PRESS RELEASE

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Thermal priming enhances heat tolerance and yield in tomatoes after recurrent heat stress

Tomatoes can prepare for recurrent heat stress. Researchers at the Leibniz Institute for Horticultural Sciences (IGZ) have shown, under both controlled and field conditions, that moderate heat stress improves the response of tomato plants to subsequent heat stress and can significantly increase fruit yield. The team also identified key molecular regulators of thermal stress memory in a study published in '*The Plant Journal*'.

High temperatures can significantly impair the growth and yield of crops, including tomato. A new study by an international research team led by Dr Justyna Olas (IGZ) has now shown that tomatoes can respond better to subsequent heat stress following moderate heat exposure. Thermal priming reprograms plants in response to an initial moderate heat stress, allowing them to retain a memory of the stress event for several days and to respond more rapidly and effectively to subsequent heat stress.

The researchers initially studied tomato plants of the 'Moneymaker' cultivar under controlled conditions. Following moderate heat exposure, the plants were subjected to severe recurrent heat stress several days later. While non-primed plants suffered substantial damage, plants previously exposed to moderate heat were better able to withstand the stress. The protective effect of 'priming' lasted longer than in the model plant Arabidopsis thaliana: a measurable protective effect was still present after a ten-day interval between the initial heat exposure and the recurrent heat stress. However, this effect decreased as the memory phase became longer and was no longer detectable after 20 days. The study therefore shows that the duration of thermal memory differs between plant species.

The subsequent effect on productivity is particularly relevant for horticulture. Under controlled conditions, plants exposed to moderate heat and subsequently subjected to recurrent severe heat stress produced, on average, 41 per cent more fruit than non-heat-stressed control plants. Total fruit mass was also higher, suggesting that thermal primed plants after recurring heat stress produced higher yield. Analyses of β-carotene and lutein as quality markers likewise showed no significant differences, indicating that the fruit quality is not affected.

The effect was also observed under uncontrolled environmental conditions. In a field experiment conducted in 2025 in Großbeeren, plants that were initially exposed to moderate heat and subsequently subjected to recurrent heat stress produced around 53 per cent more fruit than non-heat-stressed control plants. Total fruit mass was also higher. As temperature, light and humidity varied during the experiment and the field experiment was conducted only once, the results do not yet allow conclusions to be drawn about the effects of such treatment under different practical conditions. However, the results suggest that thermal 'priming' may represent a promising strategy for increasing fruit production under field conditions following recurrent heat stress.

The researchers also investigated the response of tomato plants to recurrent heat stress at the molecular level. Using RNA-sequencing of the shoot apical meristem tissue, they identified 267 genes that were particularly strongly activated following the initial heat stress and during subsequent heat stress. These so-called type II genes of transcriptional thermal memory include *SlBAG6* and *SlHSFA2*, a transcription factor which plays a central role in the thermal memory response.

In CRISPR-modified tomato plants lacking functional SlHSFA2, the ability to undergo thermal 'priming' was largely lost. Recovery of the shoot apical meristem following recurrent heat stress was

also impaired. Further analyses showed that SlHSFA2 regulates the activation of the SlBAG6 gene. In addition, SlHSFA2 interacts with other transcription factors, the ETHYLENE RESPONSE FACTORs (SlERFs), which together with SlHSFA2 enhance the activation of *SlBAG6*. When individual SlERFs were temporarily silenced, heat tolerance was reduced. The results therefore point to a regulatory module involving SlHSFA2-SlERF that contributes to transcriptional thermal memory.

The findings show that thermal stress memory can also have an adaptive function in an important horticultural crop and provide a basis for further research into, and possible use of, this mechanism in the development of heat-resilient tomatoes. However, it is not yet clear how the molecular stress-memory response ultimately contributes to increased yield.

Original publication

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Further Information

- Research group 'Stress and Developmental Integration' (SDI): https://igzev.de/en/research/research-groups/sdi
- Project profile: https://igzev.de/en/research/projects/93/ol-7671-1

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Leibniz Institute for Horticultural Sciences (IGZ)

The Leibniz Institute for Horticultural Sciences (IGZ), formerly the Leibniz Institute of Vegetable and Ornamental Crops, is a Leibniz Association research institute. It contributes to solving current global challenges by providing science-based findings from basic and applied horticultural research. These include the preservation of biodiversity, combating climate change and the still widespread malnutrition. The institute is jointly funded by the Ministry of Science, Research and Culture of the State of Brandenburg (MWFK) and the Federal Ministry of Agriculture, Food and Regional Identity (BMLEH). The IGZ is based in Großbeeren.

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