Researchers to perform sex change operation on papaya

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Researchers will produce true-breeding hermaphrodite papayas, an advance that will boost plant health, reduce growers' costs and their use of fertilizers and water. Credit: Photo courtesy of James Carr

The complicated sex life of the papaya is about to get even more interesting, thanks to a $3.1 million grant from the National Science Foundation. The grant will fund basic research on the papaya sex chromosomes and will lead to the development of a papaya that produces only hermaphrodite offspring, an advance that will enhance papaya health while radically cutting papaya growers' production costs and their use of fertilizers and water.

"We're going to change the sex of the papaya to help the farmers," said University of Illinois plant biology professor Ray Ming, who will lead the effort with researchers from the Hawaii Agriculture Research Center, Texas A&M University and Miami University. A USDA scientist will also collaborate on the initiative.

"This is a perfect case to demonstrate how basic science can help the farmers directly," Ming said. "In our case we can apply it immediately as a byproduct of the research program."

Papayas already come in three sexual varieties: male, female and hermaphrodite. The hermaphrodite produces the flavorful fruit that is sold commercially. From the grower's perspective, however, hermaphrodite plants come with a severe handicap: their seeds produce some female plants (which are useless commercially) and some hermaphrodites.

The problem is exacerbated by the fact that it is impossible to tell the sex of a seed until it has grown up and flowered. This means that papaya farmers must plant five or more seeds together to maximize the likelihood of obtaining at least one hermaphrodite plant. Once they identify a desired plant, they cut the others down.

"This is labor intensive, resource intensive," Ming said. Crowding also causes the plants to "develop a poor root system and small canopy that delays fruit production," he said.

Ming co-led an international team that produced a first draft of the papaya genome in 2008. This draft, which sequenced more than 90 percent of the plant's genes, offered new insights into the evolution of flowering plants in general, and the unusual sexual evolution of the papaya.

Ming and his colleagues have identified regions of interest on the papaya's three sex chromosomes: the X, Y, and Y^h. (XX produces a female plant, XY a male, and XY^h a hermaphrodite. All combinations of Y and Y^h fail to develop beyond the early embryonic stage after pollination.)

The Y and Y^h chromosomes contain genes that promote the development of the male reproductive organ, the stamen, in male and hermaphrodite trees. And, the researchers hypothesize, the Y chromosome also contains a gene that disables the development of the female sexual organ, the carpel. The researchers theorize that the Y^h chromosome lacks the gene that turns off development of the carpel, however, allowing both male and female organs to grow in XY^h plants.

The researchers will focus on finding these genes and testing their hypotheses, Ming said.

Once they have identified the sex-determining genes of the Y chromosome, they will move the gene responsible for stamen development into the female genome and change the sex from female to hermaphrodite - without the Y^h chromosome. The resulting hermaphrodite will produce only hermaphrodite seeds, Ming said, eliminating a major headache for farmers while improving the health of the papayas and the environment.

Further research will explore the origin and evolution of the sex chromosomes by comparing the papaya to five other related species in two genera and by conducting population genetic studies of the papaya sex chromosomes.

Source: University of Illinois at Urbana-Champaign (news : web)