Shedding new light on pollen development

Scientists have made a breakthrough in understanding the process of how pollen develops, using genetically engineered plants

A team of scientists has completed a groundbreaking study of the mechanisms that regulate plant pollen development. The team included Takuya Ito of RIKEN's Discovery Research Institute and Kazuo Shinozaki of RIKEN's Plant Science Center.

This research into altering and introducing a specific gene into Thale Cress, and thereby producing male sterile plants, could lead to the development of crops that are both non-pollinating and heat- and cold-resistant.

The study, which included collaborators from Pennsylvania State University, Japan Women's University, Hitachi Ltd. and Japan's National Institute of Advanced Industrial Science and Technology (AIST), focused on a gene known as the 'Male Sterility 1' or 'MS1' gene, taken from a plant in the Arabidopsis family. These are small flowering plants related to cabbage or mustard. One of the plants in this family is Thale Cress, the first plant to have its entire genome sequenced.

The scientists found that MS1 is active in the transfer of genetic material from the cell DNA, a process known as transcription. This happens when cells divide, creating new cells. They studied its role in the development of pollen, the fine powder produced by the male part of flowering plants, which essential for reproduction. MS1, they found, promotes pollen development by controlling other genes essential for this process.

In order to study the effects of the Arabidopsis MS1, the researchers produced a mutant version that had the effect of causing male sterility when it was re-inserted into a wild-type Arabidopsis plant. When the mutant MS1 is introduced into a plant, the pollen does not develop properly. Using scanning electron microscope, it is possible to study exactly how the pollen is damaged.

The scientists also studied the male sexual parts of the flowers, the anthers, which had been rendered sterile using the mutant MS1. They found that some plants that were only partly sterile were expressing both the naturally occurring MS1 and the engineered
mutant MS1. They were able to study the differences in the way pollen develops both in wild-type plants and in the genetically engineered sterile ones. In particular, in sterile plants, they found that the external coat of the pollen grains did not develop properly.

In addition, they studied whether MS1 has the same function in higher plants, of promoting pollen development. This was done by introducing the engineered mutant MS1 into a species of garden petunia and studying the differences in the way pollen developed, compared with natural garden petunias. They found that, although the genetically modified petunias still produced a normal number of mature pollen grains, they were deformed in shape compared with normal petunia pollen.

There was also a problem with the external wall of the mutant MS1 pollen grains, and the scientists were able to confirm that this was due to the mutant MS1. As a result, they concluded that a similar regulatory system for pollen development exists in petunias, as in the Arabidopsis plants they first studied.

The team also performed a search for MS1 in the genome sequences of other species of plants, including rice and poplar trees, which are available on the Internet, but have yet to report their findings.

**Original work:**
Ito, T., Nagata, N., Yoshiba, Y., Ohme-Takagi, M., Ma, H., Shinozaki, K.  
*Arabidopsis MALE STERILITY1* encoding a PHD-type transcription factor regulates pollen and tapetum development  
*Plant Cell*, November, 2007

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