Unexpected activity of metabolic compound helps decode plants' language of light

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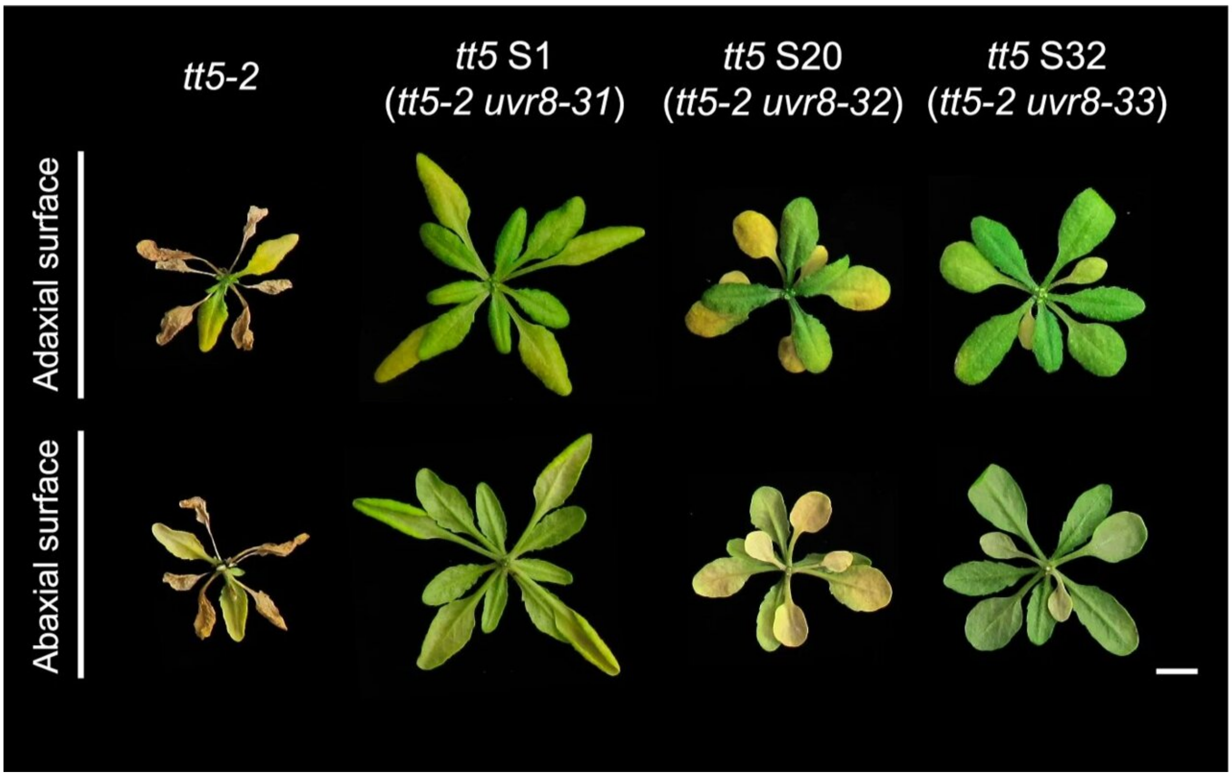

By growing arabidopsis mutants under high light conditions, researchers were able to identifiy a mutation for a specific gene called UVR8. Credit: MSU Grotewold Lab

Researchers have revealed a previously unknown way plants shape their growth in response to light—a breakthrough that could better equip crops to handle environmental stress.

In a first-of-its-kind finding, the team discovered how a compound involved in plant metabolism can actually "reprogram" an unrelated light-sensing protein.

This unexpected interaction, reported in the journal *Nature Communications*, is an exciting step toward more fully understanding plant physiology.

"In the future, this mechanism could be exploited to fine-tune plant growth, development and stress responses," said Erich Grotewold, a Michigan State University Research Foundation Professor and an author of the latest study.

"This could lead to crops with improved tolerance to light stress and more efficient use of light energy, without relying solely on environmental modifications," he added.

As much as plants need their sunshine, there can always be too much of a good thing. In fact, harsh light can lead to damage similar to a sunburn.

To shield themselves, plants produce a variety of natural "sunscreen" molecules called flavonoids and pigments. Like similar specialized molecules that defend against pests or attract pollinators, these compounds give plants an evolutionary edge in their environment.

Originally, Grotewold and his team were examining mutant variants of the model plant Arabidopsis that couldn't produce an important flavonoid enzyme. During their experiments, the researchers noticed that one type of mutant had serious growth problems when exposed to a certain kind of light—even though wild type specimens and other mutants appeared healthy under the same conditions.

They discovered the culprit was a compound called naringenin chalcone, or NGC.

Usually, this molecule is produced as part of the metabolic process that creates flavonoids. However, because the mutant was missing a key enzyme along that pathway, NGC began building up in the plant's cells.

Once they knew which molecular component was causing these growth defects, the team turned their attention to the bigger biochemical mystery: Exactly why?

By creating thousands of varied Arabidopsis mutants and raising them under stressful light conditions, the scientists were able to identify a handful of plants that appeared to grow without defects. The one element these successful specimens had in common was a mutation for a specific gene called UVR8, a protein that usually senses UV light.

Through a series of biochemical experiments, Grotewold's lab revealed that NGC physically interacts and "reprograms" UVR8, activating it to send growth-regulating signals even without the presence of UV light.

Until now, such a link wasn't known to be possible.

"We were surprised to discover that naringenin chalcone, a metabolic intermediate, could directly modulate the function of a light-sensing protein like UVR8," explained Nan Jiang, the study's lead author and a former Grotewold Group researcher who is now assistant professor at the University of Hawai'i at Mānoa.

"This kind of cross-talk between specialized metabolism and photoreceptor signaling opens up an entirely new way of thinking about how plants integrate metabolic status with environmental perception."

In plant physiology, you might think of UVR8 as an actor in a play and NGC as a backstage crewmember. NGC helps keep the show running smoothly, while UVR8 only responds to a specific cue—a particular sort of light called UV-B.

With these findings, it appeared that the backstage crew member was suddenly directing the star of the production.

As luck would have, Grotewold didn't have to look far to learn more about UVR8. Just down the hall in MSU's Department of Biochemistry and Molecular Biology was colleague Robert Last, who years earlier had isolated the protein for the very first time.

"Two decades ago, UVR8 was the last type of photoreceptor in plants we didn't know about—a photoreceptor for ultraviolet-B light," said Last, a University Distinguished Professor. "To see this new, unexpected interaction is wild and cool."

The team's latest discoveries are reshaping what we know of the complex chemical choreography that occurs between a plant's light-sensing machinery and its own growth.

As for the purpose of this surprising molecular relationship, Grotewold sees it as a way for plants to more effectively fold light signaling into their development.

"If you treat a plant with UV light and nothing else, it's nearly lethal—but if you increase that UV intensity by a hundred times in the context of white light, the plant knows exactly how to deal with it," Grotewold explained. "That's what we think NGC is doing—helping integrate light signaling with developmental signaling."

Looking ahead, these discoveries are helping expand the horizon for light-focused plant modification. By modifying a plant's ability to sense light and produce specific compounds, crops could be made to grow more efficiently in low-light or harsh environments, or even better respond to harmful pathogens.

"This work reveals a novel layer of regulatory complexity," Jiang said. "It suggests that plants can use small molecules not just as end-products or defense compounds, but also as signaling messengers that fine-tune key physiological responses like growth and development."

More information: Nan Jiang et al, Flavonoid pathway intermediates implicate UVR8 in functions beyond canonical UV-B signaling, *Nature Communications* (2025). DOI: 10.1038/s41467-025-63010-3

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