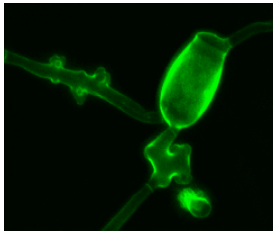
Improving Grape Resistance to Pests and Diseases

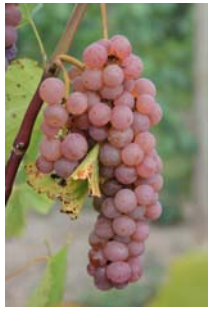
Grapevine powdery mildew reduces yields and fruit quality everywhere that grapes are produced, costing the U.S. grape industry up to $300M annually. USDA-ARS scientists in Geneva, NY and Parlier, CA are developing disease resistant cultivars to combat the problem.

The USDA-ARS genetic resources collections are rich in genes that combat important diseases. At the Grape Genetics Research Unit (GGRU), we have evaluated over 1200 accessions for resistance to several important diseases.

Root-knot nematodes are the leading problem facing grapevine roots on more acres of U.S. vineyards than any other pest or pathogen, causing more than $1 billion in losses in U.S. vineyards annually. Nematode resistant rootstocks are an alternate to methyl bromide and other fumigants. Virulent nematode populations have emerged that can damage standard nematode resistant rootstocks, so improved rootstocks are needed. Studies of the genetics of nematode resistance at the USDA ARS Grape Genetics Research Unit have identified new sources of resistance to aggressive nematode populations. Above: grapevine roots infected with root-knot nematodes



Disease management tactics target the pathogen's genome, such as by applying chemicals that disable cellular processes or by deploying resistance genes that prevent pathogen colonization. To better understand the enemy, GGRU has sequenced the genome of powdery mildew and the resulting discoveries may change the way we approach disease management.



Vignoles is a popular grape for table and dessert wines in the eastern United States, but its tight clusters are prone to bunch rot (above left). Clonal selection in a population of vines grown from radiation treated buds has identified many vines with looser clusters (above center and right). Multiple seasons of characterization will evaluate year to year stability of cluster compactness and reduction in bunch rot. Grape grower and wine maker trials will test vineyard performance and wine composition. This population will be studied to identify the genes responsible for cluster compactness, with the potential to apply genetic selection for loose clusters in other varieties.

The USDA ARS Grape Genetics Research Unit grape rootstock breeding and genetics program develops improved rootstocks with superior resistance to nematodes, including virulent nematode populations. Our most advanced selections (aand are expected to be released as new varieties to grape growers and nursery operators in FY 2011 (invention disclosure documentation filed September 2010). These new varieties have completed virus testing at Foundation Plant Services bove) have completed pest resistance testing and vineyard performance evaluation (University of California, Davis).

The selection at left is a seedling of the wine grape Rubired. It is continuously blooming on lateral branches from prompt and latent buds, but is not gibberellic acid insensitive, which makes it faster growing than Pixie and other dwarf grapevines. Seedlings from crosses of this selection with Riesling and the rootstock 125AA begin blooming within three months from planting, with no chilling requirement for flowering. The precocious and reblooming traits are derived from a wild grape species. This selection is expected to be released for breeding and genetics research in FY 2011. Germplasm development and genetics research in rapidly and precociously flowering grapevines is continuing.

PI 588213 Couderc 3306
Newly identified grandfather of Freedom

DVIT 2097 1613-59
Mother of Freedom

Freedom grape rootstock

Freedom is a nematode resistant grape rootstock bred by USDA ARS and extensively used in California. Because it is descended from open-pollinated seedlings, its complete parentage was not known. USDA ARS scientists in Parlier, California and the Grape Genetics Research Unit cooperated to identify the rootstock Couderc 3306C as the maternal grandfather of Freedom rootstock. The elucidation of the family tree used bioinformatics, molecular biology, ampelography, and germplasm from the National Plant Germplasm System grape collections. With the Freedom pedigree more fully known, breeders can make better use of Freedom as a parent and viticulturists can use Freedom as a rootstock with greater confidence in its phylloxera resistance.

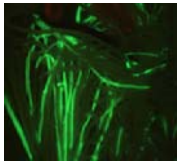
Modifying plant architecture

Grapevine plant architecture can significantly impact grape yield, quality and management practices. It can be improved by introducing desirable allelic variation of the "Green Revolution" gene, *GAI*. Illustrated in the figure (right) are transgenic GAI grapevines showing varying plant heights. These phenotypes are in contrast with that of Pixie, even though the same GAI gene was involved.

Alternative approach for controlling root-knot nematodes

Transgenic composite plant

Transgenic hairy roots



RNAi technology has been shown to be effective to control root-knot nematodes in *Arabidopsis*. We are in the process of developing the technology for grapevines. Illustrated in the figure is the generation of transgenic grapevine hairy roots for testing the RNAi technology. If successful, the technology will provide an alternative solution to the control of nematodes in vineyards.