

# SUSTAINABLE AGRICULTURE

## Methyl bromide alternative projects bear diverse fruit

by Sam Prentice and Jenny Broome, SAREP

In 1998 SAREP was awarded a one-time legislative augmentation to support research into alternatives for the agricultural fumigant methyl bromide. Six projects were funded with the special allocation (AB 1998) sponsored by Assemblywoman **Helen Thomson** (D-Yolo County) and funded through the Department of Pesticide Regulation. Methyl bromide is a broad-spectrum fumigant widely used to control insect, pathogen, nematode, weed and rodent pests. It has also been identified as a Class I ozone-depleting substance. Under the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has prohibited the production and importation of methyl bromide starting January 1, 2005. In addition, the United States has joined 140 other nations in signing the Montreal Protocol, which in 1994 froze production and importation of methyl bromide at 1991 levels, and which requires use to be reduced in developed countries by 25 percent in 1999, 50 percent in 2001, 70 percent in 2003 and 100 percent in 2005. According to EPA, continued use of methyl bromide as an agricultural pesticide may contribute five to 15 percent to future depletion of the ozone layer if it is not phased out.

This phase-out has significant implications for California agriculture, as methyl bromide is widely used as a pesticide for the



Peach trees in replant disorder research study.  
(photo by Greg Browne)

production and export of high-value crops and commodities produced statewide. Approximately 90 percent of the methyl bromide used in California is for pre-plant soil fumigation to control soil-borne pathogens and pests principally in strawberries, nursery crops, grapes, and tree fruits and nuts. When used in this manner, about 50 to 95 percent of the methyl bromide injected can enter the atmosphere. Postharvest commodity treatment accounts for another five to 10 percent of the methyl bromide use statewide and is directed largely at insects that damage nuts, cherries, grapes, raisins, and at imported materials. About 80 to 95 percent of the methyl bromide used in a commodity treatment eventually enters the atmosphere. Structural fumigation accounts for most of the remainder of the methyl bromide use in California.

Several potential chemical and non-chemical alternatives to methyl bromide have been identified nationally and internationally and some of these alternatives have been and are being evaluated in California. Below are final summaries from three of six projects funded by SAREP that investigate potential alternatives in several different cropping systems; the remaining three will be published in the next edition (Vol. 15,

See **METHYL BROMIDE** p.12

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## SAREP, Small Farm Program, Cooperative Extension collaborate in new county organic programs

As California's organic industry grows in size and value, so does SAREP's commitment to funding of statewide research and extension services to clientele interested in organic production systems and rules. I am pleased to report that **Bruce Hirsch**, executive director of the Clarence E. Heller Charitable Foundation and **Kerry Anderson**, trustee/program officer, for the True North Foundation, have authorized three-year renewable grants to SAREP for a total of \$299,810 to support the creation of new organic research and extension activities in existing UC Cooperative Extension (UCCE) programs in Sonoma, Mendocino, Nevada/Placer, Sutter/Yuba, San Diego, Santa Barbara, Fresno, and San Joaquin counties.

The programs in the latter four counties, funded by the Heller Charitable Foundation, have been initiated through **Desmond Jolly's** vision and cooperation with SAREP. Jolly is the director of the UC Small Farm Center located at UC Davis. Each county will receive support for up to three years to create an organic production research and extension program. These grants will allow county directors to address key local subjects in organic and transitional agricultural systems. The grants offer a minimum of three years of assistance to the UCCE offices and the eventual production of new organic farming extension publications in order to increase program services to clientele. It is expected that this project will result in the permanent establishment of transitional and organic farming extension projects in the targeted counties and serve as a model for the establishment of future county-based programs.

### FUNDED BY THE TRUE NORTH FOUNDATION:

#### Sonoma County

Organic horticulture. **Linda Chávez**, county director, **Paul Vossen**, farm advisor [olives for oil: varietal differences, pest man-

agement (including European approaches to organic management of *Dacus oleae*) soil management].

#### Mendocino County

Organic winegrape program. **John Harper**, county director, **Glenn McGourty**, farm advisor (winegrapes: varietal issues, pest management, cultural controls, cover crops, sanitation).

#### Sutter-Yuba counties

Organic stonefruit production program. **John Williams**, county director, **Janine Hasey**, farm advisor (stonefruit: nitrogen budgets and application issues, green manure and compost management, insect and weed management).

#### Placer-Nevada counties

Organic small farm production. **Sharon Junge**, county director/farm advisor (organic production compliance, scale and certification issues; marketing, compost, fertility).

I will report on the success of the True North Foundation-funded activities in a future issue of *Sustainable Agriculture*.

### FUNDED BY THE CLARENCE E. HELLER CHARITABLE FOUNDATION:

#### San Joaquin County

Many experienced organic farmers have faced problems with weed control in producing vegetable and specialty crops. While mowing and mulching often provides substantial weed control in tree and vine crops, vegetable and specialty crop growers do not have the room to use equipment and mulch between closely spaced crops like beans, cole crops, basil, cucurbits, tomatoes and onions. Many organic farmers spend considerable time hand weeding, or they must hire extra labor to weed.

**Benny Fouche**, small farms & specialty crops advisor, UCCE San Joaquin County, will be investigating the control of various annual weed species with the uses of allowed materials on a commercial, certified organic farm. Fouche will conduct replicated, ran-

domized trials of products like glacial acetic acid and yucca extracts (All Down Green Chemistry Herbicide), clove oil (Matran), vinegar and lemon products (Burnout) and others that have become available for organic farmers. He will produce research reports that will be made available through UCCE, the Small Farm Center, SAREP and the annual ANR Organic Workgroup conference. Short courses and field days will be scheduled for growers and others interested in this project.

#### San Diego County

San Diego County has approximately 400 organic farmers, the largest concentration in California. Many of the crops are unique to the county and grown on small acreages. Local growers have limited information to guide their production and marketing decision-making processes, which poses significant challenges for local growers to produce and market their crops. There is a need for information about the organic sector and developing and implementing research and extension activities targeting organic producers and marketers. Farm advisor **Ramiro Lobo** will expand UCCE San Diego project plans to establish an Organic Advisory Board in San Diego County. It will shape a research and extension agenda to address the needs of local organic growers, and may help promote the agenda with industry groups. It will also assess the markets and challenges faced by local organic growers. This effort will result in the development of an organic market directory for San Diego County. The Board will establish an organic blueberry research project to complement conventional blueberry research efforts. This research will focus on evaluation of blueberry varieties under organic growing systems, and evaluate soil pH management techniques and acidifying compounds for optimal blueberry production.



Mark Gaskell, UCCE Santa Barbara County/San Luis Obispo farm advisor.

### Fresno County

Diabrotica beetles, commonly known as cucumber beetles, are among the most difficult insect pests to control in organic vegetable systems. Spotted and striped cucumber beetles are the most common in the Central Valley, and they are especially harmful to cucurbits (squash, melons, cucumbers, many Asian vegetables). Besides the damage caused by the larvae on plant roots and the chewing by the adults on foliage, the beetles are also vectors of mosaic virus. UCCE Fresno County farm advisor **Richard Molinar** and **Michael Yang**, Hmong agricultural assistant, will work with several farmer collaborators to set up replicated trials in cucurbits to test organic insecticides including rotenone, sabadilla, pyrethrum, diatomaceous earth and others, and to use reflective mulches and tachinid parasite flies. The objective is to find methods that will provide cost-effective control of the pest.

### Santa Barbara County

Efficient and cost-effective nitrogen and phosphorous nutrient management systems for organic fruit and vegetable production is the focus of UCCE Santa Barbara County/San Luis Obispo farm

advisor **Mark Gaskell**. Nitrogen (N) is often a critical limiting nutrient in organic fruit and vegetable production. Research has shown wide variations in seasonal N available from different organic amendments. Phosphorous (P) has fewer problems related to availability, but repeated use of materials containing P, including compost, at high rates may cause P contamination problems. The best nutrient management system for organic production varies depending upon specific crop, soil type, cropping period and other factors. Liquid organic N sources also present special problems for growers applying fertilizer with irrigation systems. Gaskell will continue to do field trials with farmer-cooperators and provide soil and plant analysis in an attempt to determine efficient and cost-effective fertilizer systems for organic fruit and vegetables.

Each designated county will focus on disseminating information developed from research projects undertaken with the yearly funding. The designated farm advisor from each county will demonstrate and adapt new research-based organic and transitional techniques for their particular clientele each year. They will link campus-based researchers, other Cooperative Extension advisors, growers and consumers, if necessary, in this research.

During the project period, each selected farm advisor will hold at least one yearly extension meeting and one final local short course on the organic production practices for the selected crop(s). SAREP and the Small Farm Program will separately fund certain costs associated with the short courses and production of relevant manuals (or other extension materials).

SAREP will continue to carry out our legislative mandate to extend information on organic production methods and marketing with new and existing county programs.—*Sean L. Swezey, director, University of California Sustainable Agriculture Research and Education Program*

(IN OUR NEXT ISSUE: UC Organic Farming Work Group announces organizational changes and events.)

## Oakland ag fair

Sustainable Agriculture Education (SAGE) is sponsoring the second annual “Agricultural Roots Fair” September 13 at the Oakland Museum in Oakland. The daylong event will be a harvest celebration that highlights land and culture connections.

“With an increasingly diverse urban population, it is important to broaden outreach efforts and demonstrate how sustainable agriculture is relevant to the pressing issues and initiatives in communities around the state,” said **Sibella Kraus**, SAGE director.

The fair will feature ethnic music and dance performances, family activities, tastings, ethnic street foods, and a farmers and crafts market representing diverse agricultural and culinary traditions. Educational displays about nutrition, community gardening, recycling, farm-to-school programs, and agri-tourism will emphasize connections between sustainable agriculture and community health.

A key component of the project is to develop a long-term community-based management structure under the auspices of the California Department of Food and Agriculture’s Fairs and Expositions Division, Kraus said.

SAGE organized the Roots Fair in collaboration with the Oakland Museum of California. Community partners include UC Cooperative Extension Alameda County, East Bay Asian Local Development Corporation, Friends of the Peralta Hacienda Historical Park, La Peña Cultural Center, Laney College Culinary Arts Program, Marin County Farmers Market Association, New America Foundation, and Thimmakka’s Resources for Environmental Education. The main sponsor is CDFA’s Divisions of Fairs and Exhibitions; additional funders and sponsors include Bank of America, Columbia Foundation, East Bay Community Foundation, Epic Roots, GreenLeaf and SAREP. For information about the fair check [www.sagecenter.org](http://www.sagecenter.org) or email [info@sagecenter.org](mailto:info@sagecenter.org).

## STANDING-ROOM-ONLY SPRING LECTURES

# Science of sustainable agriculture series 'Measuring the Immeasurable' continues in fall

by Jenny Broome, SAREP

SAREP was pleased to help organize the successful, multidisciplinary speaker series on sustainable agriculture at UC Davis during the spring of 2003. The series will continue with 10 speakers during the fall of 2003 (schedule follows). The series received considerable support and leadership from the UC Davis College of Agricultural and Environmental Sciences Programmatic Initiative, Unilever Bestfoods Corporation, Kearney Foundation of Soil Science, UCD Department of Agronomy and Range Science, UCD Department of Land, Air & Water Resources, as well as the UCD Center for History, Society, and Culture.

The series opened with a standing room only crowd of over 100 faculty, students, and community members gathered to hear **William B. Lacy**, UC Davis' own Vice Provost for University Outreach and International Programs, and professor in the Department of Human and Community Development speak on "The Science of Sustainable Agriculture in a Context of Disciplinary and Private Knowledge." Lacy provided an overview of what sustainable agriculture is and how the university provides a challenging context within which to address it, due to disciplinary boundaries and reduced public funding.

**Kenneth G. Cassman**, professor and chair of the Department of Agronomy and Horticulture, University of Nebraska, Lincoln spoke on "Intensive Cereal Production Systems for Global Food Security and Protection of Natural Resources." Cassman suggested ways to increase global production with nutrients, crop choice, and irrigation through developed-world technologies and approaches. He suggested we do not have a global food shortage or crisis of under-production, but could have one within 20 years based on projections of population growth. **William**

**H. Friedland**, professor emeritus from the Departments of Community Studies and Sociology at UC Santa Cruz addressed "Globalization and Its Impact on California Agriculture." Friedland suggested that California agriculture has been "globalized" for a long time, and exporting commodity overproduction is only a partial economic solution to agricultural sustainability that comes with environmental and social costs. He said sustainability should be measured in terms of capital, labor, natural resources, and the scientific knowledge base.

Two European speakers followed, beginning with **Floor Brouwer**, head of Management of Natural Resources, Agricultural Economics Research Institute (LEI), The Hague, Netherlands. He talked about "Strategies for Sustainability in Agriculture: A European Perspective," and discussed the Common Agricultural Policy and the way European farm payments are changing from direct commodity payments to agri-environmental payments. He predicted that intensified export-oriented production systems located near shipping ports would continue to co-exist with extensive farming systems that preserve the countryside like Alpine Swiss dairies. **Simon Bell** addressed "Measuring Sustainability: Learning by Doing." Bell is a senior lecturer in Information Systems, Center for Complexity and Change, Technology Faculty, The Open University in the United Kingdom. He focused on the process involved in the development and use of indicators that can be used to measure sustainability. He uses an analytical approach that involves a continuous cycle of reflection, connection, modeling, and doing. He stressed the need to involve stakeholders, and the importance of the process as well as the end goal, in measuring sustainability.

The series then turned to the food system and the key role that civil society can play in changing it with **Thomas Lyson's** discussion of "Civic Agriculture and Food Citizenship: Sustaining Local Food Systems in a Globalizing Environment." Lyson is the Liberty Hyde Bailey professor in the Department of Rural Sociology at Cornell University. **Cynthia Rosenzweig** discussed global warming trends and various models used to predict impacts of different scenarios on agriculture and food production in "Agricultural Production and Climate Changes." She is a research scientist at the National Aeronautic and Space Administration (NASA), Goddard Institute for Space Studies. **Richard Howitt** presented information on the key natural resource in California—water—and presented his research on "Economic Policies to Encourage Sustainable Agriculture—Some Examples from Irrigated Crop Production." Howitt is a professor in the Department of Agricultural and Resource Economics at UCD. The final spring speaker was anthropologist **Glenn Davis Stone**, who gave an excellent overview of the crisis of overproduction of food that confronts much of the world including India where he conducts research. In "Intensive Agriculture and the New Malthus: A Perspective from India," Stone discussed research that finds Malthus was wrong in his predictions about population growth outstripping food production thus leading to famines and population reductions through starvation. Stone noted that technological improvements alone would do little to reduce poverty and hunger. Stone is an associate professor, Department of Anthropology, Washington University, St. Louis. His talk was especially timely as the USDA Ministerial Conference on Ag Biotechnology took place in Sacramento two weeks later.

# FALL 2003 SERIES SCHEDULE

*All lectures are scheduled for Fridays from 12:10 to 1 P.M. in Room 3001 of the Plant and Environmental Sciences (PES) building at UC Davis. Lectures will be video taped and posted within 24 hours on the SAREP Web site (<http://www.sarep.ucdavis.edu/seminar/>).*

OCTOBER 3

**ENERGY USE IN AGRICULTURAL SYSTEMS**, SPEAKER TO BE ANNOUNCED.

OCTOBER 10

**RANGELAND CONSERVATION AND BIODIVERSITY**

*Jill Landsberg*, ecologist, School of Tropical Biology, James Cook University, Queensland, Australia

OCTOBER 17

**INTEGRATED FARMING SYSTEMS: SOIL AND PLANT INDICES OF SUSTAINABILITY**

*Pete Smith*, senior lecturer in Soils & Global Change, School of Biological Sciences, University of Aberdeen, United Kingdom

OCTOBER 24

**HOW DO WE KNOW THE IMPACT OF SUSTAINABLE AGRICULTURE ON QUALITY OF LIFE?**

*Cornelia Butler Flora*, Charles F. Curtiss Distinguished Professor of Agriculture and Sociology at Iowa State University, and director of the North Central Regional Center for Rural Development, Iowa State University

OCTOBER 31

**LAND AND WATER MANAGEMENT IN ARID REGIONS: HISTORICAL AND CONTEMPORARY PERSPECTIVES**

*Daniel Hillel*, Center for Environmental Studies, Israel, and professor emeritus of Plant, Soil and Environmental Studies, University of Massachusetts, Amherst

NOVEMBER 7

**WHY YOU SHOULD EAT FOOD AND OTHER NUTRITIONAL HERESIES**

*Joan Dye Gussow*, professor of Nutrition and Education, Columbia University

NOVEMBER 14

**DEVELOPING A CURRICULUM FOR A SUSTAINABLE AGRICULTURE: EDUCATING THE RESEARCHERS AND FARMERS OF THE FUTURE**

Charles Francis, professor of Agronomy, University of Nebraska, Lincoln.

NOVEMBER 21

**UNFOLDING A SUSTAINABLE AGRICULTURE FOR THE 21ST CENTURY: SOME CHALLENGES FOR EDUCATION AND EXTENSION**

Fred Kirschenmann, director, Leopold Center, Iowa State University

NOVEMBER 26

**THE SCIENCE BEHIND ORGANIC AND BIODYNAMIC FARMING**

John Reganold, professor, Department of Crop and Soil Sciences, Washington State University, Pullman (invited)

DECEMBER 5

**PAST, PRESENT, AND FUTURE OF SUSTAINABLE AGRICULTURE AT UC DAVIS**

William Horwath, associate professor, Land, Air, and Water Resources, UC Davis

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See the SAREP Web site for more details and video archives <http://www.sarep.ucdavis.edu/seminar/> or contact **Jenny Broome** at 530-754-8547 or [jcbroome@ucdavis.edu](mailto:jcbroome@ucdavis.edu).

There will be an undergraduate and graduate seminar course linked to the speaker series. Contact **Mark Van Horn** for more information at 530-752-7645 or [mxvanhorn@ucdavis.edu](mailto:mxvanhorn@ucdavis.edu)

## Science of sustainable viticulture special session

by Jenny Broome, SAREP

The “Science of Sustainable Viticulture” was center stage at a special all-day session of the American Society of Enology and Viticulture’s (ASEV) 2003 annual meeting in Reno, Nev. in June. More than 250 people jammed the session, organized by **Deborah Golino**, director of UC Davis’ Foundation Plant Services program.

Golino introduced the session with comments on its importance and origins. **Jenny Broome**, SAREP associate director, presented information on “Sustainable Viticulture Programs around the World.” Broome covered both the research and the programmatic initiatives taking place in California, Oregon and other parts of the northwest United States, and in Switzerland, South Africa, and Australia. She also covered worldwide organic and biodynamic production. **Charles Francis**, agronomy professor from the University of Nebraska, provided an “Overview of the Discipline of Sustainable Agriculture.”

Other speakers selected for their disciplinary focus and expertise related to key components of sustainable viticulture research spoke throughout the day. They included **Kent Daane**, UC Berkeley Division of Insect Biology, Center for Biological Control, who presented his research on “Developing Insect-IPM Systems for Sustainable Viticulture: Increasing Vegetational Diversity to Suppress Leafhopper Pests.” **Chris**

**Penfold**, Weed Science, University of Adelaide, Australia, spoke on “Weed Management in Viticulture.” **John**

**Reganold**, Department of Crop and Soil Sciences, Washington State, Pullman, spoke on “Healthy Soils for a Sustainable Viticulture.” **Lucius Tamm**, Research Institute of Organic Agriculture, Frick, Switzerland, gave a presentation on “Crop Protection Strategies of European Organic Viticulture.” **Andrew Walker**, geneticist and breeder, UC Davis, talked about “The Role of Breeding in Sustainable Viticulture.”

**Cliff Ohmart**, director of IPM/research at the Lodi-Woodbridge Winegrape Commission, chaired a panel of practitioners and program coordinators in a session entitled “Bringing It to the Vineyard and Winery.” He also made a presentation on the topic. **Kris O’Conner**, executive director, Central Coast Vineyard Team, discussed “Grower Participation in Developing a Sustainable Viticulture System: The Positive Points System as a Management Tool.” **John Williams**, Frog’s Leap Winery, Napa Valley, spoke about “Organic Wine Production and Wine Quality,” while **Glenn McGourty**, UC Cooperative Extension viticulture advisor, Mendocino and Lake counties, spoke on “Vineyard Water Quality Planning and Clean Water Laws. **Ann Thrupp** of Fetzer Vineyards, spoke on “Growing Organic Winegrapes Sustainably.”

### November UC short course on organic winegrowing

by Jenny Broome, SAREP

Organic winegrapes are among the most important organically grown commodities in California. In response to rapid growth in this agricultural sector, UC Cooperative Extension and SAREP are sponsoring a two-day intensive winegrape short course November 17-18 at the Brutocao Vineyard Plaza in Hopland.

Statewide there are over 7000 acres of registered organic winegrapes, according to the California Department of Food and Agriculture. In Mendocino and Lake counties alone there are 50 winegrowers farming over 3500 acres of certified organic winegrapes with a crop value estimated at approximately \$18 million, according to **Glenn McGourty**, UC Cooperative Extension farm advisor in Mendocino and Lake counties. It is estimated that there are an additional 2000 acres of winegrapes in the two counties that are farmed organically but are not certified.

Other parts of the North Coast involved in organic winegrowing include Napa County (1200 certified acres) and Sonoma County (450 certified acres).

“Growers in other regions are also interested in improving their farming practices, and organic wine growing is a popular subject of discussion at many grower meetings,” McGourty said. “Growers raise organic winegrapes for a variety of reasons, but a price differential is not one of them, in most instances.”

He said growers are inspired by the quest for high-quality fruit that expresses the terroir (distinctive characteristics of the land and farming methods) of their region. Worker safety and environmental concerns are the other reasons most widely cited for their interest in organic wine growing, McGourty said.

The short course will emphasize successful practices used by North Coast organic winegrowers. Researchers will present summaries of organic research taking place in the region. Presenters will address key organically acceptable viticultural practices such as soil management, vineyard design and canopy management, cover cropping, and the use of compost. Weed, disease, insect, mite and nematode management will be addressed, as will the topic of vineyards in the landscape. The techniques and practices of organic winemaking will also be discussed (and tasted!).

Course fee: \$225. For more information, contact McGourty at 707-463-4495; [gmcgourty@ucdavis.edu](mailto:gmcgourty@ucdavis.edu); <http://cemendocino.ucdavis.edu> or [www.sarep.ucdavis.edu/organic](http://www.sarep.ucdavis.edu/organic).

The CDFAs Buy California Initiative and the USDA are providing partial funding for this event. Other sponsors include Fetzer Vineyards, Brutocao Cellars and the Mendocino Winegrowers Alliance.

The day ended with "Research Presentations From Selected Abstracts." **Kendra Baumgartner**, USDA-Agricultural Research Service sustainable viticulturist, organized and chaired this session, and presented her research on "Effects of Vineyard Floor Management on Mycorrhizal Fungi in a Central Coast California Vineyard." **Chuck Ingels**, UC Cooperative Extension, Sacramento County, presented SAREP-funded research on "The Effects of Cover Crops on a Northern California Vineyard Ecosystem." **Goro Okamoto**, of Okayama University, Japan, talked about the "Effect of Fertilizer Application Levels on Anthocyanoplast Development in Pione Grape Skin under a Root-Zone Restricted Condition." **Valerie P. Saxton**, of Lincoln University of New Zealand, presented data on "Bird Foraging Behavior in Vineyards." The final speaker was **Michael Sipiora** of Huneus Vintners, Rutherford, who spoke on "Canopy Developmental Stages for Cordon-Trained Spur-Pruned Grapevines."

Participants expressed the hope that additional sessions will be organized at future ASEV meetings as well as at the annual Unified Winegrape Symposium held in Sacramento. All PowerPoint presentations are being made available on the SAREP Web site at [www.sarep.ucdavis.edu/production/viticulture/asev2003.htm](http://www.sarep.ucdavis.edu/production/viticulture/asev2003.htm).

The planning committee that organized the sustainable viticulture session included **Kendra Baumgartner**, USDA-ARS sustainable viticulturist; **Janet C. "Jenny" Broome**, associate director, UC Sustainable Agriculture Research and Education Program (SAREP); **Deborah Golino**, Extension plant pathologist, UCD; **Randle G. Johnson**, vice president, The Hess Collection, Napa; **Mitchell Klug**, Robert Mondavi Winery, director of Napa Valley winegrowing operations, founding member of Napa Sustainable Winegrowing Group; **Cliff Ohmart**, director, IPM/research, Lodi-Woodbridge Winegrape Commission; **Dennis Martin**, Fetzer Winery, director of wine-making, ASEV past President; and **Glenn McGourty**, viticulture advisor, UC Cooperative Extension Mendocino and Lake counties.

## New BIFS program advisory review board members

SAREP's Biologically Integrated Farming Systems (BIFS) program, established in 1995 by the UC Regents at the request of the California state legislature, uses a "whole system" approach to demonstrate innovative farming practices that enhance biological processes. In partnership with farm advisors and researchers, participating farmers implement alternative growing practices that include pest management, soil building, irrigation, waste management and other biological and cultural practices. These practices are designed to reduce negative environmental impacts such as pollution from agricultural chemicals, animal waste, and soil erosion.

A 13-member Program Advisory Review Board reviews BIFS project proposals and provides program guidance. The board is composed of representatives from the University of California, relevant state and federal agencies, non-profit organizations, as well as growers and a licensed pest control adviser. The following individuals were recently appointed to serve on the BIFS Board:

**JOE GRANT** is a UC Cooperative Extension farm advisor in San Joaquin County. His principal crop responsibilities include walnuts, sweet cherries and apples. He has a bachelor of science degree in plant science from UC Davis, and postgraduate degrees from UCD in horticulture (pomology), and plant protection and pest management. Grant has been a farm advisor in San Joaquin and neighboring counties since 1985 and has extensive experience in pest management systems for orchard crops. He was the principal investigator of the walnut BIFS project, which concluded in spring of 2002.

**WILLIAM HORWATH** is a professor of soil biogeochemistry in the land, air and water resources department at UC Davis. Before coming to Davis he spent three years as a soil microbiologist with the USDA-ARS in Corvallis, Ore. doing research on composting on-farm wastes and the influence of riparian areas on water quality in agricultural landscapes. Currently he teaches nutrient cycling and management and organic chemistry of soil. His research is directed at understanding how soils store carbon or organic matter in both agriculture and forest ecosystems; results address the issue surrounding the sustainability of practices leading to soil carbon sequestration and the associated affects on nutrient cycling. These relate to the potential of using alternative management strategies in California agriculture and forestry systems to store soil carbon and mitigate the effect of rising atmospheric carbon dioxide levels on global climate change. Horwath also serves on SAREP's Technical Advisory Committee.

**PATRICK WEDDLE** is an entomologist and technical support representative for Pacific Biocontrol Corporation, a pioneering producer and marketer of insect mating disruption technologies. He is also the founder and president of Weddle, Hansen and Associates, Inc., a California based agricultural consulting firm established in 1975, specializing in the development and implementation of strategies, tactics and policies to secure adoption of commercially viable systems of crop protection with emphasis on biologically intensive integrated pest management (IPM). Prior to establishing the consulting firm, Weddle was the principal coordinator of the UC/USDA IPM implementation project in El Dorado County, California. He has taught classes, delivered lectures and written extensively on IPM and policies that relate to the implementation of sustainable systems of crop protection. Weddle has served in many professional, agency, university and industry leadership positions. He received his bachelor's and master's degrees in entomology from the UC Berkeley.

### CONTINUING BIFS BOARD MEMBERS AND ALTERNATES:

**Matt Billings, Sherman Boone, John Carlon, Bob Elliott, Tish Espinoza, Paul "Augie" Feder, Paul Gosselin, Stephen Griffin, Belinda Messenger, Gregory Nelson, John Steggall, Katherine Taylor, and Dawit Zeleke.** Biographies of these BIFS Board members appeared in the 2002 winter/spring issue of Sustainable Agriculture (Vol. 14, No.1).

# Agriculture affects amphibians (PART 2)

## Pesticides, fungi, algae, higher plants, fauna, management recommendations

by Robert L. Bugg, SAREP, and Peter C. Trenham, postdoctoral research fellow, Section of Evolution and Ecology, UC Davis

Part 1 of this article (viewable at: <http://sarepdevel.ucdavis.edu/news/15n1/sa-6.html>) addressed the consequences of climatic change, landscape-scale dynamics, hydrology, and mineral enrichment of water on amphibians. In Part 2, we discuss pesticides, associated organisms (e.g. fungi, algae, higher plants, parasites, predators, and competitors), and on-farm modifications that may favor native amphibians. The list of references is also provided.

### PESTICIDES

At sufficient doses many pesticides negatively affect amphibians. The issue is complex. Davidson et al. (2001, 2002) found that several California frogs have declined disproportionately from sites that are downwind from areas with agricultural activity. This suggests that windborne agricultural pesticides might be contributing to declines; however, it is unclear which pesticide(s). These chemicals can travel surprisingly long distances. Even frogs collected from high in the Sierra Nevada contain detectable concentrations of organochlorine pesticides that appear to be compromising their immune systems (Sparling et al. 2001).

An additional concern is that standard assays often underestimate the toxicity of pesticides. These tests typically expose tadpoles over short intervals under unnatural conditions. Problems with short-term studies, focusing only on tadpole mortality, were emphasized by Hayes et al. (2002), who demonstrated that exposure to extremely low concentrations of atrazine was not lethal, but resulted in the dramatic feminization of male frogs. Further, Relyea and Mills (2001) found that the insecticide carbaryl was much more toxic to tadpoles when the latter were stressed by the presence of a predator. This calls into question the wisdom of unnatural test conditions. Clearly, where herbicides and insecticides reduce food sources these chemicals can have indirect effects on amphibians. Also, exposure to certain chemicals can make larval amphibians more vulnerable to parasites and predators (see “Native Fauna” below).

### ASSOCIATED ORGANISMS

**Fungi.** A chytrid fungus, now recognized as *Batrachochytrium dendrobatidi*, was implicated by Berger et al. (1998) as the causal

agent for die-offs of amphibians in Australia and Central America. This fungus attacks keratinized tissues, including the mouths of tadpoles and various structures of the adults like the pelvic patch, which is the site of cutaneous respiration and osmoregulation for many frogs and toads. Fungal infections of the mouth that do not appear to reduce larval survival often spread to other organs and kill the metamorphosed young. Rollins-Smith et al. (2002a, 2002b) discovered that several peptides found in the skin of amphibians, including ranid frogs, inhibit infection and growth by the fungus and other pathogens. Rollins-Smith et al. (2002b) speculated that if environmental factors inhibit formation and exudation of the peptides, this resistance mechanism could be compromised. The fungus has been isolated from frogs in the Sierra Nevada of California, although the role it may have played in declines here remains unclear (Fellers et al. 2001).

**Algae.** Diatoms (Chrysophyta) are important foods for larvae of several frog species, including Pacific tree frog (*Hyla regilla*) (Kupferberg et al. 1994) and foothill yellow-legged frog (*Rana boylei*) (Kupferberg 1997). In streams, diatoms may occur as films on rocks (a type of periphyton) or as ephyphytes attached to some species of filamentous green algae (e.g., *Cladophora* spp., Chlorophyta). In either case, diatoms are a fat-rich food that enables more rapid growth and metamorphosis than occurs on diets of filamentous green algae alone. This suggests that algacidal chemicals may have deleterious side effects on frog reproduction.

**Higher Plants.** Aquatic, emergent, and terrestrial higher plants influence shading, food availability to larvae and adult amphibians, run-off, siltation, insulation from thermal

extremes, and refuge from predators. Different amphibians have different optima and tolerances when it comes to vegetation types and degree of cover. Management that influences vegetation in and around breeding habitats clearly may affect amphibians. In Madagascar, Vallen (2002) found that, comparing the amphibian fauna of intact rainforest with 1) secondary forest, 2) eucalyptus plantation, and 3) rice fields, that these habitats had richnesses reduced by 46, 54, and 88%, respectively. As noted by Mitchell and Power (2003), invasive introduced plants, through release from fungal and viral pathogens, may be at a competitive advantage with respect to native plants. This might be expected to have indirect consequences for associated native fauna, such as amphibians, but no formal correlative or causal linkage has been made.

There is much interest in restoration ecology, yet there are few data documenting the conditions that prevailed prior to European colonization of California. Thus, valid models or targets for restoration are controversial. A case in point occurs with the bunchgrass dominance paradigm. For many years, the prevalent belief was that purple needlegrass (*Nassella pulchra*) and other native bunchgrasses dominated much of the floor of California's Great Central Valley prior to a great drought in 1860. However, Holstein (2001) asserted that stands of rhizomatous graminoid plants (e.g., grasses, rushes, and sedges) and annual forbs were—and are—more prevalent, citing several examples where observations occurred prior to 1860 and minimal disturbance has since occurred. This and related issues may have consequences for survival not only of flora, but also of associated fauna, such as amphibians. Different





California red-legged frog (threatened). (photo by Matthew Fujita, UC Davis/UC Berkeley)

California native plant complexes have yet to be explored as determinants of amphibian assemblages.

Britson and Kissell (1996) reported that when tadpoles of upland chorus frog (*Pseudacris triseriata feriarum*) were fed oak or pine pollens exclusively during any phase of development, size and incidence of metamorphosis were reduced. Thus, although tadpoles may feed on suspended pollens, these may not by themselves sustain metamorphosis.

Hazell et al. (2001) studied frog diversity in farm ponds of New South Wales, southeastern Australia. They found the highest diversity in ponds with abundant emergent vegetation, higher percentages of ground cover in the riparian zone, and higher percentages of cover by native vegetation within 1 km. Emergent and riparian vegetation are thought to be important as shelter for adults and recent metamorphs, reducing predation and desiccation.

Driscoll and Roberts (1997) in Western Australia found that controlled burning of native vegetation, to reduce fuel load and the likelihood of catastrophic wildfire, led to a short-term 29% decline in calling males of the frog *Geocrinia lutea*.

Waldick et al. (1999) in eastern Canada found that black spruce (*Picea mariana*)

plantations harbored much lower densities of redback salamander (*Plethodon cinereus*) than did natural forests that included deciduous angiosperms.

In Maine, DeMaynadier and Hunter (1999) found higher densities of adult and newly metamorphosed wood frog (*Rana sylvatica*) and spotted salamander (*Ambystoma maculatum*) in closed canopy forest rather than in a cleared power-line right-of-way. Further, they showed that newly metamorphosed wood frogs have strong preference for closed canopy habitat.

In agricultural landscapes of southern Quebec, Canada, Maissonneuve and Rioux (2001) found that amphibian and reptile (herpetofauna) species richness and diversity were greatest in shrubby, intermediate in woody, and lowest in herbaceous riparian strips. By contrast, for small mammal species richness and diversity, highest values were in this order: woody > herbaceous > shrubby. For herpetofauna, abundance increased with increasing complexity of vegetational structure, i.e., vertical stratification of vegetation.

Kruess and Tschardtke (2002), near Hamburg, Germany, found that increased grazing intensity of pastures led to no changes in plant diversity, but insect diversity declined. This pattern might have

consequences for amphibians, such as northern leopard frog (*Rana pipiens*), which forages in meadows.

Woodford and Meyer (2003) found that lakefront housing and the associated removal of emergent and riparian vegetation was associated with greatly reduced densities of male green frog (*Rana clamitans melanota*) in Wisconsin glacial lakes. The authors pointed out that lakeside developmental and vegetation management standards could be altered and enforced to better accommodate the green frog.

**Native Fauna.** A parasitic fluke *Ribeiroia ondatrae* (Trematoda) causes limb deformation in several native California amphibians; these deformations are thought to have survival value to the flukes because they increase amphibian susceptibility to predation by birds and mammals, which serve as final hosts to the parasites (Johnson et al. 2002). In Pennsylvania, Kiesecker (2002) found that hatching tadpoles of wood frog exposed to the herbicide atrazine and the insecticides malathion and esfenvalerate, all at legally permissible levels for drinking water, led to compromised immune systems and increased infection and limb deformation by the flukes *Ribeiroia* sp. and *Telorchis* sp. In cage studies carried out in ponds, Kiesecker (2002) also found that limb deformations caused by flukes did not occur in ponds that lacked agricultural run-off containing these pesticides, although exposure to flukes did lead to reduced body mass of newly metamorphosed frogs.

Permanent water bodies enable overwintering by larvae of various dragonflies, including darners in the genera *Aeshna* and *Anax* (Odonata: Aeschnidae), which in the succeeding spring are important predators of native amphibian larvae (see Petranksa and Hayes 1998). Perhaps seasonal draining of such ponds would lessen these problems, as has been shown in other parts of the United States (Adams 2000).

Because amphibians have permeable skin, they are very vulnerable to desiccation. To avoid desiccation and predators, amphibians seek shelter. For aestivation, or summer dormancy, some amphibians find sufficient

Continued on next page

refuge under surface debris or in dense vegetation, whereas other species move underground. Although some amphibians construct their own burrows, many depend on tunnels created by other organisms.

In much of California, amphibians must survive a long, hot summer, with almost no rainfall for six months; therefore, aestivation, and underground refuges to accommodate it, are critical. Western spadefoot (*Spea hammondi*) digs its own burrows in loose sandy soils or gravel beds, where it is inactive until re-emergence. California tiger salamander (*Ambystoma californica*) relies on other animals to create its burrows. In two studies, this salamander was found exclusively in the underground burrows of mammals like California ground squirrel (*Spermophilus beecheyi*) and Botta's pocket gopher (*Thomomys bottae*) (Loredo et al. 1996, Trenham 2001). Other California species such as western toad (*Bufo boreas*) and Pacific tree frog have also been observed in mammal burrows. We believe that aestivation sites provided by fossorial (digging) mammals may be especially important on farmland, where logs and boulders are typically lacking.

**Introduced Fauna.** As indicated by Torchin et al. (2003), the success of introduced versus native animals may derive in part from their lower incidence of parasitism. The implied competitive advantage may enable invasion by an exotic species, some of which may compete with, or be natural enemies of, sensitive native species.

In California, bullfrog (*Rana catesbeiana*), which is native to the eastern United States, is the most common introduced amphibian. Replacement of extensive seasonal wetlands by permanent ponds water can enable survival of invasive exotic species such as bullfrog. Bullfrog interfere with red-legged frog (*Rana aurora draytonii*), foothill yellow-legged frog, and Pacific tree frog through larval competition for food and through predation by adult bullfrog, (Kupferberg 1997, Lawler et al. 1999, Chivers et al. 2001).

In Queensland, Australia, Crossland (2000) reported that eggs and hatchling tadpoles of the introduced toad *Bufo marinus* are toxic to the predatory larvae of the native frog

*Limnodynastes ornatus*. In artificial ponds, this led to increased survival by the native frog *Litoria rubella*, which in the absence of *B. marinus* preyed upon by *Lim. ornatus*. This work illustrates community re-structuring through direct and indirect effects, in that the presence of the introduced toad suppresses a native predator, thereby releasing another native species from predation.

Introduced sportfish and mosquito fish (*Gambusia affinis*) also interfere with native fish and amphibians (Goodsell and Kats 1999, Lawler et al. 1999), and are present in many permanent water bodies in the Central Valley, such as agricultural ponds. These fishes demonstrate a strong negative correlation with native amphibians, and have been proposed as a major threat to several species (Fisher and Shaffer, 1996). In the Sierra Nevada of California there is extensive evidence that the decline of mountain yellow-legged frog (*Rana muscosa*) is at least partly due to predation by introduced trout (Knapp and Matthews, 2000). In Australia, introduced trout species also prey on the tadpoles of native frogs; these tadpoles are unpalatable to native fish, but acceptable to the introduced ones (Gillespie 2001).

#### MANAGEMENT RECOMMENDATIONS

For farmers and other land managers committed to enhancing native amphibians, we recommend that they:

- 1) Create new ponds and avoid filling low areas that flood during winter rains. These are breeding habitats for many of our native amphibians. Wetland loss due to filling and draining is one of the main threats to amphibians worldwide. However, farmers and ranchers regularly create ponds that often provide productive amphibian breeding habitat.
- 2) Manage aquatic habitats to simulate natural Californian conditions, avoiding the substitution of permanent ponds or wetlands for ephemeral ones. As noted earlier, seasonal drainage of ponds disrupts the establishment of detrimental populations of fish, bullfrogs, and predatory insects. Seasonal wetlands with long hydroperiods may sustain the highest diversity of native

amphibians, but even short-lived puddles and ditches can support tree frogs and toads to metamorphosis.

- 3) Avoid introducing non-native fish, including mosquito fish, to seasonal or permanent bodies of water. This may run counter to mosquito and other vector-control priorities, and if so requires consideration of alternative control tactics.
- 4) Retain non-cultivated, preferably native, vegetation near ponds, streams, and wetlands. Submerged, emergent, and terrestrial vegetation are important as shelter for larval, adult, and newly metamorphosed amphibians. Vegetation provides essential cover from predators and moist shelter sites.
- 5) Minimize the introduction of agrichemicals, including pesticides and fertilizers, into aquatic and terrestrial habitats. These chemicals can have important direct and indirect deleterious effects on native amphibians.
- 6) Retain potential shelter for amphibian aestivation. Uncultivated woody or grassland patches, rodent burrows, woody debris, and rock piles provide important refugia. Pocket gopher and ground squirrels should be tolerated, where possible; this is not always the case.

Landscape-scale management issues include proximity of multiple breeding sites to one another and width of uncultivated zones that link breeding sites to forested areas or to other habitats required in the amphibian life cycles. Narrow hedgerows are probably insufficient to provide linkages (see Joly et al. 2001, Le Coeur et al. 2002).

Farm ponds and ditches are still poorly understood ecological resources in the United States; research cited here highlights the possibility of enhancing these resources (also see Pokorny and Hauser 2002, Maezono and Miyashita 2003).

Additional studies on the above and related themes will enable us to augment and refine recommendations and thereby enhance conservation of native amphibians that are influenced by agricultural practices.

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## METHYL BROMIDE CONTINUED FROM PAGE 1

No. 3) of *Sustainable Agriculture*. Overall, it appears that there is no single alternative for the use of methyl bromide that is both effective and economical. Rather, SAREP's research indicates that a matrix of alternatives is necessary to manage pests currently controlled by methyl bromide within California farming systems. Research is ongoing, as there is an urgent need to develop and evaluate effective, economical alternatives to the agricultural use of methyl bromide as a pre-plant soil fumigant and postharvest commodity and quarantine treatment.

### CULTURAL CONTROL AND ETIOLOGY OF REPLANT DISORDER OF PRUNUS SPP.

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#### Objectives

The overall goal of this research was to reduce dependence on pre-plant fumigation with methyl bromide for control of replant disease. The specific objectives were to:

1. Determine effects of pre-plant bare-fallow periods and pre-plant cover cropping on development of replant disease on peach in California.
2. Determine if cross-specificity exists between replant disease of peach and grape.
3. Determine organisms and factors that cause replant disease on selected *Prunus spp.* in California.

#### Summary

Replant disease (RD, also known as replant disorder) of *Prunus* species can complicate establishment of stone fruit and nut orchards planted after removal of a closely related crop. It results in poor growth, delayed crop production, and, in severe cases, tree death. RD is most clearly evident when it occurs in

the absence of known causes of other replant problems, which can include plant-parasitic nematodes, *Armillaria mellea*, *Phytophthora* species, *Verticillium dahliae*, or chemical or physical soil inadequacies. It can be prevented by pre-plant fumigation with methyl bromide (MB). Past research indicates that RD can severely limit tree performance even in the absence of the known causes for replant problems. Current data indicate that the causes of RD are primarily biological; RD symptoms can be prevented by soil heating (50 to 60 C) or by treating soil with diverse fumigants. The research on *Prunus* RD reported here was conducted at sites or with soils that lacked significant populations of plant parasitic nematodes.

Effects of zero- to three-year pre-plant fallow periods on performance of peach and plum trees on old orchard sites were determined in four experiments conducted by the USDA-ARS Water Management Research Lab near Parlier. In each test, a pre-plant MB fumigation treatment (350 lb/A, 0-year fallow) was included as a standard, and trunk growth and marketable fruit yields were used to assess treatment benefits. Without fumigation, each additional year of pre-plant fallow from zero to three years incrementally increased the amount of tree growth produced during the first several years after planting. However, not all fallow-induced growth increases were statistically significant, and they were not all accompanied by significant increases in first year marketable fruit yields. The results indicated that at least three years of pre-plant fallow are needed to match the growth and first-harvest yields produced following pre-plant fumigation with MB. It was not clear that one year of fallow provided a significant yield benefit, compared to no fallow, but growers should consider that optimal cultural preparation for replanting often requires a year of fallow.

Effects of pre-plant cover cropping on RD were investigated in two greenhouse experiments and are now being tested in field microplots. For the greenhouse tests,

soil samples from old peach and plum sites were planted with 10 different cover crops in pots in a greenhouse. Non-cropped and MB treatments were included for comparison. After four months of growth, the cover crops were shredded, incorporated into the soil, and allowed to decompose for one month. Nemaguard peach seedlings were transplanted in all of the soils and used to assay them for RD potential. In these tests there was no consistent effect of pre-plant cover cropping or fumigation on peach plant performance or incidence of root-associated fungi on peach. It is not certain that the greenhouse tests adequately represented field settings. To address the potential shortcomings of greenhouse tests, field microplots were established in 2002. The microplots, filled with soil from a peach RD site, received different pre-plant treatments starting in summer 2002, including short-term fallowing (one year when complete), short-term crop rotations (a summer crop of corn or Sudan grass, or a fall/winter crop of wheat) and standard fumigation with MB/chloropicrin (50:50, 400 lb/A, imposed in November). Nemaguard peach seedlings were planted in the microplots in early 2003 and will be used to test for potential benefits of the pre-plant treatments under field conditions.

Cross specificity between peach and grape RD was studied in the greenhouse and is now being investigated in field microplots. The greenhouse experiments did not provide conclusive evidence of such cross specificity, although in two of three tests, peach plants produced healthier roots in non-fumigated grape RD soil than in non-fumigated peach soil. Conversely, in the same two tests, grape plants produced healthier roots in non-fumigated peach RD soil than in non-fumigated grape soil, but the specificity was less pronounced for grape than for peach. For both crops, pre-plant fumigation with MB:chloropicrin (67:33) or autoclaving of the soil consistently increased growth (i.e., plant mass). A

microplot experiment was initiated near Parlier in 2002 to test for the cross-specificity effects under field conditions.

Factors and organisms that cause or contribute to RD on *Prunus* species were investigated near Chico and Parlier using coordinated field, greenhouse, and lab experiments. At both locations, symptoms of RD in the experimental trees' shoots (i.e., growth cessation, wilting, or defoliation) appeared to result from poor root system development. Fewer healthy feeder roots were present on trees with RD symptoms in non-fumigated plots than on healthy trees in chloropicrin- or methyl bromide-fumigated plots. Isolations from the feeder roots on healthy and RD-affected trees revealed occasional association between root infection with *Cylindrocarpum* or *Fusarium* species and incidence of the disease. Greenhouse tests confirmed pathogenicity of these fungi, indicating that they can play at least a partial role in causing RD. Hundreds of bacteria were systematically isolated and preserved from the rhizospheres of healthy and RD-affected trees in the Chico and Parlier trials. The collection will facilitate future research to determine whether certain culturable bacteria play a significant role in RD. When semi-selective fungicidal and nematicidal treatments were imposed on RD soil in the greenhouse, one of the fungicides, but not the other chemicals, resulted in less severe root symptoms of RD on test plants (Nemaguard peach and Marianna 2624 plum), providing additional evidence for fungal involvement in the disease. In field experiments, chloropicrin, which is known for effective control of several soilborne diseases caused by fungi, was more effective in preventing RD than either 1,3-D or MB.

Continued work is needed on most aspects of this research. As the work progressed, it became apparent that the field environment is needed for full expression of RD. Therefore, microplot studies were established at Parlier to augment the green-

house experiments. Although the results indicate that some fungi not previously known as important pathogens of *Prunus* spp. contribute to RD, more work is needed to characterize them and their pathogenicity and to determine involvement of other microbes. Although this research accumulated an extensive collection of bacteria from the healthy and diseased trees, continued work is needed to characterize the sample populations and determine their effects on crop health. It is apparent that molecular approaches are needed to augment culture-based approaches to determining RD etiology, because most soil microbes are not culturable.

*Field Update: With support from the Almond Board of California, Greg Browne has continued his research on replant disease. Microplots established in Parlier are being used for continuing determinations of RD etiology and management using fallow periods and cover crop rotations. Similar work on reducing incidence of RD is being carried out in the Sacramento Valley with the help of UC farm advisor Joe Connell. In addition, Bruce Lampinen and Browne have been recommended for funding by USD/CSREES for research on development and assessment of alternative pre-plant fumigation strategies for nut crops. The CSREES-funded research is a multi-disciplinary project, involving a pomologist, two plant pathologists, a weed scientist, an economist, and several UC farm advisors. The research will include nursery as well as orchard experiments and will occur over a 3-year period.*

#### DEVELOPMENT OF GRAPE ROOTSTOCKS WITH MULTIPLE NEMATODE RESISTANCE

Principal Investigator: **Howard Ferris**, UC Davis nematology department. Cooperator: **Andrew Walker**, UC Davis viticulture and enology department. *Submitted December 2002, updated May 2003.*

##### Objectives

1. To continue the development of grape rootstocks with resistance to a broad range of nematodes species and aggressive strains.

2. To evaluate the durability of resistance in advanced selections with multiple nematode resistance.
3. Field-testing of selected rootstocks for horticultural characteristics and durability of nematode resistance.
4. To develop and employ new rootstocks with resistance to a broad range of key nematode species as a sustainable alternative to the use of preplant fumigation.

##### Summary

Several species of plant-feeding nematodes are present in most vineyards, however few rootstocks have resistance to more than one species. The project screened rootstock candidates against the root-knot nematode (*Meloidogyne incognita* race 3), two strains of root-knot nematode that overcome the resistance of Harmony rootstock (*Meloidogyne arenaria* strain A and *Meloidogyne incognita* strain C), and the dagger nematode (*Xiphinema index*). Crosses made among a series of *Vitis* and *Muscadinia* species resulted in selection of candidate rootstocks with multiple nematode resistance. Of the 6,000 seedlings produced from these crosses, only 12 graduated from rooting trial and individual nematode screening trials with broad resistance to all four nematodes. These rootstock selections were tested for their susceptibility to the ring nematode, *Mesocriconema xenoplax*. Several appeared to have some resistance to this nematode as well.

To test the durability of the resistance, rootstock selections resistant to all four nematodes when inoculated individually were exposed to all of the species at the same time. When inoculated together there was a very small amount of galling on some of the broadly resistant lines. Two rootstock candidates (9407-14 and 9449-27) appeared to have broad resistance to dagger nematode and three root-knot nematode strains when exposed concurrently. These are extremely valuable plants. There are no other known examples of

Continued on next page

## METHYL BROMIDE CONTINUED FROM PREVIOUS PAGE

rootstocks for perennial crops selected for broad (multi-species) nematode resistance.

Some rootstock candidates have now progressed to field trials for tests of horticultural characteristics and to assess the durability of the resistance against field populations of nematodes in a range of environments. Ongoing and future studies will test the durability of resistance to root-knot and dagger nematodes when the plants are inoculated with other nematode species not yet tested, including citrus, pin and lesion nematodes. The research will also determine under what conditions, if any, the resistance breaks down. Preliminary experiments suggest that the resistance to root-knot and dagger nematodes may break down at high soil temperatures in some of the selections.

### ALTERNATIVES TO METHYL BROMIDE FOR CONTROL OF SOIL-BORNE FUNGI, BACTERIA AND WEEDS IN COASTAL ORNAMENTAL CROPS

Principal Investigator: **James MacDonald**, UC Davis plant pathology department. Submitted July 2001. Updated May 2003.

#### Objectives

To determine the efficacy of soil solarization (with organic amendments) for the control of selected root pathogens and weed pests of field-grown ornamentals in coastal climates.

#### Summary

The coastal regions of California represent a highly valued and productive component of California's ornamental industry, but the productivity of these regions is seriously threatened by the pending loss of methyl bromide. Some of the alternatives that have been proposed for strawberries [e.g., chloropicrin plus 1,3-D (Telone)] probably will not be suitable for ornamental production. This is because production of these specialty crops tends to be dispersed on many small parcels of land near homes and business, and cannot easily accommodate the ever-increasing buffer zone requirements. The goal of this project was to research the



Snapdragon and godetsia seedlings planted in fields solarized with tarps or incorporated with fresh broccoli for weed control. (photo by Clyde Elmore)

efficacy of biofumigation, an effect created by the decomposition of Brassicaceae (e.g., broccoli, cauliflower, mustards) in soil to release isothiocyanates (ITCs). In laboratory experiments, ITCs volatilized from macerated plant tissues have been shown to kill fungi (*Fusarium oxysporum* f.sp. *dianthi*) and nematodes (*Tylenchulus semipenetrans* and *Meloidogyne javanica*). Members of the Brassicaceae differ in the amounts and types of ITC precursors produced, so aspects of the research focused on identifying plant species that produce the most biologically-active decomposition products, and whether there are periods in a plant's development when the products peak.

Field experiments have been carried out simultaneously at Davis and Watsonville to determine the efficacy of biofumigation in natural soils. These experiments have generally involved the burying of fungal propagules (*Sclerotium rolfsii*, *Fusarium oxysporum* f.sp. *dianthi*, *Rhizoctonia solani*, and *Verticillium dahliae*), nematodes (*Tylenchulus semipenetrans* [citrus nematode] and *Heterodera schachtii* [cyst nematode]), and weed seeds (*Amaranthus retroflexus* [rough pigweed], *Portulaca oleraceae* [cheeseweed], *Convolvulus arvensis* [field bindweed] and *Poa annua* [annual bluegrass]) at different soil depths to expose them to biofumigation or chemical treatments. At intervals of 2-6 weeks following treatment, the buried organisms were recovered to quantify survival. While

results have shown a beneficial effect of biofumigation, the effect is inconsistent and efficacy does not approach that of metam sodium, the chemical treatment used as a control standard. In experiments done at Davis, tarping caused a solarization effect that dominated the treatments, although in some experiments a synergistic effect between solarization and Brassicaceae incorporation was detected. In the cooler coastal regions, a solarization effect is difficult to demonstrate, but in combination with Brassicaceae incorporation, a suppressive effect can sometimes be demonstrated. The inconsistency of biofumigation treatments is likely related to a general lack of knowledge of the factors influencing ITC volatilization from tissues in soil.

Work has continued on methyl bromide alternatives. The project continues to study Brassicaceae for their ability to reliably produce ITCs in soil. Project team members have also done experiments with a USDA grant to study chemical alternatives. They have found iodomethane plus chloropicrin and metam plus telone C35 to be among the most consistently effective treatments in a variety of field locations.

A manuscript covering these biofumigation experiments will be submitted to *Plant Health Progress*.

[Editor's Note: Three more SAREP-funded projects investigating sustainable alternatives to methyl bromide will be addressed in the next issue of *Sustainable Agriculture*, Vol. 15, No. 3.]

**WESTERN SARE ANNOUNCES PROJECTS, OFFERS FUNDS**

The Western Region USDA Sustainable Agriculture Research and Education program recently announced its selections of grants for 2003. Eleven projects were funded in California for a total of \$236,587.

Research and education grants were awarded to: **Kenneth Tate** (UC Davis agronomy and range science) \$93,184, *Research and extension program on environmentally sound grazing practices*, and **Molly Johnson** (Community Alliance with Family Farmers) \$60,000, *Workshops on planting and managing hedgerows on farms*.

Producer Grants were also awarded to the following groups and individuals: Sonoma County Grape Growers Association; **Zachary Griffin**, Ventura County citrus producer; Central Coast Vineyard Team; **Jill Hackett**, Howe Creek Ranch; **John Currey**, CR Pigs; **John Lagier**, Bay Area Agricultural Cooperative; **Warren Weber**, Marin Organics; **Jack Rice**, Larabee Hay Ranch; **Grant Poole**, UC Cooperative Extension Los Angeles.

**New Funding Available**

Western SARE is now accepting proposals for the next round of funding. **Oct. 1, 2003** is the deadline for farmer/rancher and ag professional grants; **Oct. 15, 2003** is the deadline for the Professional Development Program grants. The Calls for Proposals are available on the Web at [wsare.usu.edu](http://wsare.usu.edu) or by calling the Western SARE office at Utah State University, 435-797-2257.

**ORGANIC RESEARCH & EXTENSION INITIATIVE**

The 2002 Farm Bill mandated \$15 million for the Organic Agriculture Research and Extension Initiative to be spent at \$3 million a year from FY 2004 to FY 2008. The program will be managed at the USDA Cooperative State Research, Education, and Extension Service (CSREES). CREES will be requesting applications approximately October 2003, which will be due in December, or in January 2004. Farmers may apply independently, but are strongly encouraged to have a county Extension Specialist connection to a university or other institution. For more information, see administrative recommendations at: <http://ofrf.org/policy/index.html>. Or contact Tom Bewick at [tbewick@re USDA.gov](mailto:tbewick@re USDA.gov), 202-401-3356.

**ORGANIC RESEARCH GRANTS**

The Organic Farming Research Foundation is offering research grants of up to \$15,000 for organic farming research and related topics. Deadlines for proposal consideration are **December 15** (a change from the previous January deadline) for the spring funding cycle and **July 15** for the fall funding cycle. For more information see OFRF's Web site ([www.ofrf.org](http://www.ofrf.org)), call 831-426-6606 or email [research@ofrf.org](mailto:research@ofrf.org).

## RESOURCES

**FREE AG INFORMATION VIA WEB****ORGANIC RESEARCH DATA**

*State of the States, 2nd Edition: Organic Systems Research at Land Grant Institutions, 2001-2003*. This update of the original report released in 2001 by the Organic Farming Research Foundation is available at [www.ofrf.org/publications/SoS/SoS2.overview.page.html](http://www.ofrf.org/publications/SoS/SoS2.overview.page.html). It catalogues organic research, education, and extension projects at the nation's 68 public land grant agriculture schools, public research stations and Cooperative Extension, including SAREP. According to the report, though the total number of organic research acres in the U.S. land grant system has more than doubled between 2001 and 2003, it is not keeping pace with the growth of commercial certified organic acreage. Organic research occupies only 0.13% of available research acreage in the land grant system (up from 0.07% in 2001), while 0.3-2% of U.S. farmland is cer-

tified organic, depending on crop type. Certified organic research acreage is only 0.06% of the total research acreage available, up from 0.02% in 2001. The report is particularly suited for use in an electronic format, as it contains links to many Web sites. Order hard copies at OFRF, PO Box 440, Santa Cruz, CA, 95061-0440; [research@ofrf.org](mailto:research@ofrf.org); 831-426-6606. A tax-deductible donation of \$10 is requested.

**ONLINE FARM-TO-SCHOOL MANUAL**

*Crunch Lunch Manual: A case study of the Davis Joint Unified School District Farmers Market Salad Bar Pilot Program and A Fiscal Analysis Model*, by Renata Brillinger, Jeri Ohmart and Gail Feenstra, UC SAREP. A new downloadable version of SAREP's farm-to-school "how to" manual will be available on its Web site in September 2003. Go to [www.sarep.ucdavis.edu/cdpp/](http://www.sarep.ucdavis.edu/cdpp/)

**farmtoschool/crunchlunch32003.pdf**

The manual is part of an effort to support school districts interested in piloting a salad bar project.

**ORGANIC AG ONLINE DATABASE**

A new resource for information on organic agriculture is now available at [www.organicaginfo.org](http://www.organicaginfo.org). OrganicAgInfo is an online database of research reports, farmer-to-farmer information and outreach publications, searchable by keywords, region, crop or livestock type. Information on organic agriculture may be added to the database. OrganicAgInfo, hosted by North Carolina State University, was funded by a grant to the Scientific Congress on Organic Agricultural Research and the Organic Agriculture Consortium from the Initiative for Future Agriculture and Food Systems through the USDA/CSREES.

# CALENDAR

## \*SAREP WEB CALENDAR AND ONLINE COURSE

SAREP offers a regularly updated sustainable agriculture calendar on our World Wide Web site at: [www.sarep.ucdavis.edu](http://www.sarep.ucdavis.edu) (click "Calendar" on top menu bar). Please feel free to add sustainable agriculture events. In addition, we offer an online course for pest control advisers and others titled *Ecological Pest Management in Grapes*. Up to 11 CE credits for California PCAs. See [www.sarep.ucdavis.edu/courses/grapes/](http://www.sarep.ucdavis.edu/courses/grapes/)

## \*NATIONAL/INTERNATIONAL CALENDAR

The National Agricultural Library maintains a calendar as part of AgNIC at [www.agnic.org](http://www.agnic.org). It links to more than 1,200 major national and international agricultural conferences.

## \*MONTHLY MEETINGS

*Lighthouse Farm Network*. The Community Alliance with Family Farmers sponsors informal monthly meetings for growers to discuss issues related to pesticide use reduction. Contact: Molly Johnson, (530) 756-8158, ext. 30, [molly@caff.org](mailto:molly@caff.org); or Merrilee Buchanan, (831) 761-8507, [merrilee@storypages.com](mailto:merrilee@storypages.com); [www.caff.org](http://www.caff.org)

## SEPTEMBER

**1** *Organic gardening, farming apprenticeship applications due for 6-month training course* at UC Santa Cruz's Center for Agroecology. Classes, field work on 25-acre farm/garden. 20 units UC Extension. Cost: \$3,250. Scholarships available. Application deadlines: Sept. 1 for international applicants; Nov. 1 for U.S./Canadian applicants. <http://lzyx.ucsc.edu/casfs/training/index.html> or [apprenticeship@cats.ucsc.edu](mailto:apprenticeship@cats.ucsc.edu) or 831-459-3240.

**13** *Agricultural Roots Fair*, Oakland, Calif. Oakland Museum. Organizers: Sustainable Agriculture Education (SAGE), Oakland Museum of California, East Bay Asian Local Development Corporation, New America Foundation, UCCE Alameda County. Harvest celebration, land/culture connections. Highlights California's changing demographics/support for sustainable agriculture. Features: ethnic music/street foods, dance performances, family activities, tastings, farmers/crafts market with diverse agricultural/culinary traditions. Nutrition, community gardening, recycling, farm-to-school programs, agri-tourism educational displays. [www.sagecenter.org](http://www.sagecenter.org); [info@sagecenter.org](mailto:info@sagecenter.org)

## OCTOBER

**4-5** *Hoes Down Harvest Celebration*, Capay Valley (Yolo County). Showcases sustainable agriculture, rural living in fun-filled workshops/events. Educational farm tours, a children's area, games, live music, local farm products, organic food. Cost: \$15 adults, \$5 children (ages 2-17), under 2 free. Sunday workshops registration separate. Information (including camping Saturday night): [www.hoesdown.org](http://www.hoesdown.org) or call (800) 791-2110. Proceeds benefit the Ecological Farming Association/other local non-profit organizations.

## NOVEMBER

**17-18** *Organic winegrapes short course*, Brutocao Vineyard Plaza, Hopland. Sponsors: UC Cooperative Extension/SAREP. Information on organically acceptable viticultural practices (soil management, vineyard design and canopy management, cover cropping, use of compost; weed, disease, insect, mite, nematode management; vineyards in the landscape; techniques of organic winemaking). Wine tasting. Information/registration contact Glenn McGourty, 707-463-4495, [gtmcgourty@ucdavis.edu](mailto:gtmcgourty@ucdavis.edu). Other sponsors: CDFAs Buy California Initiative/USDA, Fetzer Vineyards, Brutocao Cellars, Mendocino Winegrowers Alliance.

## JANUARY 2004

**24** *Annual Ecological Farming Conference*, Asilomar, Calif. World's foremost sustainable agriculture conference features prominent keynote speakers, 50 + workshops in ag production, marketing, & research, + opportunities to exchange information, renew spirits. Contact: Ecological Farming Association, 406 Main St., Ste. 313, Watsonville, CA 95076; (831) 763-2111; [info@eco-farm.org](mailto:info@eco-farm.org); [www.eco-farm.org](http://www.eco-farm.org)

## FEBRUARY 2004

**2-8** *North American Farmers' Direct Marketing Conference & California Farm Conference*, Sacramento, Calif. Sponsors: 15 public/private non-profits. "A Bounty of Golden Opportunities" is the theme; 1000 farm direct marketers are expected. 3-day farm tour, trade show, 120 speakers, workshops, 40 sessions. Sheraton Grand Hotel/Convention Center. Scholarships available. [www.nafdma.com](http://www.nafdma.com); [marica@whiteloafridge.com](mailto:marica@whiteloafridge.com); 530-756-8518 ext. 16.

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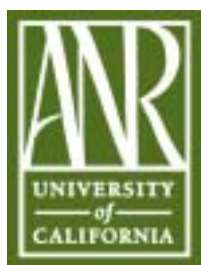


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