New plant research discoveries could benefit global agriculture

By Carol Kelly

Research, supported in part by NIEHS, is addressing big questions about plant growth, and offers potential solutions for meeting increased agricultural demand, globally.

An international group of scientists, led by Julian Schroeder, Ph.D., *(http://biology.ucsd.edu/faculty/schroeder.html)* professor of cell and developmental biology and NIEHS Superfund Research Program (SRP) grantee at the University of California, San Diego (UCSD), has discovered important properties about the ways plants grow and upload nutrients, which could beneficially affect global agriculture.

The discoveries, *(http://www.ncbi.nlm.nih.gov/pubmed/23636397)* published May 2 in Nature, centered on transport proteins within plant cell membranes. Transport processes are crucial, enabling plants to survive environmental stresses, including those anticipated to result from global climate change. With improved transporters, plants can better resist toxic metals and pests, increase salt and drought tolerance, control water loss, and expand energy storage.

One project in Schroeder's interdisciplinary lab focuses on identifying genes that mediate sodium stress and drought resistance, and heavy metal uptake and detoxification in plants. (Photo courtesy of Julian Schroeder)

"Many recent plant discoveries around the world have previously been under the radar — known only to a small group of plant biologists — but, by disseminating these findings widely, we hope to educate policymakers and speed the eventual application of recent discoveries," said Schroeder.

Addressing food deficiencies

Implications from the new research for increasing the supply of food include enhanced staple crop yields, increased nutrient content, and improved tolerance to unfavorable soil conditions, which could mean farming on previously unusable or marginally useable land. With the global population expected to reach 9 billion by 2050, improving nutritious and sustainable food production is essential for human and environmental health, according to the U.K. Government Office for Science Foresight project Global Food and Farming Futures final report. *(http://www.bis.gov.uk/assets/foresight/docs/food-and-farming/11-546-future-of-food-and-farming-report.pdf)*

Along with analyzing plant iron content to search for mutants that can more readily absorb iron, Guerinot researches harmful metal uptake in edible plants, such as arsenic and cadmium in rice. (Photo courtesy of Dartmouth College)

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Schroeder discovered a sodium transporter, named HKT1, which plays a key role in protecting plants from soil salinity stress, a contributor to major crop losses. In field trials using durum wheat, a staple commercial grain crop, agricultural scientists found that a particularly active member of this HKT1 transporter family removed excess sodium from plant leaves. As a result, crop yields were boosted by 25 percent.

"Saline soils are causing increasing losses in agriculture yields globally," said Schroeder. "More fundamental knowledge and basic discovery research is needed, and would enable us to fully exploit these advances and pursue new promising avenues of plant improvement, in light of food and energy demands and the need for sustainable yield gains."

Plants are the major point of entry for essential nutrients into the food chain, and the work of collaborator Mary Lou Guerinot, Ph.D., *(http://www.dartmouth.edu/~guerinot/LAB_/Mary_Lou_Guerinot.html)* a molecular geneticist, contributes to understanding how plants absorb and distribute essential metals, such as iron, and toxins, such as arsenic (see story). In conjunction with SRP research at Dartmouth College, Guerinot's work is laying the foundation for crops, particularly rice, that have higher micronutrient levels and offer safer, sustainable solutions for malnutrition.

More than two billion people worldwide are malnourished and have diets with deficiencies in essential nutritional minerals, such as iron and zinc, according to the paper's authors.

Investigating toxicant accumulation in plants

The UCSD SRP is also working to determine the molecular mechanisms by which plants accumulate toxicants. They are investigating the potential for phytoremediation, a process in which green plants are intentionally chosen for planting in certain areas, based on their ability to uptake harmful chemicals from contaminated land. Schroeder's lab collected and is analyzing plant samples from a brownfield site owned by the Jacobs Center for Neighborhood Innovation in southeastern San Diego. A brownfield site is land for which redevelopment or reuse may be complicated by the presence, or potential presence, of a hazardous substance, pollutant, or contaminant.

"This research will help us avoid accumulation that harms crop plants, but also enhance bioremediation through noncrop plants that do accumulate toxicants," said Schroeder.

Citation: Schroeder JI, Delhaize E, Frommer WB, Guerinot ML, Harrison MJ, Herrera-Estrella L, Horie T, Kochian LV, Munns R, Nishizawa NK, Tsay YF, Sanders D. *(http://www.ncbi.nlm.nih.gov/pubmed/23636397)* 2013. Using membrane transporters to improve crops for sustainable food production. Nature 497(7447):60-66.

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The Jacobs brownfield site, shown above, is in a community where exposure to toxicants in land and water is a concern. Investigators in the UCSD SRP hope to identify plants that could help clean up the contaminated land. (Photo courtesy of UCSD)