Researchers look at reducing yield loss for crops under stress

March 30 2010

People feel it, animals feel it, and yes, plants sense it too. It's stress.

Plant researchers are taking a long look at stress in order to improve crop productivity, especially when faced with issues of climate change.

"Imagine what a plant goes through when it hasn't rained for over a week and it's feeling dry - its leaves are wilting," says Stephen Howell, professor of genetics, development and cell biology at Iowa State University's Plant Sciences Institute. "Add in some strong afternoon sunshine with no option to move into the shade because its roots are planted in the ground. That's stress. And the plant has got to stand there and deal with it!"

Understanding and eventually curbing crop susceptibility to certain stresses could allow for higher yields during drought years in the agricultural areas of the world. It may also allow drier areas of the planet to support sustainable yields and profitable crops, according to Howell.

Howell studies the model plant system *Arabidopsis*, a relative of mustard, with the long-term goal of applying discoveries to crop plants. He, along with postdoctoral researcher Jian-Xiang Liu, recently released research that outlines new features about plant stress response mechanisms in *Arabidopsis*. The research is highlighted in the March 5 issue of The *Plant Cell*.

"The system protects plants from adverse environmental conditions, but

these responses slow or delay growth," explains Howell. "So there's a tradeoff."

Plants respond to different types of stress, such as salt or heat, through multifaceted molecular signaling pathways. Understanding these pathways -- identifying the key molecules and their specific roles -- provides a treasure trove of opportunity for molecular breeding approaches to enhance the ability of crop plants to survive stressful conditions without major yield loss.

Howell and his colleagues have determined how special molecular indicators stationed inside the cell, but outside the nucleus, respond when stress warning bells go off. These sensors pick up on cues that appear as misfolded proteins.

These misfolded proteins are recognized as untidy. Much like a meticulous housekeeper would realize something was wrong if he or she discovered heaps of unfolded clothes in the closet, according to Howell.

"Correct folding is very important to the function of a protein. Incorrectly folded proteins or unfolded proteins will malfunction," says Howell. "But protein folding is a very finicky process and can mess up when environmental conditions are bad, as during a period of intense heat. Under these conditions, unfolded proteins accumulate and alarm bells are set off in the plant cell."

When these alarm bells go off inside the plant cell, the sensor molecules, called molecular-associated transcription factors, are unleashed. They enter the cell's nucleus -- its command center -- and turn on specific genes that send out reinforcements to help the protein-folding process.

In the research, Howell and his colleagues reveal how these transcription factors find and activate their target genes. When coupled with a

previous study from this group, the paper describes how there are actually two sets of factors involved. One set specializes in activating genes in response to salt stress. The factor in this study responds to heat stress and the accumulation of unfolded proteins. Together they help plants withstand a variety of stresses.

Provided by Iowa State University