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## Weighing crop water use

**A** multi-year irrigation study of several vegetable crops on the San Joaquin Valley's West Side has yielded new data that should help growers to enhance water use efficiency.

Lead researcher Jim Ayars, an agricultural engineer with the U.S. Department of Agriculture, conducted the study of crop water use in partnership with Fresno State's Center for Irrigation Technology.

Continuing water shortages have made irrigation efficiency more crucial than ever not only for West Side growers but all California farm producers, Ayars noted in a recent report on his research. With reduced water allotments from state and fed-

eral sources, many West Side growers have been forced to abandon traditional field crops such as cotton and alfalfa and focus on smaller acreages of higher-value cash crops such as vegetables.

Vegetables, however, are among the trickiest crops to irrigate efficiently.

*"Many growers tend to over-irrigate vegetables because they are relatively sensitive to water stress, and good information on the requirements of many of these crops is lacking," Ayars said.*

Over-irrigation not only wastes water, it reduces profit potential. For example, if a grower over-irrigates a crop by 20 percent, that means he

or she actually could have grown 20 percent more crop with that same amount of water, earning potentially 20 percent more in gross profit.

"What we're trying to do is get a better definition of what the crop water requirements are on West Side saline soils," he said.

Ayars and his research team have spent several years studying crop water use of selected vegetable crops, including lettuce, bell pepper, garlic and broccoli, on the West Side. Key research objectives were to specifically determine water use by each of these crops, to develop seasonal crop coefficients growers can use to guide irrigations, and to compare efficiency of surface drip, subsurface drip and furrow irrigation systems.

See *Crop Water* on page 7



Plant scientist Ron Seligman checks crop water use data from a mini-laboratory inside underground weighing lysimeter on the San Joaquin Valley's West Side.

# Cactus as Cash Crop?

**R**esearch scientists from the U.S. Department of Agriculture and Fresno State are wondering whether cactus could some day be a cash crop of choice for farm producers on the San Joaquin Valley's West Side.

In fact, they are doing more than wondering. USDA plant science researcher Gary Banuelos is conducting a research study on a 35-acre trial plot to learn if Indian fig *Opuntia*, known by the common name prickly pear cactus, could be developed into a production crop on the West Side.

*Opuntia* is native to the American Southwest and has been introduced in many other countries in the Mediterranean and western Pacific regions. It grows wild in desert and arid regions, producing fruit called cactus figs. The fruit can be peeled and eaten, or its pulp and juice used to produce jams, jellies, candy or other fruit products.

A key to producing *Opuntia* on the West Side is its potential to take up and volatilize selenium from West Side soils with minimum water.

"Introducing a new alternative crop for drainage impacted areas



Above: Research technician Christian Bitterli takes cuttings from *Opuntia* cactus plants during propagation work at the U.S. Department of Agriculture's Agricultural Research Service facility east of Fresno.

Right: Closeup of cactus fruit.

can help utilize naturally occurring selenium present in the soils and waters," Banuelos said.

*"This project will provide new and realistic information for growing and producing value-added products from Opuntia under adverse growing conditions."*

Based at the USDA's Agricultural Research Service facility southeast of Fresno, Banuelos has monitored small trial plots of various plants that have potential for production in the San Joaquin Valley. He has worked with numerous varieties and clones of *Opuntia* and found that some have the ability to absorb selenium.

With financial support from the California Department of Water Resources and the California State University Agricultural Research Initiative (ARI), Banuelos engineered a partnership with West Side grower John Diener of Red Rock Ranch to

establish a 35-acre trial plot featuring several clones of *Opuntia*.

Included in the growth trials are three main irrigation treatments: 1) good quality water, 2) poor-quality water (higher levels of salts and selenium), 3) and no water at all.

Special Plexiglas chambers are being used to record and measure volatile selenium that escapes from the soil as a gas. In addition, plant material is being collected and processed for measurement of selenium absorption from the soil.

## New food products explored

A second phase of the project is to explore new and improved food products that could be produced from the fruit or thick cactus stems, Banuelos said. Joining in this work is food science research specialist Gour Choudhury, professor in

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## Update

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# Turning west... to trade with the East

Proposed program aims to equip Fresno State students to engage China's vast trade markets

**A** newly-proposed agricultural business program at Fresno State aims to launch students into successful relationships with America's most dynamic trading partner – China.

The Central California China Council (C4) would be the first entity of its kind in the western United States, reported Mickey Paggi, director of the Fresno State's Center for Agricultural Business (CAB). It would help to prepare students for the myriad opportunities in the field of agricultural trade with the Asian giant.

"American agricultural exports to China have grown rapidly since that country joined the World Trade Organization in 2001," Paggi noted.

*"Our farm-related exports to China increased from \$1.9 billion in 2001 to \$12.1 billion in 2008. That's an increase of over 500 percent in seven years, and there are no signs that trade will not continue to grow in the future," he said.*

The C4 has two key objectives: First is to promote knowledge of Chinese agriculture and food issues. This will help to prepare undergraduate students for opportunities in global business markets, as well as in local, state and national governments.

The second objective is to strengthen Central California's academic and commercial opportunities with China by establishing a research facility in and for the region, dedicated to Chinese agriculture and food science.

"China is a market of significant challenges, but also extraordinary opportunities," Paggi said.

## Multidisciplinary approach

Operated through the Center for Agricultural Business, the C4 program will feature multidisciplinary undergraduate course lectures on Chinese agriculture and food issues. It will also create experiential learning opportunities, eventually sponsoring language courses in Mandarin Chinese.

"This project is an opportunity for Fresno State to expand its educational impact by accessing experience, expertise and research materials on a variety of Chinese topics," said Bill Erysian, coordinator of international projects for the Jordan College of Agricultural Sciences and Technology (JCAST) and one of the C4 planning members. Erysian, who also serves as campus director for the

Sino-American 1-2-1 Dual Degree Exchange Program, will serve as a consultant in C4 coursework development as the program moves forward.

"This will expand students' knowledge about a country that is a huge player in globalization – something that food and agribusiness employers are looking for," Erysian said.

Also involved in the planning is Annette Levi, chair of Fresno State's Department of Agricultural Economics, and Edward Lanfranco, a Fresno area marketing strategist and specialist in U.S.-China trade.

Startup funding for the center is being sought through a proposal to the U.S. Department of Agriculture's Higher Education Challenge Grant Program. Paggi said that if funding is released, plans are to begin implementation in the Fall 2010 semester.

For more information on the C4 program, contact Paggi at [mpaggi@csufresno.edu](mailto:mpaggi@csufresno.edu).



## Tree nut husks, shells tested as growth media

**A** Fresno State food science specialist is leading student researchers in continued efforts to develop high-quality compost for mushroom and other high-value food crops.

Previous research has focused on developing compost from peach processing by-products. Recent work conducted by the team features the use of pistachio by-products.

“California is a national leader in pistachio production, and primary processing of these nuts results in by-product streams (hulls and shells) that are more than 75 percent of the harvested crop,” Choudhury said in outlining the project.

### New approach to disposal

Traditionally, these by-products have been used either as animal feed, as a fuel for energy generation, or they’ve been discarded as waste. Some disposal methods are not environmentally friendly, and others are costly for the processor.

“The industry needs to develop efficient and profitable by-products recovery and utilization systems to sustain production growth and to comply with increased environmental regulations and enforcement,” Choudhury said.



Experimental trials feature Shitake mushrooms growing on media developed from tree nut hulls and shells.

Like peach pits, pistachio hulls and shells are rich in carbohydrates, and since mushroom production requires a media rich in carbohydrates, the pistachio by-products have excellent potential to serve as a foundation for a growth media.

Research is being carried out at Fresno State’s Center for Food Science and Nutrition Research (CFSNR). Student technicians are evaluating the composition of the pistachio by-products and determining a suitable mushroom variety. Additional work includes conditioning the media substrate, spawning the selected mushroom variety, monitoring mushroom yield and quality, and evaluating the spent bed for compost.

According to Choudhury, new methods developed through the study could significantly boost industry economics.

“Successful implementation of this project will result in development of a resource recovery and utilization system that will increase revenue from tree nut processing and comply with



Pistachio hulls and shells are rich in carbohydrates and may serve as a foundation material for growth media for mushroom or other high-value crops.

state and federal pollution control regulations for solid by-products disposal,” he said.

*The project also will foster economic development in California’s Central Valley, which depends to a large degree on the state’s agricultural resources, including the food and nut processing industry, Choudhury said.*

Financial support for this project is being provided by the California State University Agricultural Research Initiative (ARI) and the Western Pistachio Association. Local industry collaborators include Meridian Nut Growers of Clovis, California.

Initial product reports and analysis are to be completed later this year, Choudhury said. For more information, contact the CFSNR at 559-278-5924 or Choudhury at gchoudhury@csufresno.edu.

## Las Vegas Water Czar to Speak at Conference

### Biennial leadership event will explore solutions to California water shortages

One of the most influential water consortium leaders in the western United States will share her thoughts on water issues during a keynote address at the 2010 Water Technology Conference to be held May 11 and 12 in Clovis, California.

Pat Mulroy, general manager of the Southern Nevada Water Authority (SNWA), will discuss challenges and lessons learned during her 20 years of SNWA leadership. The authority is responsible for acquiring, treating and delivering water to agencies collectively serving two million residents and 40 million annual visitors to southern Nevada, including Las Vegas.

Mulroy has built a reputation as an astute manager and powerful protector of water resources for her region. She was a principal architect of the water authority, which has served as a model for other western water agencies since its creation in 1991. She also is active at the national level, serving on boards of directors of both the Association of Metropolitan Water Agencies and the Water Research Foundation.

The theme of the 2010 conference is "Where Water, Science & Technology Connect." It will focus on water tech-

nology innovations and science that can help enhance water use efficiency in California, the region and the world.

Additional speakers include Timothy Quinn, executive director of the Association of California Water Agencies (ACWA), and Peter Williams, chief technology officer for IBM's Big Green Innovations incubator.



Pat Mulroy

### Bond measure to be discussed

Quinn has more than 25 years of experience in California water issues. He will discuss California's proposed \$11.1 billion bond measure that, if approved by voters in November, would provide funding for construction of water delivery and storage systems. Bond measure project proposals include regional water delivery projects, underground banking systems, recycling programs, groundwater protection, a dam east of Fresno, and environmental upgrades in the Sacramento-San Joaquin Delta.

Williams and the IBM Big Green Innovation team offer creative strategies that reach across ecosystems to solve problems.

Their technology and expertise has helped water utilities, agencies, and private industry to improve water quality and water system performance.

In addition to the general and breakout sessions, the conference will host forums where sci-

entists will offer research and poster presentations. Irrigation system manufacturers and service providers also will host exhibits outlining new and innovative products.

Sponsorships and exhibit space were still available at the time of this writing. For more information visit the ICWT website at <http://www.icwt.net> or call (559) 278-2066.

The conference is sponsored by Fresno State's International Center for Water Technology (ICWT), the Center for Irrigation Technology (CIT), and the federal Environmental Protection Agency. Planners anticipate attendance of 350 or more participants and exhibitors.

The ICWT is a public-private partnership supporting development and application of advanced technologies that enhance water use for urban, environmental and agricultural purposes.

Through applied technology, the ICWT's goal is to provide efficient first use and effective reuse of water supplies worldwide.

## Upcoming events

**May 11-12** – International Water Technology Conference at the Clovis Memorial Building in Clovis, California. Sponsored by the International Center for Water Technology (ICWT) and the Center for Irrigation Technology (CIT). For details, visit <http://www.icwt.net/> or call (559) 278-2066.

For more information on these and other upcoming events related to water and irrigation issues, visit Fresno State's Center for Irrigation Technology (CIT) website at <http://cati.csufresno.edu/cit>.



## The Color of Wine...

### Fresno State winemaker seeks to enhance wine color, quality in yeast study

**E**nologists at Fresno State's Viticulture and Enology Research Center (VERC) are tracking the behavior of phenolic compounds in an effort to improve color and quality of wines from grapes grown in California's San Joaquin Valley.

Research scientist Susan Rodriguez, microbiologist Roy Thornton and winemaker John Giannini recently completed a two-year study using nine wine yeast strains and analyzing their effects on phenolics during fermentation. Yeast catalyzes the fermentation of the grape juice and promotes many complex organic

and chemical interactions that combine to produce wine. Phenolics are a complex set of compounds found in grape skins and seeds; they influence the color, structure and complexity of red wines.

Rodriguez believes this line of study holds economic promise for the region.

### Color, quality linked

"The San Joaquin Valley produces more than 60 percent of the wine grapes in California but receives low prices compared to wine grapes produced in premium areas such as

Napa and Sonoma," Rodriguez said. "A major factor in the price difference is the warmer valley climate – it reduces the development of color in red wine grape varieties." And color and quality are inextricably linked, she noted.

Vineyard management studies continue to be conducted in the San Joaquin Valley to bring more color and complexity to grape berries prior to harvest, Giannini noted. Experiments include different irrigation regimes, canopy management strategies and fertilizer treatments. However, enologists also have tools that can be used to enhance color and complexity.

*"We are constantly trying to find things that will help improve the quality of San Joaquin Valley wines," he said.*

Techniques commonly used by winemakers include adding different enzymes, cold-soaking the must before fermentation, varying temperature during fermentation, even adding oak chips. "In this case, what we are asking is, 'Does yeast strain make a difference in enhancing phenolic compounds and helping to stabilize the color in wine?'"

The two main commercial yeasts used in the study were *Saccharomyces cerevisiae* and *Saccharomyces bayanus*. During the first year of trials, strains of these and others were added to small experimental lots of juice from Cabernet Sauvignon and Zinfandel grapes. Color analysis was performed on all the lots, and an assortment of colors resulted from among the different treatments,

Winemaker John Giannini draws a wine sample from one of the 845-gallon tanks used for both experiments and production at the Fresno State Winery.



### Upcoming events

**May 20** – Annual Dinner for Department of Viticulture and Enology Graduates - at the Fresno State Viticulture and Enology Research Center. For more info, call 559-278-2089.

For more information on these and other upcoming events related to viticulture and enology issues, visit Fresno State's Viticulture and Enology Research Center (VERC) website at <http://cati.csufresno.edu/verc>.

*See Wine Color on page 8*

# Crop Water: Crop coefficients available

from page 1

The primary method for measuring crop water use was a large-scale weighing lysimeter installed in an experimental field west of Fresno, near Five Points. The lysimeter was employed over several seasons to measure daily water use of the different vegetable crops. Using crop-water-use data obtained from those trials, researchers applied both deficit and over-irrigation treatments in follow-up trials and recorded the yield data.

The most important results have been the development of crop coefficients which growers can use to gain maximum irrigation efficiency for West Side conditions, Ayars said. Repeated trials featuring irrigation at over 100 percent of established crop needs did not result in yield increases.

## Irrigation methods show differences

Results also indicated that with all other factors being equal, both surface and subsurface drip irrigation systems produced higher yields than furrow irrigation, suggesting the greater water use efficiency of those systems, Ayars said.

Dissemination of coefficients and other project details has been ongoing, through a variety of formats, Ayars reported. Growers or farm managers seeking specific information may contact him at [james.ayars@ars.usda.gov](mailto:james.ayars@ars.usda.gov).



Above: Joining Ron Seligman (from pg. 1) at the weighing lysimeter are USDA field scientists Nedal Katbeh-Bader (left) and Naem Mazahreh, monitoring growth of red bell peppers. Left: Another field view of the lysimeter.

"We're trying to get people engaged in an irrigation program where you carefully evaluate what your water requirement is," the researcher said. "That way, even if you have a limited amount of water, you're still going to get a good yield."

Partial funding for this project was provided by the California State University Agricultural Research Initiative (ARI), which is overseen at Fresno State by the California Agricultural Technology Institute (CATI). For more information on ARI research and activities, visit the website at <http://ari.calstate.edu>.

## ARI/CATI on the Web!

The California State University Agricultural Research Initiative (ARI) oversees applied agricultural, agribusiness and natural resources research on behalf of California agriculture. For information on our research and project results, visit our website at <http://ari.calstate.edu>.

The California Agricultural Technology Institute (CATI) administers ARI funding and oversees additional applied agricultural research. For more information about CATI and its research centers, visit us at <http://cati.csufresno.edu>, or at our centers:

- Center for Agricultural Business (CAB) – [cati.csufresno.edu/cab](http://cati.csufresno.edu/cab)
- Center for Food Science and Nutrition Research (CFSNR) – [cati.csufresno.edu/cfsnr](http://cati.csufresno.edu/cfsnr)
- Center for Irrigation Technology (CIT) – [cati.csufresno.edu/cit](http://cati.csufresno.edu/cit)
- Viticulture and Enology Research Center (VERC) – [cati.csufresno.edu/verc](http://cati.csufresno.edu/verc)
- Agricultural Technology Information Network (ATI-Net) – [cati.csufresno.edu/atinet](http://cati.csufresno.edu/atinet)

*Cactus study entering second year, cont'd. from pg. 2*

Fresno State's Department of Food Science and Nutrition.

Choudhury has experience in developing new food products using extrusion technology. Some cactus products in early stages of development include marmalade, chutney, and puffed cheeto-like snack foods.

The *Opuntia* study is entering its second year. After two more years of production data collection and new product development, the researchers will determine whether to pursue prickly pear cactus trial production on a broader scale.

*"Because Opuntia thrives under arid conditions with a minimum input of water, successfully growing this crop under rain-fed-only conditions may provide the semi-retired land areas within the Westlands Water District with a new potential crop," Banuelos said.*

For more information on this project, contact Banuelos at [gary.banuelos@ars.usda.gov](mailto:gary.banuelos@ars.usda.gov).

# Wine color cont'd.

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Giannini said. The three yeast strains producing wines of superior color and quality were selected for further study during the second year, using commercial-size lots of about 300 gallons.

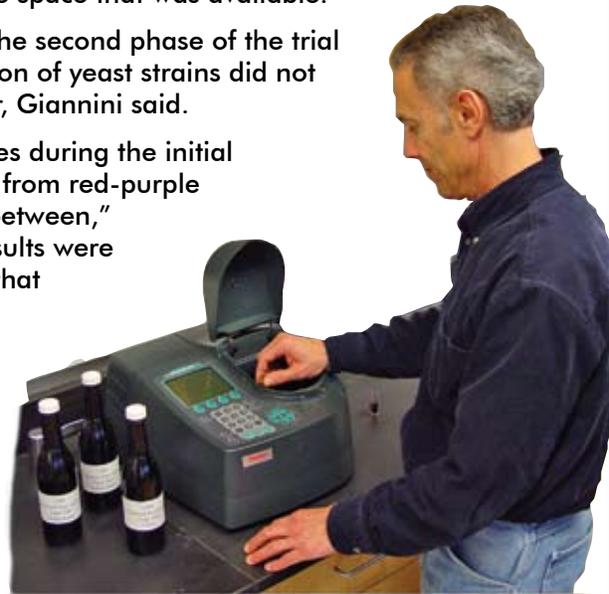
Unfortunately, with the lot numbers reduced to three, the second year results of color and sensory analysis did not result in significant differences among the three wines, Giannini said. While one of the three lots showed higher levels of tannins – a group of phenolic compounds, assays of anthocyanins and total phenolics did not reveal differences. Sensory analyses for differences among the three wines also were inconclusive.

One limitation in moving trial wine lots to commercially-sized tanks is simply one of space, Giannini noted. The Fresno State Winery has six 845-gallon tanks, which are in demand for commercial winemaking as well as experiments. In this case, a trial using three lots, each replicated twice, required those six tanks, and that was all the space that was available.

The lack of conclusiveness during the second phase of the trial does not mean the original collection of yeast strains did not have different effects on wine color, Giannini said.

"We absolutely had color differences during the initial trials. We had some amazing hues from red-purple to red-orange, with everything in between," he said. "And although my final results were inconclusive, we've demonstrated that yeast strains do make a difference in color. We hope there will be more opportunities to pursue this."

John Giannini analyzes wine samples using a spectrophotometer, which measures light absorption at different wavelengths.



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