

Research fuels sustainable viticulture revolution

Spurred by decades of University of California research, sustainable viticulture has become increasingly mainstream in California. Sustainability helps both the environment and wine-grape growers, with benefits that range from reducing agrochemicals that pollute water and harm wildlife to cutting costs, enhancing wines and boosting public perception of the industry.

"Sustainability is a big tent," says Deborah Golino, director of the UC Davis-based Foundation Plant Services, which certifies disease-free grape stock and which celebrated its 50th anniversary in July 2008. "Some sustainable practices are driven by environmental regulations, and more are driven by green marketing and stakeholders wanting to be good stewards of the land."

For the wine industry, economic benefits are key. "The bottom line is that sustainability has to work in a business model," says Karen Ross, president of the California Association of Winegrape Growers. "The fundamental reasons to change practices are increasing quality and marketability, and decreasing costs." This industry group represents more than half of the state's grape crush and actively promotes sustainability, defining it as economically viable, environmentally sound and socially responsible.

What's good for the wine industry is also good for California, Ross says. About 4,600 wine-grape growers farm more than 520,000 acres in 46 coun-

ties statewide, and about 2,000 wineries produce more than 90% of wine nationwide. Altogether the wine industry pumps close to \$52 billion yearly into the California economy.

To help keep wine-grape growers in the sustainability loop, Golino maintains several comprehensive viticulture Web sites. "People in industry don't always know where to look," she says. "We want to let everybody know how much UC is doing" (see box).

The implementation of sustainable viticulture has been spurred by important research-based advances that have been extended to grape growers.

Leaf removal for bunch rot

One of the most widely adopted sustainable practices, leaf removal to control bunch rot and improve grape quality, was developed in the 1980s by Douglas Gubler, UC Cooperative Extension (UCCE)

Foundation Plant Services staff members Sue Sim (sitting, left) and Wacław Pudo shared information with grape nurseryman Craig Stoller and his wife Nancy about technology used to create collections of disease-screened strawberries, grapes, fruit and nut trees and other plants, during the FPS 50th anniversary celebration on July 1, 2008.



Beverly Ferguson



Web sites organize sustainable grape-growing info, research grants

Deborah Golino, director of Foundation Plant Services at UC Davis, has set up and runs several comprehensive Web sites to organize critical information for wine-grape growers and viticulture researchers. "Wine-grape growing is complicated by the sheer number of clones and varieties available and the fact that each variety can have multiple names, plus the abundance of information on pest, weed and disease management," Golino says. "These sites can help."

The National Grape Registry (<http://ngr.ucdavis.edu>) enables growers to access information for all grape varieties available in the United States. Growers can find out which nurseries carry a particular variety or clone — the first time there has been a central site to answer this question. There is also a special search feature that allows users to sort through multiple names (or synonyms) for grape varieties.

UC Integrated Viticulture Online (<http://iv.ucdavis.edu>) makes UC research more accessible, listing grape researchers, a calendar of upcoming events and information about grape-growing topics in 30 categories, including diseases, rootstock and vineyard economics.

Viticulture Consortium West (<http://vcw.ucdavis.edu>) and **Unified Grant Management for Viticulture and Enology** (<http://uvegrants.ucanr.org>) coordinate grape-growing research programs and grant-making for experiment stations and universities in the Western states, as well as in Oklahoma and Texas.

Also of interest: **California Association of Winegrape Growers** (www.cawg.org) and **California Sustainable Winegrowing Alliance** (www.sustainablewinegrowing.org).

plant pathologist at UC Davis; Larry Bettiga, UCCE viticulture advisor in Monterey County; and Jim Marois, UC Davis plant pathologist. “We stumbled onto it — we were originally looking at how canopy management affected spray coverage,” Gubler says. “We found that leaf removal controlled bunch rot better than three fungicide applications.”

Caused by the fungus *Botrytis cinerea*, bunch rot infects grape berries through wounds or even directly through the skin. Once a grape is infected, if conditions are favorable the fungus spreads rapidly to infect the rest of the cluster. This type of bunch rot afflicts vineyards in cool moist areas, notably those along the coast, in the marine-influenced northern San Joaquin Valley and in the southern San Joaquin Valley (table grapes).

The technique entails removing leaves around grape clusters when the berries are just formed or the blossoms have just dried. This allows increased light penetration, decreased relative humidity and increased wind speed through the canopy. Berries dry more rapidly after rainfall, warding off or stopping infection. In addition, this technique can decrease leafhoppers and mites, because these pests are concentrated on the basal leaves that are removed. Leaf removal also exposes clusters to sunlight, which further increases bunch rot resistance by thickening the berry’s epicuticular wax layer. Another benefit of sun exposure is that it increases

berry quality and therefore wine quality.

In the late 1980s, Gubler and colleagues showed that machine leaf removal could control bunch rot as effectively as hand-removal, making the technique feasible for large acreages of wine grapes. By 1990, leaf removal was practiced on about one-fifth of the state’s bunch rot-susceptible wine grapes, decreasing fungicide use by at least half. Today leaf removal is widespread in most of California’s production regions and also around the world. “It’s working really well in disease control and increases quality,” Gubler says.

Powdery mildew control without sprays

Another successful tool for controlling grapevine diseases sustainably is the UC Davis Powdery Mildew Index. Also called the Gubler-Thomas Index, this approach was developed in the 1990s by Gubler and then-lab member Carla Thomas. Caused by the fungus *Erysiphe necator*, powdery mildew is among the worst grapevine diseases in California. The fungus occurs in all grape-growing regions of the state and accounts for most vineyard pesticide use. Infected leaves are covered by a web of white strands that bear dustlike spores, giving the disease its name. Powdery mildew can also cause grape berries to crack, allowing *Botrytis cinerea* to infect through the injured tissue. In addition, as little as 3% infection of berries can produce off-flavors in wine.

Powdery mildew is a fact of life for grape growers. “We can’t eradicate the pathogen,” Gubler says. “They just have to expect it.” While the infection varies over the course of a growing season and from year to year, its inevitability and huge potential for crop destruction led many growers to spray fungicides on a fixed schedule, whether they needed to or not. This was because they could not tell when powdery mildew would strike initially and when it would spike over the course of the growing season.

“The disease is driven by moderate temperatures and rainfall,” Gubler says. The team developed a model to predict the onset and severity of powdery mildew in vineyards. The onset of infection is predicted based on temperature and leaf wetness, and its subsequent severity is predicted based solely on temperature. In 1995 the researchers validated their model in Kern, Napa and Sonoma county vineyards, using networks of weather stations that were established with a grant from the UC Statewide Integrated Pest Management (IPM) Program as well as grower contributions.

Today the UC Statewide IPM Program offers an online Powdery Mildew Index (PMI) for Fresno, Madera and San Joaquin counties. In other parts of the state, grape growers can either subscribe to private online PMI services or buy their own weather



UC researchers have developed environmentally friendly treatments for several important grape diseases. *Top left*, basic research has shown that many wood infections diagnosed as *Eutypa* dieback were actually *Botryosphaeria* canker disease; *bottom left*, the spread of Bot canker can be slowed down by double-pruning in winter and early spring; *top right*, to ward off bunch rot, leaves around clusters can be removed as berries form; *bottom right*, the Powdery Mildew Index uses weather data to help growers spray fungicide only when necessary.

(*Eutypa* and bunch rot) William J. Moller; (Bot canker) ivurdavis.edu; (mildew) Jack Kelly Clark

stations. Following the PMI lets growers spray only when necessary, which can add up to substantial cost savings. "At \$40 per acre, eliminating three sprays a year on 5,000 acres is a big savings," Gubler says. "Spraying less also reduces environmental concerns about pesticide use."

To assess implementation of the PMI, Gubler and Travis Lybbert, an agricultural economist at UC Davis, surveyed growers in early 2008. For the first few years after the PMI was introduced, less than one-third of growers used it. Today more than half do. Participating growers generally are more experienced, manage larger vineyards they are less likely to own, and produce higher-value grapes. Reasons for not using the PMI included not trusting it. "It's hard to change," Gubler says. "They're nervous about stretching the interval between sprays." To build trust, he encourages growers to start small, setting aside 5 acres for following the PMI while spraying the rest as usual. "Once they start, they really get hooked," he says. "People who use it love it."

Grape growers will soon have more reason to use the PMI than ever. "We're refining it," Gubler says. "Right now it errs on the side of caution and we're making it less conservative, which means growers will be able to reduce spraying quite a bit more."

Double-pruning for canker disease

Gubler and his colleagues also recently developed yet another widely adopted sustainable practice: double-pruning to control canker diseases. These fungi infect pruning wounds, and ultimately so much wood that grape production declines, necessitating early vineyard reworking or replacement. The infection is insidious, often escaping detection for 8 to 10 years until wedge-shaped cankers are evident in the trunk or arms. The most common canker diseases in California vineyards are Bot canker (see page 161), and *Eutypa* dieback. A decade ago losses to the latter were estimated to exceed \$260 million statewide.

To clarify the causes of canker diseases in California, Gubler's team identified the fungi in infected wood samples from 180 vineyards around the state between 2004 and 2007. They found that contrary to the conventional wisdom, Bot canker is more common than *Eutypa* dieback, which afflicted 90% and 55% of the study vineyards, respectively. They also identified nine species of *Botryosphaeria* causing Bot canker and found that four of these grow much faster than the others. "They grow up to 10 or 12 inches a year compared to about an inch with *Eutypa*," Gubler says. "They can kill wood fast."

The best way to limit canker diseases is pruning in early spring, when the wounds heal faster and



Miguel Altieri

In Napa Valley, researchers are studying the use of summer cover crops such as alyssum planted under the vines with a buckwheat-phacelia seed mix in the middles. Early monitoring has shown that beneficial insects are attracted to the vineyard.

also "bleed" and wash away the fungal spores. But this is not feasible in large vineyards because pruning is so labor-intensive. Gubler's team got around this by doing the bulk of the pruning in winter and then snipping off a bit more in early spring. The second cut doesn't take much time and removes any wood that may have gotten infected after the first cut. Gubler estimates that a high percentage of vineyards in the Napa Valley are now double-pruned. "It's gaining every year," he says.

Double-pruning on its own is not enough to prevent canker diseases, however, because wounds from spring pruning can still be susceptible to infection. Gubler found that painting these wounds with a boron paste could keep them virtually infection-free for up to 6 weeks. "It's a great treatment," he says, noting that boron is a natural, nontoxic compound. This work has resulted in a commer-

Following the Powdery Mildew Index lets growers spray only when necessary.

cially available wound treatment called B-LOCK. Another promising treatment is painting vines with latex paint (see page 161).

Biocontrol for vineyard pests

Other sustainable practices target the weak points of pest insects. A likely approach to controlling vineyard pests is planting summer cover crops, according to a UC study currently under way in Napa and Sonoma counties. Cover crops provide food and shelter for beneficial insects such as minute pirate bugs, which eat thrips, and *Anagrus* wasps, which are tiny parasites that lay their eggs inside leafhopper eggs. However, most wine-grape growers plant cover crops during the winter (see pages

Research news

Jack Kelly Clark



Cultural practices such as strategic pruning to prevent grapevine diseases are increasingly being adopted by grape growers throughout California.



Sustainable Ag Expo to feature research, best practices

The Fourth Annual Sustainable Ag Expo will feature trade exhibits and programs to help growers and ranchers maintain economic viability while also protecting the environment and promoting healthy communities. "Farmers of all crops and commodities can learn about sustainable farming methods," says Kris O'Connor, executive director of the Central Coast Vineyard Team, sponsor of the Expo.*

Expo seminars will focus on best management practices to protect water quality, alternative energy sources, erosion control and integrated farm management practices, including reduced-risk pest control and whole-farm practices. Among speakers from government, agriculture and academia, featured UC researchers include:

- Michael Cahn, UC Cooperative Extension farm advisor.
- Trevor Suslow, UC Davis extension research specialist.
- Jay Gan, UC Riverside professor.
- Gail Feenstra, UC Sustainable Agriculture Research and Extension Program.
- Andy Walker, UC Davis professor.
- Jean-Jacques Lambert, UC Davis soil science scientist.

What: Sustainable Ag Expo

When: Nov. 13 and 14, 2008

Where: Monterey County Fairgrounds

More info: www.sustainableagexpo.org

*California Agriculture journal is a media partner with the Sustainable Ag Expo.

184 and 190), which means that insect pests have fewer natural enemies during the summer. "Some growers are spraying insecticides several times a season," says study leader Miguel Altieri, an agro-ecologist at UC Berkeley. "This increases the expense and the environmental impact."

Altieri is testing two summer cover crops on 1- to 2-acre test plots in seven vineyards. The first summer cover crop is sweet alyssum, which is planted along drip-irrigated rows. Sweet alyssum is small with shallow roots and so does not compete with grapevines for water, nutrients and sunlight. The second is a seed mix planted between the rows, where there is no irrigation. The seed mix ensures continual blooming with no extra water: buckwheat and phacelia bloom from late March to June, and wild carrot (or Queen Anne's lace) blooms for the rest of the season due to its taproots.

To see how well summer cover-cropping works, the researchers monitor both the pest and beneficial insects. The study began last year and so far is promising. "The results are pretty dramatic," Altieri says. For example, last summer the plots with the buckwheat seed mix exhibited substantially fewer leafhopper nymphs than plots under organic insecticide sprays.

Altieri works closely with growers, sharing the data with them monthly. Pest control has been so effective that a participating grower plans to expand the cover-cropped area to 10 acres next year. Ultimately, Altieri envisions scaling up the study to include 10- to 20-acre test plots in 50 vineyards by the end of 2010.

Altieri also involves the participating vineyards by training farmworkers in Spanish to identify the various insects. This lets the farmworkers help monitor the insects, which benefits both the researchers and the workers themselves. "They're very excited," Altieri says. "They enjoy doing something more intellectual plus they know this could reduce their pesticide exposure."

Pest-resistant rootstocks

Another way of decreasing pesticide use in vineyards is to breed pest-resistant rootstocks. Many of the currently available rootstocks are susceptible to nematodes, tiny soil worms that eat plant roots. Nematodes plague grapevines in the Central Coast and San Joaquin Valley, where vineyards were often planted following vegetable crops that had high levels of these pests. State regulations limit chemical treatments, and UC has provided growers with the environmentally friendly option of planting five new nematode-resistant rootstocks.

"Resistant rootstocks are the best solution now that fumigants are almost gone and nematicides are on their way out, as they should be," says

Andrew Walker, UC Davis geneticist who developed these rootstocks over 15 years. "It's either use these or other resistant rootstocks or don't grow grapes in areas with nematode buildup."

Released in April 2008, these rootstocks were derived from multiple parents that each resist different kinds of nematodes, including dagger, lesion and root-knot. "We bred them to be as resistant as possible," Walker says. Even so, he expects that these pests may eventually adapt. By rotating among the five types, however, growers should be guaranteed a long period free of nematode problems.

Walker is also developing wine grapes that resist powdery mildew and Pierce's disease, a fatal bacterial illness spread by sharpshooters. These projects entail breeding commercially grown wine grapes (*Vitis vinifera*), which are native to the Mediterranean, with disease-resistant wild North American grapes. To get as close to wine grapes as possible, disease-resistant hybrids are selected and then repeatedly crossed back to pure wine grapes. This backcrossing increases the ratio of wine grape-to-wild grape in the successive hybrids while retaining their disease resistance. The powdery mildew project is still in early stages, while the Pierce's disease project has made strong advances. "We have good fruit quality and Pierce's disease re-

sistance," Walker says. "After one more backcross, we'll be at 96% *Vitis vinifera* and we'll test those by evaluating for wine quality."

In other research, UC Berkeley plant pathologist Steven Lindow has discovered a signaling system involving the secretion of a small molecule produced by *Xylella fastidiosa*, the cause of Pierce's disease. This molecule is involved in the suppression of *Xylella* virulence when cells become abundant in the plant. Artificially increasing the abundance of this signal molecule in various ways, including the use of plants that have been genetically engineered to produce it, has led to the suppression of virulence of the pathogen and Pierce's disease control. Extensive greenhouse tests are under way, but field studies will not commence before next year at the earliest.

As scientific advances occur and are made available, even more growers will be encouraged to adopt sustainable practices. "The work by UC has been critical to our success," Ross says.

— Robin Meadows

Cover crops provide food and shelter for beneficial insects such as ladybugs, which eat aphids, and pyrethroid wasps, which are tiny parasites that lay their eggs inside leafhopper eggs.

Nest boxes can attract wildlife to vineyards

Placing nest boxes for songbirds, owls and bats in and around vineyards can contribute to the sustainable management of pests and help mitigate oak-woodland habitat losses, according to a new booklet published by the UC Division of Agriculture and Natural Resources, "Songbird, Bat and Owl Boxes: Vineyard Management with an Eye toward Wildlife."

"Nest boxes are readily accepted by a number of bird and bat species and provide places for these animals to roost and nest. Used properly, they can help maintain biodiversity in vineyard landscapes," says Emily Heaton, co-author of the 51-page booklet with Rachael Long, Chuck Ingels and Tom Hoffman.

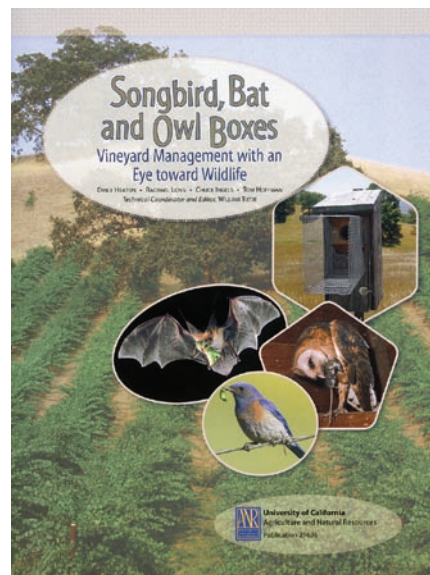
The booklet is illustrated with color images and provides information on the rationale for placing nest boxes and bat houses in vineyards; which species may be attracted to them, as well as feeding and nesting behavior; detailed plans for building, placing and monitoring bird boxes and bat houses; and references and resources.

"The growers that I worked with really enjoyed seeing birds in the vineyards," says Heaton, a UC Berkeley doctoral student who has conducted

research on songbird boxes in vineyards. "Plus the birds are in there eating insects, and that may have some beneficial effect in terms of pest control."

Many species native to woodlands — such as some songbirds, owls and bats — use cavities in oak trees for roosting or nesting, and they lose habitat when trees are cleared for new agricultural plantings. Vineyard development expanded rapidly during the 1990s, especially on the Central Coast and North Coast, says Bill Tietje, technical editor of the booklet. "Unlike most row crops, soil characteristics and topography did not completely restrict some new vineyard development from areas formerly classified as oak woodland."

"There was a lot of public concern about impacts on views and biodiversity," Tietje continues, "and growers would like to demonstrate that they are



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