Plants under heat stress must act surprisingly quickly to survive

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In new results reported in *The Plant Cell*, molecular biologist Elizabeth Vierling at the University of Massachusetts Amherst and colleagues in India and China report finding a crucial mechanism that plants need to recover from heat stress.

She points out that high temperature damage to crops is increasing with climate change, and uncovering mechanisms of heat tolerance are important not only as basic knowledge, but for possible future attempts to enhance plants' ability to survive high temperatures.

She says, "One of our most interesting findings is the fact that stressed plants not only need to produce new proteins to survive the stress, they need to make them right away. We found that a delay of even six hours of new protein translation will inhibit optimal growth and reproduction. The plants might not outright die, but they are severely impaired without the rapid synthesis of these new proteins." This dramatic time sensitivity of protein translation was not known before, she adds.

"Plants can't move to avoid unfavorable growth conditions such as insufficient water availability or extremes of temperature," Vierling explains. "When confronted with stressful environmental conditions, you may not see any changes, but in order to survive plants are busily responding, often by synthesizing new proteins in a process called translation."

She adds, "Proteins are major workhorses in all cells. They help capture

light for photosynthesis or act as enzymes to produce the sugars in fruits or the components of wood. In unfavorable environments, whole new sets of proteins can be made that provide plants with the ability to counteract stress."

Vierling, who is a Distinguished Professor in the biochemistry and molecular biology department, explains that she and colleagues at the China Agricultural University, Beijing, and the National Research Centre on Plant Biotechnology, Delhi, India, used biochemical and next-generation sequencing methods to examine changes in protein translation and gene expression in wild type Arabidopsis plants and in mutants that have lost their ability to survive high temperatures.

They found that the mutated gene specifies a "translation factor," that is, a protein required by all organisms including humans, to synthesize other proteins. "So we found out more about the general, universal process of protein translation. Ours is the first study of this type investigating this aspect of protein synthesis. It was significant to find that this translation factor is needed for recovery of plants from stress, and that it may have a previously unrecognized role in translating specific proteins."

The protein encoded by the mutated gene, a translation initiation factor called eIF5B, was already known, the biochemist says, but she and colleagues discovered a potential new role for it.

They write, "Through studies in Arabidopsis of a temperature-sensitive allele of eIF5B1 (hot3-1), we demonstrate that restoring translation immediately following heat stress is critical to stress recovery. In addition, translational profiling of a more severe allele (hot3-2) under optimal growth temperatures demonstrates that eIF5B1 is essential for normal growth and development in plants and further suggests that eIF5B may differentially affect translation of specific mRNAs."

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Provided by University of Massachusetts Amherst

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