Korea researchers discover a molecular switch protecting crops from freezing cold

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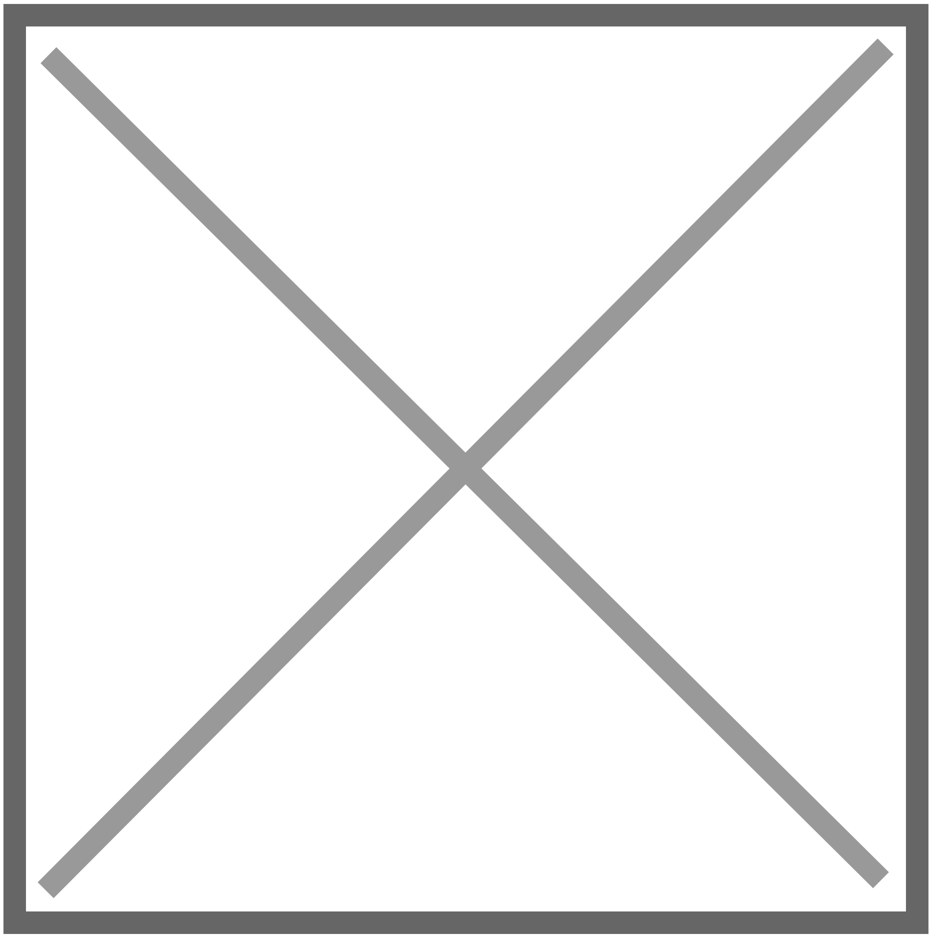
A research team from Korea have uncovered how plants rapidly activate a hidden genetic "switch" helping them survive in cold environments. They demonstrate that low temperatures induce a rewiring of a hormone signaling pathway, triggering the breakdown of auxin/indole acetic acid repressors, releasing ARF7 and ARF19 to activate the master geneÂ*CRF3*, helping plants survive the cold. This offers a new path to breeding crops that remain productive even under unpredictable climate conditions.

The onset of sudden cold spells can threaten plant survival, especially during early growth phases. But how do plants detect low temperatures fast enough to initiate life-saving changes? Researchers at Chonnam National University have identified a hidden molecular "off-switch" that quickly reprograms root development to withstand the adverse cold conditions.

The study was led by Professor Jungmook Kim, Department of Bioenergy Science and Technology at Chonnam National University, working with researchers Uyen Thu Nguyen, Na Young Kang, and Dr. Dong Wook Lee, also from CNU.



A new study from Chonnam National University reveals how cold stress rapidly degrades auxin/indole acetic acid proteins, releasing ARF7/19 to activate CRF genes and remodel plant roots for improved survival in adverse cold conditions.

The team discovered that cold stress triggers the rapid degradation of auxin/indole acetic acid (Aux/IAA) proteins, which normally suppress growth-related gene activation. Once these repressors break down, key regulators ARF7 and ARF19 are released, enabling them to activate cytokinin response factor 3 *(CRF3)*, a master regulator that reshapes root architecture to cope with cold conditions.

"Cold stress doesn't simply slow plant growthâ??it actively rewires hormone signaling to adapt root development," says Prof. Kim.

The study also reveals that cold conditions activate cytokinin signaling to induce *CRF2*, which works together with *CRF3*. The two genes act as integrators, combining environmental cues with internal hormone signals to fine-tune lateral root initiation under stress. This also established that auxin and cytokinin pathways converge at *CRF*s, forming a unified cold-response module.

"Plants survive because they integrate external stress with internal developmental programs," Prof. Kim added. "We have identified one of the key switches enabling that integration."

The findings highlight opportunities to protect crops from rising climate instability. By enhancing *CRF2/CRF3* signaling or stabilizing ARF activity via targeted degradation of Aux/IAAs, scientists could develop crops that maintain stable root growth in cold soils. Such varieties would improve early-season growth establishment, increase nutrient uptake efficiency, and support sustainable agriculture with reduced fertilizer use. The study also highlights the potential for the development of synthetic molecules or biostimulants that could protect seedlings during unexpected spells of extreme cold.

Over the next decade, this molecular pathway may help enable crop cultivation in harsher climates, and serve as a foundation for precision breeding and CRISPR-based engineering of climate-resilient crops.