



High Hopes for Gene-Spliced Rice / UC Davis team's disease-resistant plants could boost food supplies

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Scientists at the **University** of California at Davis reported yesterday that they have created rice plants with a powerful resistance to one of the crop's most devastating diseases -- a genetic engineering achievement that is bound to boost the world's food supplies.

The scientists said that they not only determined the chemical sequence of the gene that confers resistance to bacterial leaf blight, but that they cloned it and then showed that their altered rice plants could pass the resistance to the next generation of crops.

This is the first time that a disease-resistant gene has been successfully introduced into a crop. Rice is the major food source for half the human race -- and in many rice-dependent countries in **Asia and Africa**, farmers lose up to half their annual crop to leaf blight.

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Similar genes also protect wheat and corn against strains of the same bacterial blight, so that it may be possible to use the technique to increase production of all three major food grains and to greatly reduce the need for pesticides.

INTERNATIONAL NETWORK

"We hope to move the practical results of this breakthrough into a large international network of specialists right away, so they can get it out into farmers' fields as quickly as possible," said **Gary Toenniessen** of the **Rockefeller Foundation** in New York, which has financed more than 15 years of international research that led to yesterday's report in the journal Science.

The achievement, Toenniessen said, "marks a new era in plant genetics and resistance breeding. It took decades of classical crop breeding to make plants resistant to disease, but now it should take a year or less."

The UC Davis team is headed by **Pamela Ronald**, a 34-year-old geneticist, and includes scientists at the **Scripps Research Institute** in La Jolla and the **Chinese Academy of Sciences** in Beijing.

In an interview yesterday, Ronald said she and her colleagues are already at work on a genetic engineering effort to produce rice plants with resistance to a fungal infection called blast, another serious problem for rice farmers.

Ronald and her colleagues at Davis described how they first isolated and cloned the gene that produces the unique protein that makes the leaf cells of rice plants resistant to the bacterial invasion. Known as Xa21, the gene is located on the 11th of the 12 pairs of chromosomes that make up the hereditary endowment of all the world's many rice varieties.

Inserting cloned copies of any gene into the nuclei of cells and making sure they function is an extremely difficult task. In this case, with colleagues at the **International Laboratory for Tropical Biology** at Scripps in La Jolla, the researchers used a gun fueled by compressed helium gas to bombard the leaves of 1,500 rice plants in their laboratory with microscopic gold particles coated with the genes.

Fired deep inside the nuclei of the rice cells, where their genetic machinery is located, the Xa21 genes lodged there, and the plants were then grown in the laboratory and tested for resistance to disease.

The researchers trimmed the leaves with scissors dipped into a solution containing the bacteria. Ten days later, 50 of the plants proved to be resistant to the blight, Ronald said.

Those 50 plants have already produced seeds that have grown into a new generation of rice plants, and the new plants have inherited a resistance to the disease, Ronald said.

In the report in *Science*, Ronald and her colleagues described the complex pathway by which they believe the Xa21 gene works. DNA, the cell's genetic material, creates a specialized kinase protein that closely resembles the disease-resistance proteins of animals and humans.

INVADING BACTERIUM

One portion of that protein, lying outside the cell, acts as a receptor that recognizes the invading bacterium; a second portion lies across the cell membrane and transmits a signal that an invader is threatening; and finally, the protein's third portion, inside the cell, mobilizes a defense response.

Experts in China and Thailand are already planning to bring to the United States samples of the varieties of rice grown in different regions of their countries, Toenniessen said. The plants will be genetically engineered to resist blight and the new varieties, with their built-in resistance, will be taken back to be introduced in the countries in question, he said.

For many decades, farmers in tropical rice-growing regions have used pesticides to protect their crops against leaf blight, Toenniessen said. But the chemicals are expensive, and meanwhile, the leaf blight bacteria have become more and more resistant, so that farmers have had to increase their use of the chemicals.

The genetic research leading to yesterday's report began 15 years ago at the Rockefeller-supported **International Rice Research Institute** in the Philippines. Ronald, who earned her doctorate at the **University of California at Berkeley**, picked up the rice gene research as a post-doctoral fellow at **Cornell University**, and pursued it with her colleagues at Davis, where she is an assistant professor of plant pathology.

HOW THEY DID IT

Pamela Ronald and her colleagues at the **University of California at Davis** first isolated and cloned the gene called Xa21, which produces the protein that makes rice plants resistant to bacterial leaf blight.

With colleagues at the International Laboratory for Tropical Biology at Scripps in La Jolla, the researchers used a gun fueled by compressed helium gas to bombard the leaves of 1,500 rice plants with microscopic gold particles coated with the genes. The genes lodged deep in the nuclei of the rice cells.

The plants were then grown in the laboratory and tested for resistance to disease. The researchers trimmed the leaves with scissors dipped into a solution containing the leaf blight bacteria.

Fifty of the plants proved to be resistant to the blight. Seeds from those plants have been cultivated, and the new plants have inherited a resistance to the disease.

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