PEGGY GREB (K10801-1)

Gennaro Fazio, director of the Plant Genetic Resources Unit, Geneva, New York, evaluates trees developed from different rootstocks in an apple rootstock breeding project. The tree in the foreground is smaller and more productive than the one in the background and represents a good candidate for high-density orchards being planted today.

Short Apple Trees
Faster and Healthier

PEGGY GREB (K10808-1)

Technician Sarah Wyatt performs DNA fingerprinting on several rootstock genotypes to discover molecular markers linked to dwarfing genes.

Keeping it short is a way of life for apple rootstock scientists at the ARS Plant Genetic Resources Unit in Geneva, New York.

That's because one of their top priorities is development of disease-resistant dwarf and semidwarf lines of apple tree roots—also known as rootstocks. These dwarf lines draw the attention of orchard owners because they improve apple tree productivity, are easier to prune and pick, and lead to more efficient use of pesticides.

"While apple trees normally grow to a height of 20 to 30 feet, dwarf varieties grow only 10 to 12 feet high," says Gennaro Fazio, director of the Geneva lab's apple rootstock breeding project. "Their yield and fruit size are the same as from full-sized trees, but you get more trees per acre." He says a grower can plant about 485 dwarfs per acre; normal-size apple tree density is 60 to 80 per acre.

The dwarf varieties became more popular as more high-density apple orchards came into use throughout North America during the past 25 years. But just like their full-grown counterparts, the dwarfs are susceptible to an array of tree ailments.

"The most popular, commercially available dwarf and semi-dwarf rootstock varieties have poor resistance to some of the more prevalent biotic stresses," says Fazio.

Among these stresses is fire blight, a destructive bacterial disease of apples and pears that attacks blossoms, shoots, and limbs in late spring, sometimes killing entire trees and orchards when the rootstocks are infected. Other stresses are the soilborne illnesses such as root rot, which attacks apples—causing a 2- to 3-year decline in the tree and its eventual death—and replant disease, which causes fruit trees to grow poorly in soil that previously supported the same, or closely related, species.

"Tree losses caused by these diseases can range from 30 to 100 percent in an orchard, depending on the severity of the outbreak," says Fazio.

Among the most valuable tools needed to develop resistant dwarf varieties is patience. "The apple rootstock breeding process, from cross to release, is usually about 30 years long," says Fazio. "It takes 12 years just to be able to tell whether a tree is a dwarf." And once released, the rootstocks must also be converted to nursery stock, a process that takes at least a year.

Getting To Know Trees Much Sooner

Now, a recent discovery by Fazio and his assistant, plant biologist H. Todd Holleran, may put a big dent in that waiting time, as well as improve trees' chances against diseases.

"Through gene mapping, we've discovered the genetic inheritance of the dwarfing character in apple rootstocks," Fazio says. "We're working on characterizing this trait at the molecular level, to understand the dwarfing mechanism. Once we understand it, we'll be able to transfer the knowledge to other tree fruit systems," he adds.

Holleran says analysis of the genetic inheritance can help researchers find molecular markers that would help identify dwarfing plants—as well as positive and negative traits within them—early in their development. "This will allow us to eliminate varieties susceptible to diseases much sooner," he says.

Fazio says the ability to read genetic markers for characteristics of dwarfing and disease resistance can cut evaluation time in half—from 30 years to 15. "And there is always a strong demand among U.S. apple growers and nurseries for new apple rootstocks that are highly productive and resistant to diseases and pests," he says.

Liking Apple-Derived Dollars

Apples are a $1.5 billion-a-year industry. They are grown commercially in 35 states and make up about 17 percent of the noncitrus fruit market in the United States. Each year, nurseries produce 10 to 15 million apple rootstocks, worth about $6 million. Apple tree nurseries gross about $30 million annually.

Discovery of the genetic inheritance of dwarfing is one of many achievements by the Geneva unit. A major accomplishment involves advances against fire blight. This disease, caused by the bacterium *Erwinia amylovora,* causes several million dollars in annual losses. Fazio says there have been significant outbreaks in New York and Michigan and a smaller outbreak in Washington. It's also a concern in Europe and New Zealand.

The research has led to fire blight-resistant dwarf and semidwarf lines that are being commercialized. Four clones have been released since 1994, including Geneva 202, which produces a tree about 40 percent the size of normal apple trees and is resistant to woolly apple aphids. This rootstock will be available to U.S. growers in 2005.

"In 2004, we expect to release two more rootstocks," says Fazio. Both Geneva 3041 and Geneva 5935 are fire blight-resistant and very productive. Their trees are 30 percent (for 3041) and 50 percent (for 5935) the size of normal-sized trees.

Also, in research done in collaboration with plant pathologist Mark Mazzola at the ARS Tree Fruit Research Laboratory in Wenatchee, Washington, Fazio is investigating the resistance, or tolerance, of Geneva apple rootstocks to apple replant disease at several grower sites in Washington State.

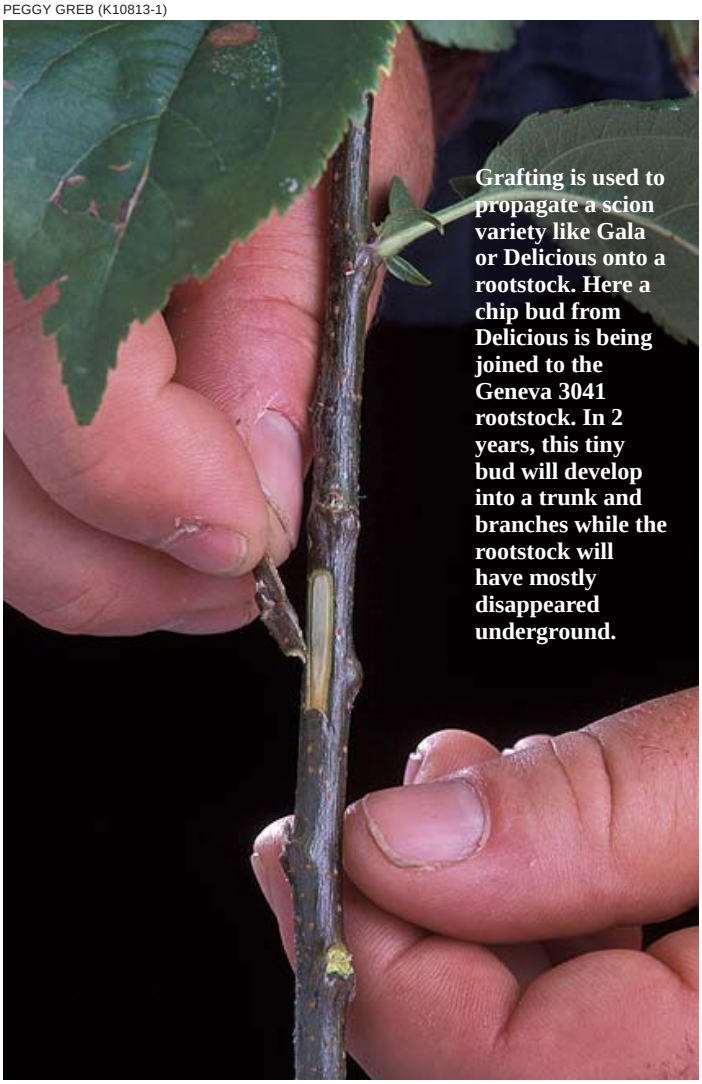
The Geneva rootstocks program was started in 1968 by Cornell University and reorganized in 1997 through a cooperative agreement between ARS researchers and Cornell's Terence L. Robinson, pomologist, and Herbert S. Aldwinckle, plant pathologist. The unit is on what is now a Cornell campus that's the home of the New York State Agricultural Experimentation Station. "This is the only ARS program working on the genetics of apples," says Fazio, "and there are no other apple rootstock breeding programs in the United States."

Besides obvious gains the apple rootstock research program presents growers and nurseries, Fazio says there are indirect benefits that include reduced use of chemicals, such as methyl bromide and streptomycin, and increased profitability.—By **Luis Pons,** ARS.

This research is part of Plant, Microbial, and Insect Genetic Research, Genomics, and Genetic Improvement, an ARS National Program (#301) described on the World Wide Web at www.nps.ars.usda.gov.

Gennaro Fazio is in the USDA-ARS Plant Genetic Resources Unit, Cornell University, Collier Dr., Geneva, NY 14456; phone (315) 787-2480, fax (315) 787-2216, e-mail gfazio@pgru.ars.usda.gov. ★

PEGGY GREB (K10813-1)



Grafting is used to propagate a scion variety like Gala or Delicious onto a rootstock. Here a chip bud from Delicious is being joined to the Geneva 3041 rootstock. In 2 years, this tiny bud will develop into a trunk and branches while the rootstock will have mostly disappeared underground.

PEGGY GREB (K10797-1)

Young apple trees require a lot of training in the nursery. Here, biologist Todd Holleran trains a recently grafted apple tree into a single shoot that will become a full-grown nursery tree in 2 years.