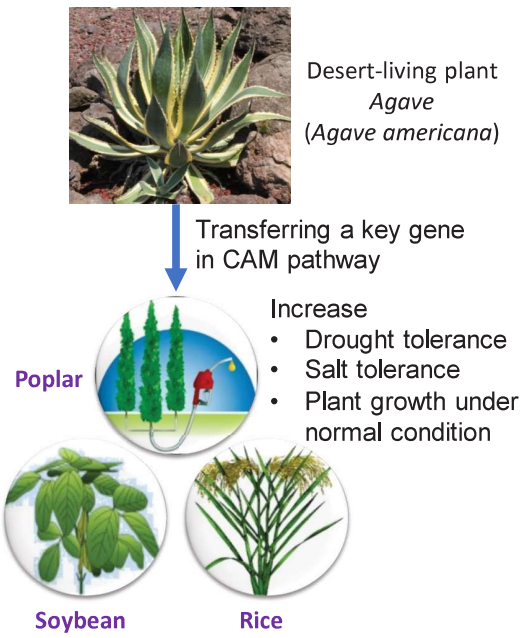
Genetic Improvement of Salt and Drought Tolerance in Crop Plants

Problem: Drought and salt stresses impose big challenges on crop production. To keep American farmers competitive, developments that increase crop tolerance to seasonal drought and salt stresses—and enhance growth under normal conditions—are urgently needed. However, it has been very challenging to simultaneously improve growth, drought tolerance, and salt tolerance in plants, and it is very difficult to find a single solution that achieves improvements in all three areas.

Solution: Crassulacean acid metabolism (CAM), a natural water-use efficiency mechanism that facilitates plant adaptation to water-limited and salinized environments, employs a key CAM gene from the desert-dwelling plant Agave to simultaneously increase biomass yield under normal conditions and resistance to both drought and salt stresses. This technology has been successfully established in model plant tobacco, and it is currently being extended to food crops (e.g., rice, soybean) and bioenergy feedstocks (e.g., poplar). Overexpression of this key gene enhances the expression of multiple genes relevant to CO_2 fixation, consequently improving photosynthetic efficiency and biomass yield, and increases the accumulation of proline, a key player in plant tolerance to drought and salt stresses.



Impact: This technology facilitates the sustainable production of food and bioenergy on marginal lands or under seasonal drought conditions, with potential to generate significant positive impact on the food, bioenergy, landscape, and timber industries, which together represent a combined market opportunity of hundreds of billions of dollars each year. Such markets are essential for our national food, energy, and economic security. In an average year, the world experiences a 50–80% yield loss of crops due primarily to drought and high soil salinity. Application of this technology will help meet the increasing demand for food, biofuel, and animal feed while increasing the competitiveness of the US agricultural industry in an environmentally friendly way.

Xiaohan Yang, PhD
Energy and Environmental Sciences Directorate

Dr. Xiaohan Yang is a senior research staff member in the Biosciences Division at ORNL. He obtained his PhD in horticulture, plant molecular biology, and plant breeding from Cornell University. He has expertise in plant genomics, bioinformatics, and plant synthetic biology. Dr. Yang's research focuses on molecular signaling, plant-gene editing, and plant biosystem design in relation to bioenergy research and plant–microbe interactions. He has published more than 80 journal articles. His research garnered a 2018 R&D 100 award, which is considered the "Oscars" of research and innovation toward commercialization.

Intellectual Property

Gene for enhancing salt and drought tolerance in plants; ID -201804140

BESC-Gene for Enhancing Salt and Drought Tolerance in Plants; 62/797,452

For more information, please contact
Jennifer Tonzello Caldwell, Ph.D.
Group Leader, Technology Commercialization
caldwelljt@ornl.gov
865-574-4180