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# Is Organic Papaya Production in Hawaii Threatened by Cross-Pollination with Genetically Engineered Varieties?

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The organic certification regulations of the U.S. Department of Agriculture (USDA) currently define "organic" foods to exclude "genetically engineered" crop varieties. Genetically engineered crops are conventional crops that have been genetically altered by the intentional introduction of one or more genes from another organism, usually a different species, to improve the agricultural quality and value of the crop. Genetic engineering is a relatively new plant breeding tool that has been used extensively in the USA since 1994, when the first genetically engineered variety, the FlavrSavr™ tomato, was released for commercial production. Other examples of improvements accomplished in major crops through genetic engineering include insect resistance in corn and cotton, herbicide resistance in soybean, and virus resistance in potato.

Public concern exists about long-term risks to human health and the environment from genetically engineered organisms, despite the fact that development and testing of genetically engineered foods is conducted according to strict government regulations—formulated and monitored not only by USDA but also by the Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA)—and that the products commercialized to date have a good safety record.

## Concerns about papaya

In Hawaii, the genetically engineered papaya varieties 'Rainbow' and 'SunUp' were released in 1998 to provide protection from a damaging disease, papaya ringspot virus, which threatened to destroy the papaya industry. The rapid adoption of these varieties on about half of the total production acreage in Hawaii has caused concern among growers of organic papayas, who fear that uncontrolled pollination of their plants by genetically engineered papayas in the vicinity will make their fruits unmarketable as organic produce. This publication provides pertinent information for growers who want to continue to produce organic papayas in regions where genetically engineered trees are common.

The most important fact to remember is that the edible part of a papaya fruit *always* has the same genetic constitution as the tree that produces it. Said another way, if you plant trees that you know are *not* genetically engineered, the edible fruit they produce will *not* be genetically altered by cross-pollination, no matter what the source of the pollen. If the fruit happens to be pollinated by a genetically engineered plant, the seed inside the fruit may become genetically engineered, but that will not change the genetic character of the edible part of the fruit.

Therefore, to ensure that papayas grown organically can be sold as organic produce, it is only necessary to plant seed that is not genetically engineered. This can be guaranteed by using seed that you have produced yourself by bagging unopened flowers on a hermaphrodite plant of a conventionally bred papaya variety (such as 'Kapoho', 'Sunrise', 'Waimanalo', 'Kamiya'/'X77', etc.) to prevent cross-pollination. Flowers of hermaphrodite papaya plants are bisexual and self-fertile; consequently, they normally are entirely self-pollinated, but bagging ensures that foreign pollen is excluded.

## Research on pollen movement

Tests conducted by CTAHR researchers in Puna, Hawaii, in 1997 traced the movement of pollen from a 1-acre field of genetically engineered 'Rainbow' papayas into surrounding rows of conventionally bred 'Sunrise' papaya plants and nearby fields. The results from immediately adjacent border-row plants (within 85 ft of the 'Rainbow' field) confirmed the fact that cross-pollination occurred much less frequently on hermaphrodite

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plants than on female plants, which produce no pollen of their own (Table 1). While 70 percent of female plants received at least some pollen from the 'Rainbow' field, only 13 percent of hermaphrodite plants did. Of the seeds analyzed from 'Sunrise' females, 43 percent were pollinated by 'Rainbow' (the average contamination percentage), while the comparable figure for hermaphrodites was only 7 percent.

Hermaphrodite plants typically self-pollinate even before the flower bud opens, so in commercial fields, where only hermaphrodites are grown, the rate of cross-pollination should be low under normal conditions. But for purposes of seed production, it is best to prevent any possibility of contamination by pollen from other plants by covering the unopened flower bud with a light paper bag secured with a string or twist-tie until after the flower opens and the petals fall off. Leaving the bag on longer will not harm the fruit and will serve to identify fruits with self-pollinated seeds to be saved and used for the next cycle of planting.

As expected, the Puna test also showed that the amount of genetically engineered pollen tended to decrease with distance from the 'Rainbow' field. This tendency was statistically significant, but the distance between the edge of the 'Rainbow' field and the farthest 'Sunrise' border row plants was not great enough (maximum 85 ft, most less than 30 ft) to determine an adequate isolation distance beyond which genetically engineered pollen disappeared.

Consequently, on two different occasions in May, 1997, assays were performed on seeds from non-genetically engineered plants in a commercial field about ¼ mile downwind from the Puna test site. Vegetation blocked the direct line of sight between the fields, but there were no other natural or man-made obstacles. No genetically engineered seeds were found among approximately 1000 seeds assayed.

These results show that cross-pollination between genetically engineered and organically grown papayas will occur in immediately adjacent fields, particularly if female plants are present in the organic planting. The results also suggest that when commercial fields of hermaphrodite plants are separated by more than ¼ mile, cross-pollination will be, at most, a rare event.

**Table 1. Contamination levels for female and hermaphrodite 'Sunrise' papaya plants (non-GE) adjacent to rows of genetically engineered (GE) Rainbow papaya.**

| Sex of plants | No. of plants | Plants with GE contamination[1] (%) | Average contamination (%) |
|---|---|---|---|
| Female | 44 | 70 | 43 |
| Hermaphrodite | 56 | 13 | 7 |

[1]Movement of Rainbow pollen was detected by assaying for expression of the beta-glucuronidase (GUS) marker gene in seed produced on Sunrise border-row plants using a histological staining procedure. On April 29 and May 20, 1997, one mature fruit was harvested from each of 56 hermaphrodite and 44 female plants in the border rows surrounding the Rainbow field. On both dates, twelve seeds were assayed from each fruit. The percentage of Rainbow outcrossing for each tree was determined by doubling the percentage of GUS-positive seeds in the fruit, since pollen originating from Rainbow was hemizygous for the GUS transgene, and consequently only about half of the Rainbow papaya pollen would be revealed by the GUS assay.

## Main points for organic papaya producers

*DO* plant seeds or seedlings that you know are *not* genetically engineered. By bagging flower buds on your preferred hermaphrodite papaya plants, you can produce your own papaya seeds that are free of any influence from pollen of genetically engineered papaya plants.

*DON'T* plant seeds of unknown origin or seeds from open-pollinated (unbagged) fruits. Open-pollinated seeds, even if obtained from trees that are not genetically engineered, *may* have become genetically engineered by cross-pollination.

*IF* organic practices are followed for growing trees that are not genetically engineered, the fruits from them can be marketed as "organic." Pollen source is not an issue.*

*"As long as an organic operation has not used excluded methods and takes reasonable steps to avoid contact with the products of excluded methods, as detailed in their approved organic system plan, the unintentional presence of products of excluded methods should not affect the status of an organic product or operation." [USDA, National Organic Program, preamble to Applicability section]