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Heat priming boosts tomato yields by up to 53% under recurrent heat stress, study finds

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Research led by Germanyâ??s Leibniz Institute for Horticultural Sciences finds that moderate heat exposure can help tomato plants withstand subsequent heatwaves, with implications for climate-resilient horticulture



Moderate heat exposure could help tomato plants better withstand subsequent periods of extreme temperatures and improve fruit production, according to a new study led by Dr Justyna Olas at the Leibniz Institute for Horticultural Sciences (IGZ) in Germany.

Published in The Plant Journal, the research shows that a process known as thermal priming can activate a plant's stress-response mechanisms, enabling it to respond more effectively to recurring heat stress. The findings suggest a potential route to improving tomato resilience as rising temperatures increasingly threaten horticultural productivity.

The international research team initially tested the approach on tomato plants of the 'Moneymaker' cultivar under controlled conditions. Plants exposed to moderate heat before experiencing severe heat stress sustained less damage than plants that had not undergone the initial exposure.

The protective effect persisted for up to 10 days after the initial heat treatment, although it weakened over time and was no longer detectable after 20 days. This suggests that the duration of heat-stress memory varies across plant species and could influence how the approach is applied in crop production.

The yield results were particularly notable. Under controlled conditions, thermally primed plants subjected to recurrent severe heat stress produced an average of 41 per cent more fruit than non-heat-stressed control plants. Total fruit mass was also higher, while measurements of ?-carotene and lutein showed no significant differences, suggesting that the treatment did not

compromise these fruit-quality markers.

The researchers also observed a similar response in a field experiment conducted in 2025 in Großbeeren, Germany. Plants that received an initial moderate heat treatment before recurrent heat stress produced around 53 per cent more fruit than non-heat-stressed control plants, with higher total fruit mass.

However, the field findings require further validation. The experiment was conducted only once under variable temperature, light and humidity conditions, limiting the conclusions that can be drawn about the treatment's effectiveness across different production environments.

Beyond measuring plant performance, the researchers investigated the molecular mechanisms underlying thermal memory. RNA sequencing of shoot apical meristem tissue identified 267 genes strongly activated during the initial and subsequent heat-stress responses.

Among these were SlBAG6 and SlHSFA2, a gene encoding a transcription factor central to the plant's thermal-memory response. Experiments using CRISPR-modified tomato plants lacking functional SlHSFA2 showed that the ability to benefit from thermal priming was largely lost. Recovery of the shoot apical meristem following recurrent heat stress was also impaired.

Further analysis indicated that SlHSFA2 regulates the activation of SlBAG6 and interacts with ethylene response factors (SlERFs), which work alongside SlHSFA2 to strengthen SlBAG6 activation. Temporarily silencing individual SlERFs also reduced heat tolerance, pointing to a regulatory network that helps tomato plants retain and use a molecular memory of previous heat exposure.

The findings establish a link between thermal stress memory and crop performance, although the precise mechanisms connecting the molecular response to higher yields remain unresolved.

For horticulture, thermal priming offers a potential avenue for developing heat-resilient tomato production systems. Further research will be needed to establish the optimal treatment conditions, the duration of protection under commercial growing environments and the consistency of yield benefits across cultivars and locations.

While the results are promising, the approach remains at the research stage. Its practical value will depend on whether the benefits can be reproduced reliably under diverse field conditions and translated into manageable crop-production practices.