'Molecular memory' of light exposure helps plants to remember daylight during winter nights

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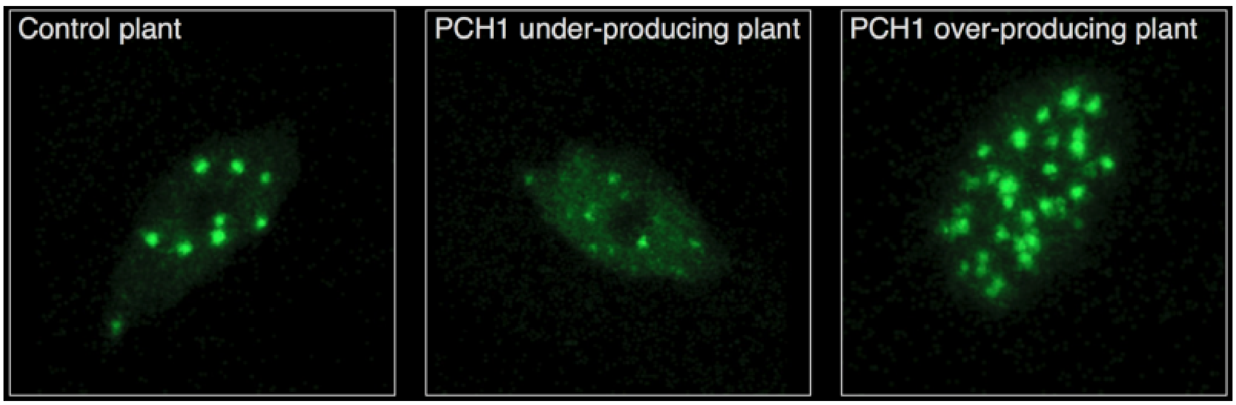

Altering PCH1 levels changes the size and number of photoreceptor -- containing photobodies four hours after dusk in plants. Credit: Meng Chen from the University of California, Riverside.

Dmitri A. Nusinow, Ph.D., assistant member at the Danforth Plant Science Center and researchers in his lab studying plants' circadian clock have discovered a gene that allows plants to remember daylight during the long nights of winter, helping them tailor their growth appropriately to the seasons. The gene, PCH1 accumulates at dusk and stabilizes light signals in the early hours of the night, keeping the plant from growing too much during extended dark periods.

The findings were published today in a paper titled, "PCH1 integrates circadian and light-signaling pathways to control photoperiod-responsive growth in Arabidopsis," by lead author He Huang, post-doctoral associate and senior author, Nusinow in the open access journal *eLife*. Nusinow and his team discovered PCH1 in the model plant Arabidopsis, but found that other plants, including rice, have the same gene.

Plants respond to seasonal change in day length by flowering and changing growth patterns. Dawn can occur anywhere from eight hours after dusk in the long days of summer to sixteen hours after dusk in winter and plants have to adapt to seasonal changes in day length to time their growth properly. PCH1 serves as a "molecular memory" of the light plants absorb during the day, delaying the start of growth during long nights. Without PCH1, plants grow more than is ideal during long nights, making a spindly plant that is not as sturdy as those with PCH1.

"Our goal is to manipulate PCH1 in crops to extend the range of latitudes—which have different lengths of day over the growing season—where crops are grown effectively," said Nusinow. "The plants we study are not growing during the day, because they are concentrated on photosynthesis; instead, they grow fastest in the hours just before dawn."

In humans and other animals, light signals perceived in the eye train a master clock in the brain, which coordinates the daily cycles of many bodily processes. "In plants it's a much more intimate system where every cell is affected," said Nusinow. Without a central nervous system, the coordinated response to day length and seasonal changes across the whole plant rely on each cell training itself to the sun. These behaviors include photosynthesis, flowering and growth.

Next the Nusinow lab wants to determine if PCH1 behaves the same in crop species such as soybean, with the goal of making it easier to adapt different crops to grow best at any latitude. As a warming climate changes the temperature—but not the day length—at higher latitudes, this kind of adaptation may prove useful for keeping crops productive.

"As much as global warming will affect climate, it will never change the angle of the sun," Nusinow stated.

More information: PCH1 integrates circadian and light-signaling pathways to control photoperiod-responsive growth in Arabidopsis, dx.doi.org/10.7554/eLife.13292 , elifesciences.org/content/5/e13292

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