Scientists discover a drought tolerance gene that may help plants fight against global warming

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(upper panel) *Arabidopsis* under normal condition is shown; growth of control plant (left) the same as plants (middle and right) with increased ACBP2 protein. (lower panel) *Arabidopsis* under drought conditionis shown; growth of control plant (left) much slower than plants (middle and right) with increased ACBP2 protein. Credit: The University of Hong Kong

Global warming increases the amount of moisture that evaporates from land and water, leading to drought in most parts of the world. In drier regions, evapotranspiration produces periods of drought that lowers the water level in rivers, lakes, and groundwater, and reduces soil moisture in agricultural areas. As global temperature rises, the land mass affected by drought is expected to increase, with potentially devastating consequences for agriculture.

In recent years, scientists have been researching on how to improve drought resistance in plants, so as to enhance growth and productivity of crops in dry weather conditions. A ground breaking technology from the University of Hong Kong (HKU) may provide a solution to this problem on drought stress. The technology, currently with patent pending in different countries, has just been licensed to an internationally recognized agricultural company specializing in the development of new varieties of the oil crops *Camelina sativa*.

The Chye Lab at HKU, funded by the Wilson and Amelia Wong Endowment Fund, has identified a gene from the model plant *Arabidopsis thaliana* which encodes an acyl-CoA-binding protein (ACBP). The gene, designated as ACBP2, can confer drought tolerance in transgenic *Arabidopsis*. Overexpression of ACBP2 (i.e. increase in ACBP2 protein in the plant) in these transgenic lines promoted stomatal closure, reduced water loss and enhanced drought tolerance.

Professor Chye Mee Len, Wilson and Amelia Wong Professor in Plant Biotechnology at the HKU School of Biological Sciences, and her lab members have discovered in the past years that *Arabidopsis* acyl-CoA-binding proteins can confer stress tolerance in transgenic *Arabidopsis* plants. *Arabidopsis* was used as a model plant because it can be easily manipulated in the lab - it has a small genome, a short life cycle and well-developed genetics. Discoveries can be rapidly made in model plants to enable researchers achieve fundamental knowledge for applications in more complex plant species with larger genomes.

Professor Chye said: "Drought stress adversely affects plant growth, and reduces plant yield and food production in agriculture. The stomata, found in leaves and stems, hold the key to water loss in plants and ACBP2 was observed to be expressed in the guard cells which regulate stomatal aperture. ACBP2 was induced by drought and the phytohormone, abscisic acid (ABA) which triggers a pathway in drought protection.

ACBP2-overexpressing plants showed ABA-mediated reactive oxygen species (ROS) production in the guard cells, thereby promoting stomatal closure. In contrast, the acbp2 mutant plants, which had lost ACBP2 function and served as one of the controls in the research, were more sensitive to drought stress. "

Professor Chye further explained: "ACBP2 overexpression up-regulated the expression of Respiratory Burst Oxidase Homolog D (AtrbohD) and AtrbohF, two NAD (P)H oxidases essential for ABA-mediated ROS production, whereas the expression of Hypersensitive to ABA1 (HAB1), an important negative regulator in ABA signalling, was down-regulated. These observations support a positive role for ACBP2 in promoting ABA signalling in the drought response."

The work was published in the journal, *Plant Cell and Environment* (Vol. 36: pages 300-314), in 2013 with Dr Du Zhi-yan from the Chye Lab as the first author. Dr. Du is a named co-inventor on the recent patent application.

The invention has been licensed to Agragen LLC., an internationally recognized agricultural company whose main business is on *Camelina sativa*, a biofuel and biolubricant production crop, for potential applications in oil production and commercialization.

Camelina sativa is known to have a number of advantages over other traditional oil crops, including its wide adaptability to harsh weather conditions, and it has lower fertilizer and pesticide requirements. It can be grown on marginal land, and can be used as a rotation crop with wheat, corn and sorghum. Hence, *Camelina sativa* represents a promising platform in the production of renewable energy, and the use of HKU technologies to generate potentially drought-tolerant *Camelina* varieties will make it even more efficient as a source of biofuel.

The commercialization of this technology was assisted by the HKU Technology Transfer Office, and Versitech Limited, the commercial arm of the University operating on a non-profit making basis to promote technology innovations by HKU researchers.

Provided by University of Hong Kong