Molecular feedback loop gives clues to how flowers drop their petals

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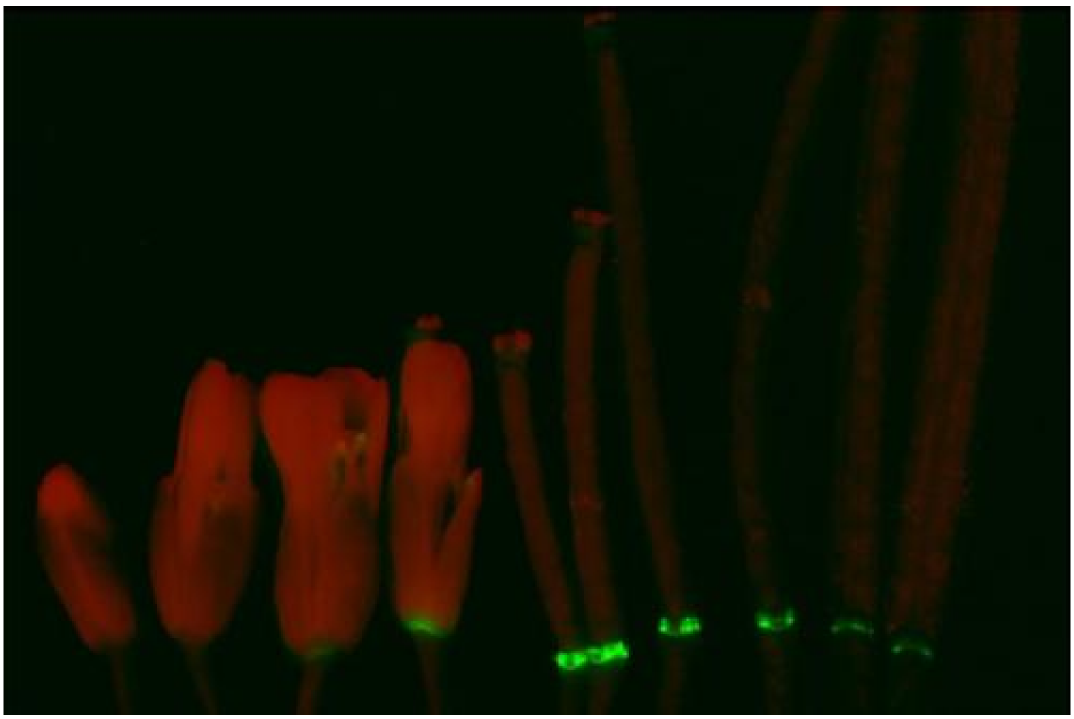

The exponential increase in expression of HAESA in the abscission zone of *Arabidopsis thaliana* (shown here using a fluorescent protein) is driven by a molecular feedback loop. Credit: University of Missouri Biological Sciences Division

As Valentine's Day fades into the past, you may be noticing a surfeit of petals accumulate around your vase of flowers. A new study from the University of Missouri sheds new light on the process that governs how and when plants shed their petals, a process known as abscission. The findings are reported this week in the online Early Edition of the *Proceedings of the National Academy of Sciences*.

"Abscission is the process by which plants shed their organs - petals, flowers, leaves, and fruit," said O. Rahul Patharkar, a postdoctoral fellow in the Division of Biological Sciences and lead author of the study. "Insight into the process of floral abscission in the model plant Arabidopsis thaliana provides a foundation for understanding this fundamental process across organs and in other plant species."

The earliest steps of abscission involve changes in a special layer of cells, called the abscission zone, at the base of the flower. As a flower matures, cells in this layer begin to separate from one another along the entire length of this zone, creating a clean rift between the base of the flower and the petals. As the rift enlarges, the petals will fall off and be sent tumbling to the ground. Scientists have long wondered how a plant regulates this cell separation process, in particular the molecular mechanism that both triggers and powers the process.

"We know that when a plant is a little ways away from abscising its petals the activation of genes is already beginning. A lot of this gene activity, which we call transcription, is exponentially increased in a relatively short time, which ultimately leads to abscission," said Patharkar.

One such gene that gets a boost in its activity is called HAESA, a gene known to be required for floral abscission to occur. Previous studies have shown that activity of this gene increases by a magnitude of 27-fold from the time the flower bud opens to when it decides to abscise its petals, a period of about 2 days in Arabidopsis. In the new research, the scientists identify two important connections in the mechanisms that explain this rapid increase in HAESA gene expression.

Building on previous work, the scientists found that plants that overexpress a protein, called AGL15, do not activate HAESA and do not abscise their flower petals. The finding suggests that AGL15 is a negative regulator of HAESA, meaning it prevents expression of the HAESA gene by blocking its transcription. However, they also link this protein to a set of molecular switches, known as MAP kinases, that are responsible for transducing the very early signal of abscission from HAESA and, in turn, signaling AGL15 to lift its suppression of HAESA. The signaling from HAESA to the MAP kinases and AGL15 and then back to HAESA essentially creates a positive molecular feedback loop that leads to the rapid increase in HAESA gene expression observed during abscission.

"The positive feedback loop provides the exponential signal amplification we see in HAESA expression during abscission," said Patharkar. "A turbocharger is a good analogy since that also amplifies an engines power."

John C. Walker, Curators' Professor of Biological Sciences and corresponding author of the publication, called the findings a "tour de force" in abscission research. "The study puts together a number of different genes and proteins into a new model that helps explain how plants precisely control floral organ abscission."

Patharkar said that understanding the process - which likely also applies to the dropping of leaves and fruit - is important for understanding both plant development and responses to environmental queues, such as drought and pest infection. It will also interest the fruit and cut flower industries, which want their products to stay in place until ready to harvest.

More information: *PNAS* 2015 ; published ahead of print February 17, 2015. www.pnas.org/content/early/201 … 595112.full.pdf+html

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