recovery. To gauge the plants' stress responses, they noted physical changes and measured root damage, leaf growth, electrolyte leakage in the leaves, and sap flow and volume.

The researchers found that these stress responses were about the same between the two variants under drought conditions. However, plants with JcPIP1 disabled were slower to recover from salt damage.

Analysis of plant parts during the stress and recovery stages showed that JcPIP2 was mostly active in the early stages of stress while JcPIP1 expression was greater during recovery. The timing indicates that JcPIP1 may be crucial in helping *Jatropha* recover from damage while JcPIP2 may play a role in prevention.

How the two genes affect other plant functions remains unknown, and how large a part they play in the entire network of drought resistance relies on further study.

"Plants have complex genetic and biochemical pathways for environmental stress resistance, that includes (multiple) genes and pathways," said Carlson. "This inherent redundancy in stress responses ensures survival under varying environmental conditions, and provides many possible approaches to improving resistance."

According to the research team, the next step is to find how the JcPIP genes work at the cellular level, which can provide more detailed profiles of each gene's exact function.

Provided by Pennsylvania State University

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