Biotech In focus

Cooperative Extension Service
Biotechnology Outreach Program
College of Tropical Agriculture and Human Resources
University of Hawai'i at Manoa

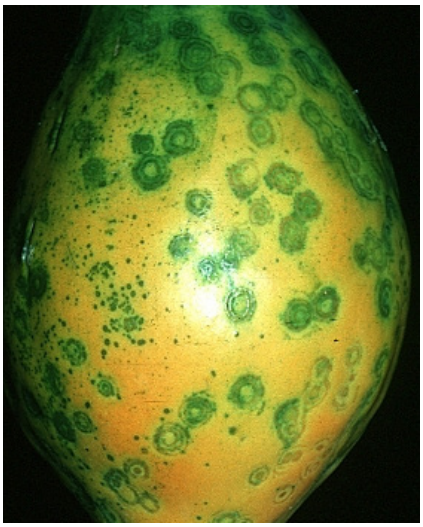
November 2014 Issue 21 of 24

Biotech Goes Local: GM Papaya in Hawaii

Every morning, Hawaii residents and visitors can sink their spoons into fresh papaya, rich in vitamins, minerals, and fiber. The availability of this healthy breakfast item highlights the potential benefits of agricultural biotechnology and the challenges that Hawaii farmers face every day in dealing with pests, diseases, and changing markets.

'Rainbow' papaya, genetically engineered to resist papaya ringspot virus (PRSV), doesn't fit the usual GM crop narrative. Papaya isn't a commodity like corn, soy, or cotton developed by large companies. 'Rainbow' papaya was developed by academic researchers and licensed to the local Hawaii growers' organization for free distribution. This GM papaya shows how universities, government agencies, and patent holders can help small farmers who grow minor crops.

In the 1940s, when the ringspot virus was first reported in Hawaii, most of the territory's papayas were grown on Oahu. Aphids spread the virus from plant to plant, and the disease quickly decimated papayas, and yields plummeted. In response, the industry relocated to Hawaii (the Big Island). PRSV reached Hilo in the 1970s, threatening papaya farms in nearby Puna.



When conventional crop breeding and crop protection failed to stop PRSV, researchers from Cornell University, the University of Hawaii, the U.S. Department of Agriculture, and Upjohn Corp. collaborated to solve this problem. The collaborators isolated the gene for the virus's protein coat and used tiny DNA-coated projectiles to shoot the gene into papaya cells. One of these cells added the new gene to its own DNA, and this was incorporated into a new papaya variety. This virus gene, inserted into papaya, makes so many copies of the instructions for the PRSV coat protein that the cell's defenses recognize the gene product as foreign and destroy them. If PRSV tries to infect a protected GM papaya the plant chops the virus particles into pieces and no infection occurs.

People have been eating PRSV genes and proteins for decades and people can't be infected by plant viruses. Inserting the virus gene into the papaya plants does not produce a fruit that has genes or gene product that people have not been exposed to when eating papaya in Hawaii after it arrived in Hawaii in the 1940's previously. Exhaustive tests have shown that the GM papayas are as nutritious as conventional papayas and have no new allergens or toxins.

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Thank you to Carol Oshiro for web design, Jessica Radovich for graphics and Kathleen Vickers for text editing.

RAINBOW CONTROVERSY

Without 'Rainbow', it's doubtful that the Puna District's papaya industry would have survived. Acreage, harvests, and the number of papaya farms all declined dramatically between 1992, when PRSV first reached Puna, and 2011. Japan, previously a significant market for Hawaii papaya fruit obtains most of its papayas from the Philippines, as the transgenic Rainbow papaya were not permitted to be imported there until recently. After exhaustive testing, Japan authorized the import of 'Rainbow' papaya in 2011, but the market did not rebound. 'Rainbow' shipments to Canada have grown steadily since 2003, but have not replaced losses in Japan.

The 'Rainbow' papaya story reveals some of the complexities of coexistence between GM, conventional, and organic crops. Widespread adoption of 'Rainbow' makes the virus less prevalent in the environment and thereby reduces the possibility of non-GM papaya plants being infected. At the same time, GM papaya has evoked strong opposition. On several occasions, anti-GMO vandals have cut down 'Rainbow' papaya plants in farmers' fields.

The research team developing the resistant papaya GM varity raced to breed a high-yielding, orange-fleshed, virus-resistant papaya. By 1998, when 'Rainbow' papaya was released to farmers, production had declined by 45 percent in regular papaya plantations. 'Rainbow' was rapidly adopted and today accounts for more than three-quarters of Hawaii's papaya crop. For their timely, cutting-edge work, Dennis Gonsalves, Richard Manshardt, Maureen Fitch, and Jerry L. Slightom received one of agriculture's top honors, the Humboldt Prize, in 2002.

Minimal Drift

Commercial papaya varieties are self-pollinating, and pollen drift is minimal over distances greater than 12 feet. Unintended cross-pollination by GM pollen does not violate USDA organic standards, which are based on farming processes rather than products.

Crosses In Seeds

Moreover, cross-pollination transfers genes only to the seeds of the resulting papaya, not its flesh. For some growers and consumers, however, this is not acceptable.

Preventing Crosses

To prevent cross-pollination, a grower can place paper bags over the papaya flowers, or ensure that no Rainbow papaya are grown in close proximity to their crop.

The 'Rainbow' papaya story might offer a preview of the future, as Florida orange growers battle citrus greening disease, another devastating plant disease transmitted by insects. In coming years, we will learn whether GM orange juice, like GM papaya, can find a place at the breakfast table.

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