Gatekeeper for tomato pollination identified

December 23 2010

Tomato plants use similar biochemical mechanisms to reject pollen from their own flowers as well as pollen from foreign but related plant species, thus guarding against both inbreeding and cross-species hybridization, report plant scientists at the University of California, Davis.

The researchers identified a tomato pollen gene that encodes a protein that is very similar to a protein thought to function in preventing self-pollination in petunias. The tomato gene also was shown to play a role in blocking cross-species fertilization, suggesting that similar biochemical mechanisms underlie the rejection of a plant's own pollen as well as foreign pollen from another species.

Roger Chetelat, director and curator of UC Davis' Charles M. Rick Tomato Genetics Resource Center, and Wentao Li, a postdoctoral researcher in the Department of Plant Sciences, report their findings in the Dec. 24 issue of the journal *Science*.

Their discovery will likely find application in plant breeding, particularly for California's $1.5 billion tomato industry, and in developing a better basic understanding of the biology of pollination.

"Flowering plants have several types of reproductive barriers to prevent accidental hybridization between species in nature," Chetelat said. "We have identified one piece of this puzzle, a gene that helps control whether or not tomato pollen is recognized and rejected by flowers of related wild species.

"Understanding and manipulating these reproductive barriers might help breeders access desired traits found in wild tomatoes," he said.

Not all pollen is welcome:

In the mid-1800s, naturalist Charles Darwin observed that many flowering plants reject pollen from their own flowers as well as pollen from foreign plant species — the first because it is too similar and the other because it is too different. They do allow fertilization, however, between two plants of the same species.

In plants, as well as animals, breeding between closely related individuals is generally considered detrimental because it leads to the expression of harmful mutations and leaves subsequent generations genetically ill equipped to deal with environmental changes or diseases.

And crossbreeding with individuals from different species can be equally detrimental because it frequently results in hybrid offspring that cannot reproduce.

During the past several decades, scientists have studied the molecular mechanisms that cause plants to reject their own pollen. They have found that in the Solanaceae (nightshade) plant family, which includes tomatoes, prevention of self-pollination is controlled by the "S-locus." This is a genetic region responsible for producing distinct proteins in the flower's pollen and in its pistil, the female organ where pollination occurs.

While this mechanism for preventing self-pollination has been relatively well characterized, the mechanism that prevents crossing with plants of other species is much less understood.

The UC Davis study:

To explore these processes in the tomato plant, Chetelat and Li set out to locate the chromosomal regions harboring genes that control fertilization and can cause a plant's flower to reject pollen from other species. The researchers identified a gene expressed in pollen known as a "Cullin1" gene, which interacts genetically with a gene at or near the S-locus to block cross-species pollination.

They found that a mutant (inactive) form of the Cullin1 protein is present in cultivated tomato, as well as in related red- and orange-fruited wild tomato species, all of which are capable of being fertilized by their own pollen. However in the green-fruited tomato species, most of which block self-pollination, the Cullin1 protein is functional.

In short, their findings suggest that the Cullin1 protein is part of a biochemical gatekeeper: An active form of the protein is required for pollen to fertilize plants of another species, if that species is capable of rejecting its own pollen.

While these findings are from a study of tomato hybrids, the researchers suspect that they will be relevant to other members of the Solanaceae family, which also includes potatoes, chili peppers and eggplant.

Provided by University of California - Davis