KYUSHU UNIVERSITY

Public Relations Office, Kyushu University
744 Motooka Nishi-ku Fukuoka, 819-0395
TEL:092-802-2130 FAX:092-802-2139
MAIL:koho@jimu.kyushu-u.ac.jp
URL:http://www.kyushu-u.ac.jp

PRESS RELEASE（2017/08/XX）

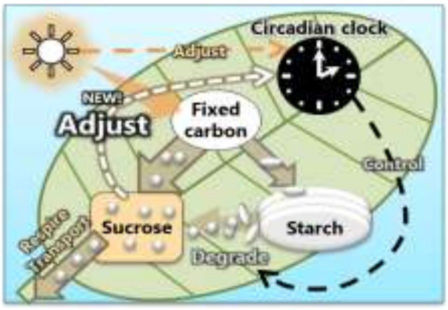
Plants have flexible clock enabling nutrient homeostasis—Mutual feedback model between starch metabolism and circadian oscillator

An international team of researchers, led by Dr Akiko Satake (Kyushu University) and featuring partners from the University of Cambridge, UK (Professor Alex Webb) and the Centre for Plant Bioethanol Technology, CTBE, Brazil (Dr Camila Caldana) have uncovered that plant circadian clocks are more flexible than previously thought. This was found to be very important for plants to provide the fuel for their cells to survive the dark of the night.

Like humans, plants have a 24 h internal circadian clock set by the time of dawn. For plants, that capture the light energy of the sun to turn carbon into sugars, the daily timing of the production and storage of sugars must be tightly controlled, in part by the 24 h circadian clock. A challenge for plants is to survive the dark of the night when they cannot produce sugars by photosynthesis. Their solution is to store some of the sugars produced during the day and then breakdown them down at night to provide a continued supply of fuel to power the plant's cells. In many plants, the sugar is stored as insoluble starch granules that accumulate in the chloroplast during the day and are broken down at night to provide glucose as cellular fuel. Storing too little starch will lead to sugar deficiency during night, while storing too much starch will impair plant growth during the day, raising the problem of optimal control. The problem is even more difficult as the daylength changes seasonally. The mechanism behind this efficient and flexible carbon allocation is much investigated and different theories of how this occurs abound. Dr Satake's team developed a mathematical model of starch metabolism that incorporated the circadian clock, light, and sucrose as a representative of soluble sugars that fuel the cell (Fig. 1). The phase of the clock is adjusted when dawn and dusk is sensed, similar to a human adjusting to a new time zone. The model found light regulation of the circadian clock was not enough to explain the timing of starch accumulation and consumption. Satake's team made a breakthrough when they discovered that the circadian clock shifted the timing of starch degradation in response to the levels of sucrose, a measure of the cell's fuel levels. Professor Webb's team tested predictions of the model using Arabidopsis mutants whose circadian clock is unresponsive to sucrose signals. The mutants accumulated and consumed starch in a 24-hour cycle since they had a circadian clock sensitive to the light signal. However, as predicted by the model, they could not flexibly control the starch accumulation activity, resulting in the excessive starch storage in a long summer days (Fig. 2).

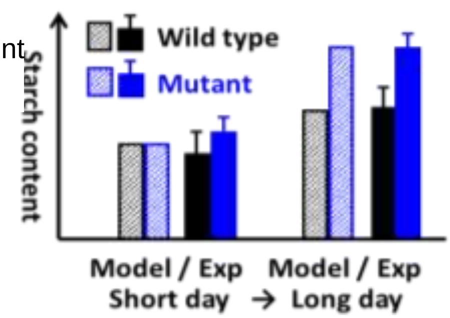
The present study focusing on diel starch metabolism provided a fresh perspective that the plant circadian clock is not a passive timer, instead it dynamically resets through the day responding to metabolic signals generated by the plant. For more information, see https://doi.org/10.1038/s41598-017-08325-y.

Motohide Seki, Takayuki Ohara, Timothy Hearn, Alexander Frank, Viviane da Silva, Camila Caldana, Alex Webb & Akiko Satake: “Adjustment of the Arabidopsis circadian oscillator by sugar signalling dictates the regulation of starch metabolism.” *Scientific Reports* http://www.nature.com/articles/s41598-017-08325-yX.



« (Fig. 1)
Schematic of the present starch metabolism model.

(Fig. 2) »
Model predictions and experimental results on the amount of stored starch.



【Contact】
Akiko Satake, Associate Professor
Department of Biology, Faculty of Science