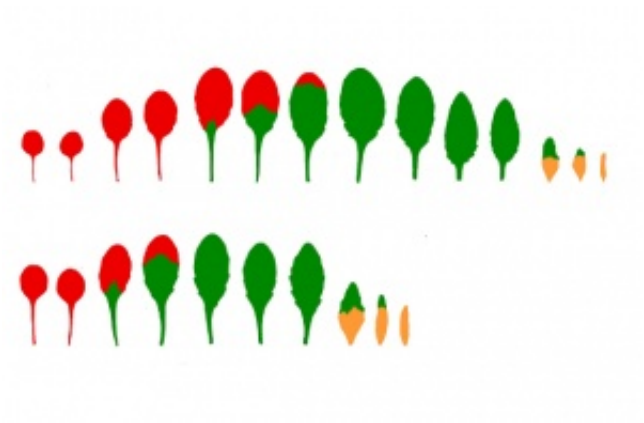
Sugar triggers plants to mature to adulthood, biologists find

March 28 2013



A normal Arabidopsis plant (top) takes longer to mature than one with mutant microRNAs (bottom).

(Phys.org) —Like animals, plants go through several stages of development before they reach maturity. It has long been thought that some of the transitions between these stages are triggered by changes in the nutritional status of the plant. Now, based on experiments with the plant Arabidopsis thaliana, a team of researchers from the University of Pennsylvania Department of Biology has provided fresh insights into the role of sugar in "vegetative phase change," the transition from the juvenile form of a plant to the adult plant.

"It has been known for a long time that mineral nutrients and sugars can affect plant growth, but it has been unclear until now if they trigger

developmental transitions," said Scott Poethig, a biology professor at Penn and senior author on the paper, which was published online yesterday in the open-access journal *eLife*.

The research was led by Penn graduate student Li Yang, and other co-authors included postdoctoral researchers Mingli Xu and Yeonjong Koo and graduate student Jia He.

The new work takes advantage of the fact that vegetative phase change is controlled by two genes that encode microRNAs, or miRNAs. Arabidopsis has eight miR156 genes, but the Penn team confirmed that supplying plants with sugar reduces the expression of just two of these—miR156A and miR156C—while sugar deprivation increases their expression. They found that removing leaves also leads to upregulation of both genes and delays the juvenile–to–adult transition.

Given that this effect can be partially reversed by providing the plant with sugar, it is likely that sugar produced in the leaves, or one of its metabolites, is the signal that triggers the juvenile–to–adult transition through the reduction of miR156 levels.

Consistent with this idea, Poethig and colleagues revealed that plants genetically engineered to be deficient in chlorophyll showed elevated levels of miR156 and a delayed transition to the adult form. In addition, the researchers showed that a gene called HXK1, which encodes a glucose signaling protein, helps to keep plants in the juvenile form under conditions of low sugar availability.

HXK1 also contributes to the glucose-induced decrease in miR156 levels and does so, at least in part, by regulating the transcription of miR156A and miR156C genes into messenger RNA. HXK1 is not solely responsible for the juvenile–to–adult transition, however, because plants that lack this protein are only slightly precocious in their transition to the

adult form.

"Our results are significant because they demonstrates that nutrition is important for developmental maturation in plants—the switch from juvenile to adult development—just as it is in animals, including humans."

In other words, just as fruit flies use their nutritional status to regulate the onset of metamorphosis and mammals use it to control the onset of puberty, so plants use the level of sugar in their leaves to trigger the transition from juvenile to adult forms.

More information: elife.elifesciences.org/content/2/e00260

Provided by University of Pennsylvania