Ethanol helps plants better tolerate heat stress

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A dose of ethanol, better known as common alcohol, can enable plants to

withstand heat stress that might otherwise kill them, RIKEN biologists have found. This could offer a low-cost way to make crops more resilient to the effects of climate change.

Global warming is increasing the risk of heat-related yield losses in agricultural crops worldwide. Discovering methods to reduce these losses could help protect the sustainability of agriculture.

Genetic engineering is a powerful technique to achieve this, but there is also a great need for lower-tech solutions that are easier and cheaper to implement. "We need to develop novel, simple and less expensive technologies because genetically modified plants are not readily available in all countries," notes Motoaki Seki of the RIKEN Center for Sustainable Resource Science.

Pre-treating crops with safe chemical compounds is a promising approach for realizing this. Scientists are exploring this approach by investigating the ability of a variety of chemicals to make plants more tolerant of environmental stresses.

Now, Seki and his co-workers have found that simply applying ethanol to plants prior to heat exposure can make them more tolerant to heat. "External application of ethanol could be a simple, cheap and effective way to enhance heat tolerance in a variety of plants," Seki says.

The team exposed lettuce and thale cress to a low concentration of ethanol in their soil for several days. Treated and untreated control plants were then briefly grown at temperatures high enough to induce heat stress. Only 10% of the untreated plants survived the heat stress, whereas up to 70% of the treated plants survived, indicating a very significant benefit from the ethanol.

The researchers also gained clues about the molecular mechanisms

behind the effect. They identified a set of genes and biochemical processes activated by the ethanol treatment.

One feature of the response is increased production of a protein called Binding Protein-3, which is involved in stress adaptation in an organelle called the endoplasmic reticulum. This stress response is known as the unfolded protein response, as it mitigates the effects of misfolding of proteins that can occur during environmental stress.

Seki and his team intend to glean further insights into the mechanism. "Although we found the unfolded-protein response is involved, we now need to undertake further studies to reveal the undiscovered aspects of the ethanol-mediated network for environmental stress adaptation," says Seki. Learning more about the mechanism could reveal ways to enhance the protective effect and perhaps fine-tune it to benefit a wider range of species.

The study is published in *Plant Molecular Biology*.

More information: Akihiro Matsui et al, Ethanol induces heat tolerance in plants by stimulating unfolded protein response, *Plant Molecular Biology* (2022). DOI: 10.1007/s11103-022-01291-8

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