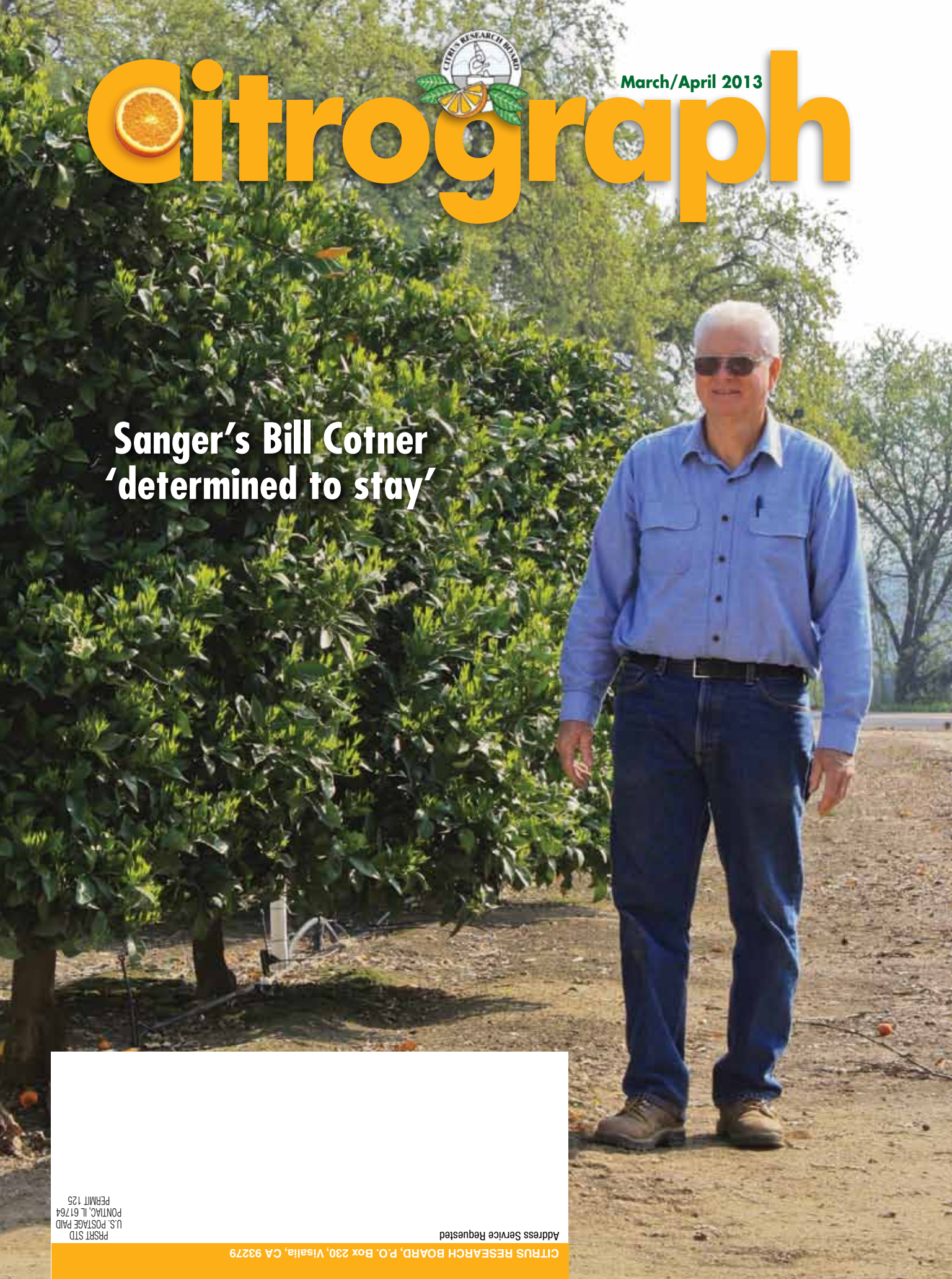
Citrograph

March/April 2013

Sanger's Bill Cotner 'determined to stay'



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IN THIS ISSUE

Citrograph is published bimonthly by the Citrus Research Board, 217 N. Encina, Visalia, CA 93291. ***Citrograph*** is sent to all California citrus producers courtesy of the Citrus Research Board. If you are currently receiving multiple copies, or would like to make a change in your ***Citrograph*** subscription, please contact the publication office (above, left).

Remember, it's all about the TREE!

It is the tree that provides the fruit we sell and feeds the economic machine we all rely on.

In these days when we all feel like we are continuously drinking from a fire hose trying to stay up with this issue or that regulation which is coming at us, we must take a step back and remember why we are here. It certainly is NOT to see who is the most important person in the system or what is the most important program in the industry, it is truly all about the tree. That is where we all get our livelihoods from and what provides the standard by which we live. For it is the tree that provides the fruit we sell and feeds the economic machine we all rely on.

For the past 20 years, I have had to constantly remind myself of the *purpose* of the industry programs. It is all too easy to get caught up in the details of a research project that seems new and exciting with the discovery of a new gene or new method of managing a disease and forget the key factor, which is what will this do to the tree and the fruit quality. The same applies when it comes to programs and other distractions. We all seem to get so caught up in organizational posturing and details that we forget why we are doing the program in the first place.

As an industry worldwide, we are facing a serious threat from the Asian citrus psyllid and the disease it vectors, huanglongbing. HLB is all about the tree; we know from experience that it will kill the tree and, during the slow death, render the fruit inedible and unmarketable.

True, there are pest management hurdles that lead to regulatory hurdles that lead to higher costs that threaten profitability. This is not a pretty picture. However, the key point to remember is "What does it take to protect the TREE?" Experience from other parts of the globe tells us that control of the vector is the first line of defense in protecting groves from a possible invasion of the bacteria associated with HLB.

Now I am hearing questions like "Why are we spending money on searching for HLB in urban areas?" This is simple: that is where the bacteria is, and the sooner we find it the better chance we have of keeping it contained and away from commercial production. CDFA can only exercise their authority of removing an infected tree if we/they can find it and confirm the presence of the disease.

Yes, this is an expensive program and threatens profits in tough times. But what are the costs of having the disease overtake the state and force you to completely re-tool your operation to another commodity? Just remember, HLB kills the tree and our industry is "All about the tree!!"

The Mission of the Citrus Research Board:

Develop knowledge and build systems for grower vitality.
Focus on quality assurance, clonal protection, production research, variety development, and grower/public education.

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CALENDAR

May 2	Kern County annual Spring Citrus Meeting, Bakersfield, CA. For information, contact the UCCE office at (661) 868-6200.
June 27	CRB Board Meeting, Four Points by Sheraton Ventura Harbor, Ventura, CA. For information, contact the Citrus Research Board at (559) 738-0246.
August 20-22	CRB Research – Presentation of Proposals and CRB Board Meeting, DoubleTree Hotel, Bakersfield, CA. For information, contact the Citrus Research Board at (559) 738-0246.
September 17	CRB Annual Meeting, Lindcove REC, Exeter, CA. For information, contact the Citrus Research Board at (559) 738-0246.

DO YOU KNOW...?

What do all of these things have in common: tangy and garlicky Caribbean sauces, extra-special marmalade, Belgian-style white ales, the liqueurs Grand Marnier and Curaçao, essential oil of petitgrain, and essential oil of neroli. Hint: it's something growers are familiar with for some other use entirely. *(Go to page 12 for the answer.)*

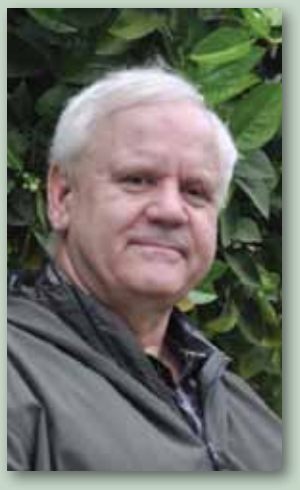
Citrograph asks: What were the most significant take-home messages from the recent international research conference on HLB?

Some 300 scientists from 22 countries met in Orlando, Florida, in early February for IRCHLB III, the 3rd International Research Conference on Huanglongbing. The researchers were joined by industry leaders, bringing the total number of participants to 480.

The conference was four full days of presentations and poster sessions -- 167 topics in all -- dealing with the biology, epidemiology, management, and economics of huanglongbing disease and the Asian citrus psyllid. **(The agenda and proceedings are available at http://irchlb.org.)**

Hosted by Florida Citrus Mutual, IRCHLB III was organized by representatives of the USDA Agricultural Research Service (ARS) and the University of Florida's Institute of Food and Agricultural Sciences (IFAS).

The Citrus Research Board, California Citrus Mutual and Sunkist helped sponsor the conference along with Florida's Citrus Research & Development Foundation (CRDF), Texas Citrus Mutual, Fundecitrus, Cutrale, KeyPlex, and Syngenta.



Disturbing news from the HLB meeting in Orlando is that we are starting to understand that ACP and HLB form a high co-evolved vector-pathogen system. We knew that Las bacteria (*Candidatus* Liberibacter asiaticus) are mostly dependent on ACP for movement to new plants where the bacteria can reproduce, but what is now becoming clear is that the presence of Las bacteria in plants benefits ACP in terms of shorter development time of nymphs and more eggs produced by females (paper #4.3). A second piece of evidence for this is that uninfected adult ACP appear to be attracted to Las+ citrus more than to clean citrus, but after feeding on infected plants (with the potential to pick up the bacterium) they tend to leave infected plants and are then more highly attracted to clean trees (paper #5.2).

A third piece of evidence for this co-evolution was the statement at the meeting that preliminary evidence suggests an infected ACP adult can land on an uninfected citrus tree, will choose an area of the plant to feed on, can inject the bacterium, will lay eggs in the vicinity of where it fed, and her offspring can acquire Las as nymphs from what had previously been a clean tree. It is amazing (and disappointing) that transmission to the next generation can occur this quickly.

This news suggests to me that we cannot be too vigilant in California in chemically controlling ACP and rapidly removing HLB-infected trees. We are at a critical point in time, and the industry must come together to deal with this vector-pathogen system in a very aggressive manner. From what we have heard in Florida, area-wide management of ACP can be surprisingly effective, but this breaks down if only a few growers decide not to treat. Thus, it is critical that ALL growers become part of area-wide management programs if we are going to effectively manage this deadly disease. ***-- Dr. Joseph Morse, University of California, Riverside***

"Control, Control, Control." The message was succinct and direct. The Asian citrus psyllid must be controlled at the highest level possible to enhance the efforts against the introduction or spread of huanglongbing. The results of the Florida industry's failure to control ACP early on has those growers fighting for their "citrus lives", willing to try anything, at considerable expense, to extend the lives of the trees and insure some level of production until research produces "the cure."

Millions of dollars are being invested, and thousands of research projects are being conducted worldwide -- several of which were highlighted at the conference. To the layman, it appears the answer is getting closer, but the timeline remains nebulous.

For California growers, it is encouraging to see the potential of new tools coming on line for the early detection of HLB prior to visible tree symptoms being exhibited: 1) Development of a VOC sniffer, 2) Ability to detect the unique RNAs produced by the plant as a defense response to Liberibacter, 3) Identified proteins are secreted by the bacteria that are translocated throughout the tree, 4) Recent work shows the bacteria has been detected in the tree roots before visible symptoms on the scion and leaf tissue through PCR analysis. ***-- Shirley Batchman, California Citrus Mutual***

The HLB conference was an ears-pinned-back tempest of information and new words ("tetrazygs" was one of my favorites; they are crosses of four rootstocks, each of which imparts resistance to a different disease).

The wide array of research projects being explored all around the citrus-producing world gave me great hope that something, somewhere will be successful. And because we are behind most of the world in the progression of ACP and HLB, we have a better chance of having a viable industry to save when research does come to fruition — IF we heed the message that we heard reinforced repeatedly —CONTROL THE PSYLLID!

"It takes a lot fewer psyllids to spread HLB than we thought." "Control of ACP must be almost perfect." "Failure to control ACP one year will result in a multi-year increase in HLB infection rates." It came from multiple angles from people all over the world. ACP is relatively easy to kill, and the fewer of them around when HLB appears, the slower the disease — for which there is no cure — will spread. We are at a crucial juncture in California — the early stages of infestation — and we have one shot to get this right. ***-- Leslie Leavens, Leavens Ranches***

It was most disturbing to find out (paper #7.3) that Florida citrus trees with huanglongbing had dropped fruit twice this season and resulted in two corresponding reductions in the industry crop estimate. More fruit drop had occurred than from any previous freeze or hurricane.

Researchers have found (paper #4.3) that the bacteria (Las) causes greater egg production in infected psyllids. Mike Irey (paper #6.11) said that growers aren't scouting very well for HLB. Tree infection rates need to be kept under 5 to 8 percent (the percent of tree removal per year to stay in business). Under Florida conditions, one ACP caught in a yellow sticky trap equals approximately 1,000 ACP in the field (Dr. Lukasz Stelinski). We learned at the University of Florida Lake Alfred station meeting with Dr. Stelinski and Dr. Michael Rogers that Kaolin clay applications are helping keep young trees protected. In Brazil (paper #6.8), mineral oil has a repellent effect on ACP. Oil reduces egg laying and kills adults also. Citrus Health Management Areas (CHMAs) have reduced ACP risk and slowed down the HLB epidemic (paper #3.2). ***-- Tom Roberts, Integrated Consulting Entomology***

My observations of the development in research on HLB and related topics were:

1. Significant progress in all areas of research, understanding of Liberibacters.
2. Lessons learned from Florida -- early reaction, control ACP, rogue out HLB.
3. Development in breeding, both genetic and conventional.
4. Improving early detection of HLB and advancement of therapeutic ideas.
5. HLB is not seed transmissible; coordinated methods are successful.

Progress in all areas of HLB research is advancing much faster and knowledge gaps are being filled in, especially with respect to the genetic understanding of the Liberibacters which most probably cause the tree decline. A new Liberibacter was recently discovered that may lead to a much better understanding of HLB and maybe the ability to culture a very closely related bacteria for the first time. This is a significant forward step. (Since the conference, several other related C. Liberibacters have been identified; the needed information to help detect, understand, and control the pathogen may be near.)

Also, the action plan for any grower is to have healthy trees, especially roots; survey for ACP and HLB; control ACP, (area-wide cooperation), rogue out HLB-infected trees as soon as detectable! Replant with clean trees as necessary (FL), and in California, search for the presence of HLB symptoms! Control root pathogens, as weakened roots are more susceptible to the effects of HLB than healthy roots! HLB may first be at work in the roots prior to the scions! This may help us with early detection and action plans.

The long-term solutions may include genetically modified trees to confer resistance to CLas and/or clear the pathogen from the trees. Significant progress has been made on the science side of the equation; soon the regulation side will have to be addressed, not an insignificant process. However, there has recently been a very encouraging result of traditional breeding which shows resistance to HLB -- keep an eye on "US9" as it is studied in trials. More work is ongoing and shows promise in both genetic and conventional methods.

Several methods of early detection are maturing rapidly: VOCs (volatile organic compounds), DNA test kits, antimicrobial tests, small secreted molecules, electron microscopy, hypo spectral methods of disease detection, host plant response methods are all advancing rapidly and will lead to a set of methods for use in various environments as well as being supportive to each other. All methods of detection are revealing opportunities to develop ideas to control the pathogens as well. The last of the results to report here is that HLB is not seed transmissible!

With advancements in the science and cultural practices, we will have the methods to fight this and other major citrus diseases. The future is looking brighter. We must all work together! ***-- Earl Rutz, Rancho Pauma Granite***

I have been fortunate to have attended each of the first three International Conferences on HLB. If I had to briefly characterize the mood or mindset at each one, it would be as follows:

• 2008 - doom and gloom... Florida was reeling from the wide spread onslaught of HLB in all its growing areas.

• 2011 - still concern… but there seemed to be a more positive and upbeat attitude -- my guess would be as a result of the massive amount of funds that were made available for ACP/HLB research since the previous conference.

• 2013 - a real sense of urgency to find a solution. The decline in orchards was more evident as we traveled through parts of the growing areas we had seen in prior years. In addition to the symptoms you might expect to see, a very significant amount of fruit drop was also adding to growers' woes. This was a first since the onset of the disease.

Other takeaways from this 2013 Conference:

• Tree nutrition… This is becoming more widely adopted by growers. Improving the tree's health through better nutrition seems to have some benefit in keeping orchards in a better productive state while mitigating the effects normally associated with HLB-infected trees. We visited one of Maury Boyd's groves, and while the trees still fell short of the type of tree we normally see in California, it was still producing fruit that was in good shape and acceptable for processing. There was also a noticeable lack of dropped fruit there, too. *Let me add that this is not a cure.* The trees are still infected with HLB. The real question is, how long will the nutritional program continue to be effective?

• HLB movement in the tree… We learned that upon infection of the tree by ACP, the disease first moves downward into the root system where it may sit for quite some time before it starts the upward movement into the scion of the tree. Perhaps this plays a role in the disease's latent proclivity to express itself. It was suggested that testing the roots of suspect trees may give us much earlier indications of a tree's health.

• Since these conferences occur every two years or so, 2015 will be the next. If you are familiar with the dice game Craps, you know that rolling a seven or an eleven is a good thing. Let's hope that the next conference (seven years since inception brings results from our scientific community that results in the solution so urgently demanded this year. Eleven years may be too late for some.

-- Dan Galbraith, Limoneira Company

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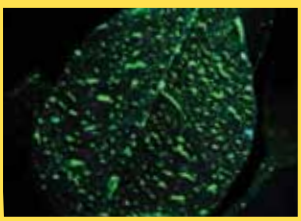

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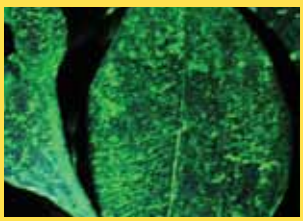

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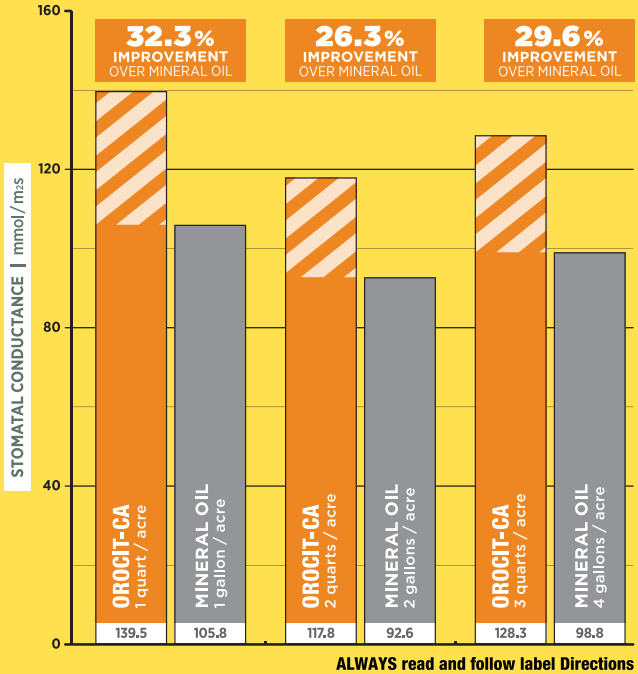

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ABOUT THE COVER

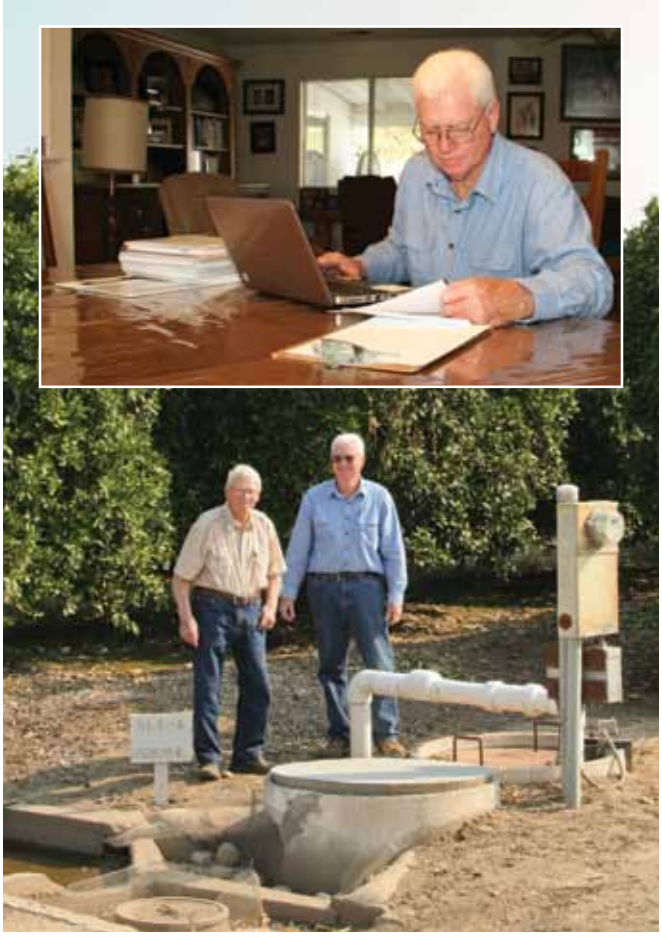
Working to stay ahead of the curve

Anne Warring

Every issue of *Citrograph* since November/December 2011 has featured a grower on the cover, and this time it's Fresno County's William Cotner.

Bill is in some ways representative of a number of producers in our industry these days who farm less than 100 acres and who have, in his words, "grave concerns" about the long-term sustainability of small family farming.

He made the comments about an uncertain future while being interviewed about getting food-safety certified. Gesturing toward the 5" thick GAPs binder next to his laptop, he said, "large corporations hire people just to do this. That's one of the ways small farmers are at a disadvantage because we don't have the financial ability to pay someone to take care of it for us.



Roy Cotner and son Bill at the return system installed 25 years ago that keeps all water on the property even after a heavy rain. Inset: Bill updating his food safety paperwork. *Photos by Alex Cotner.*

"If you farm by yourself, you're the farmer, you're the money manager, the one who stays current with all the requirements, the one who goes to classes, the one who does all the paperwork. And the hoops you have to jump through are getting higher and higher.

"I see a time when us little farmers will not exist because we will not be able to keep up with the rules and regulations that government is laying on us."

Even so, having said all of that, he is nowhere near ready to throw in the towel. In fact, quite the opposite. "I want the hearse to haul me away from this place!"

'I love farming'

"I love the farming business," he says, "and I am determined to stay here and do this." What's more, he and his wife, Dee, are looking forward to the day when their son Alex takes over and follows in the footsteps of his father, grandfather, and great-grandfather.

Bill has been the ranch manager for his parents, Roy C. and Eva Cotner, for 20 years. Both couples have homes on their 35-acre ranch near Minkler where they grow mainly Frost Washington navels but also have a few acres of Fukumotos and Becks. Closer to Sanger, they have another 18 acres of Fukumotos on a ranch that Eva inherited.

Bill has lived on the ranch for all but five of his 65 years, and, like every grower's son, has always been hands-on. But he has also had another career in information technology.

He was introduced to computers during active duty with the Air National Guard and went on to work for the County of Fresno for 33 years in various IT supervisory positions before opting to take an early retirement in 2006 to be able to do the farming full-time. His parents own the ranches, and Bill runs the business under contract. He took over operations when Roy became semi-retired at age 70.

So, what is Cotner's approach, as he copes with the ever-increasing requirements and the ever-increasing workload?

It's obvious from spending just an hour or two with him that Cotner is a high-energy person who is eager to get on with things, and when those things include difficult issues, he deals by being proactive.

It may be a cliché, but "proactive" is really the right word for Bill because it's how he operates -- "acting in anticipation of future problems, needs, or changes."

It's a natural inclination he says he gets from his dad, noting that Roy was ahead-of-the-curve in recognizing air quality concerns and adopted a no-burn policy early on.

He also mentions Roy's early instincts about water issues and points to the irrigation water return system they installed some 25 years ago. The purpose at the time was water conservation, but when they went to microsprinklers they kept the return in place. It's significant today, of course, because there is absolutely no runoff of any kind from the property, Bill says, even after a downpour.

'Grower GAPS' a challenge to be met

Cotner has been looking at the food safety issue for these past several years as a challenge to be met head-on.

One of the standards he sets for himself is to always stay on top of things.

He had been following the news of food-borne illnesses involving other commodities -- (though citrus is grown off the ground, he had stopped applying manure after the 2006 E. coli outbreak in spinach) -- and he was well aware of packinghouses needing to undergo third-party audits. *...continued on p. 12*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But his attention to the issue became a whole lot sharper when he saw a newspaper story that two of the largest big-box retailers wanted only produce that was certified safe at the grower level. "I showed the article to my folks that same day and said I think we should pursue this."

He recalls "mulling it over for about a week" and then calling the manager of Orange Cove-Sanger Citrus Association, Kevin Severns, to discuss it.

Less than a month later, Severns had arranged for Cotner to meet with Sunkist's food safety director Bob Elliott and Elliott's colleague, food safety specialist Elena Jimenez.

At the time, Cotner was shipping though both Sunkist and Duda Farm Fresh Foods, so very shortly he was also in contact with Melissa Mundo at Duda.

Hosted a mock audit

There are a number of people in California citrus who have been working in the food safety arena for years -- for nearly a decade in some cases -- and they come together quite often as an informal group to coordinate efforts.

Two years ago, the group had a draft set of templates and checklists for commodity-specific GAPs for citrus and wanted to test them in the field to see how practicable they would be, especially for a small-scale operator, and how a grower's food safety program based on those checklists would fare in an audit.

This work was part of an initiative by the entire U.S. fresh produce industry to develop a Harmonized GAPS Food Safety Standard.

At that point -- June 2011 -- Cotner had become so immersed in the subject and was so engaged, he was willing to be the guinea pig. He hosted a half-day "mock audit" in his pole barn and made his ranch and all of his preliminary self-audit paperwork available for scrutiny.

He was then asked to talk about his experiences as a panelist for a food safety breakout session at California Citrus Mutual's 2012 Citrus Showcase.

When he was ready to be audited for certification, he chose to work through CDFA and USDA and singles out the staff at the CDFA office in Dinuba as especially helpful.

Overall, he says, the process was constructive.

"Most of the small growers are against this, still to this day," he says. "I've got many associate farmers in my area who are my size who really don't know why I'm so involved with this."

With mandates on the way from the Food Safety Modernization Act, his advice is to "learn all you can and do all you can" to be in the best possible position, adding that there are excellent tools available especially on the CCQC and CCM websites.

He thinks most growers will find they are "already doing a lot of it," though probably not with the full documentation required.

Bottom line, Cotner says, "It's do-able. It is what it is, and you've got to get with the program and live with it." ●

THE ANSWER

From page 5, what do all of those things have in common? The answer is sour orange. To read a wonderful article by David Karp, go to www.latimes.com. Search for "sour oranges david karp," scroll down to "where to buy sour oranges" and then open "sour oranges find sweet spot in California."

CRB 2012 Annual Report

Ted Batkin, President

The 2012 season brought about more changes in the Citrus Research Board relationship with the Citrus Pest and Disease Prevention Committee (CPDPC) and the California Department of Food and Agriculture (CDFA). During the fiscal year, CRB turned over the supervision of the field trapping program to CDFA for regulatory purposes. This allowed the trapping program to provide certification for Australian shipments under the USDA Bilateral Agreement for Asian citrus psyllid (ACP) populations within the groves. As a result, the amount of money expended by CRB for the trapping program was reduced from the previous year as the funds were shifted directly to CDFA for the activities in April.

One significant change to the general effort in the past fiscal year was the addition of the High Risk Urban Survey conducted by CDFA under contract with USDA-APHIS. This survey is conducted in urban areas throughout Southern California to look for the bacteria associated with huanglongbing disease in citrus trees. While the focus is on plant material, samples of Asian citrus psyllid taken in the survey are being processed at both the CDFA laboratory and the CRB laboratory in Riverside as part of the overall program.

The CRB research program continues to seek long-term solutions to HLB while developing short-term detection mechanisms for infected trees. The VOC sensor system continues to be the foundational tool for early detection with confirmation systems coming from three other methods of detection. All these systems are based on finding the host plant response before the actual HLB symptoms become visible or detectable in the tree by currently certified methods. This has been the outcome of five programs funded by the CRB over the past 10 years. Additionally, the Lateral Flow Microarray program has reached the level of commercialization and will be available later this year to the grower community for confirmation testing in Florida where HLB exists.

The Board welcomes your comments and observations to the Citrus Research Program. The following table lists the audited financial statement for the 2012 fiscal year. A complete copy of the audit is available for viewing at the CRB office at 217 N. Encina, Visalia, CA. You are welcome to visit us at any time to discuss any elements of the program and see what we are doing. This is your program, and we look forward to hearing from you.

CITRUS RESEARCH BOARD

October 1, 2011 through September 30, 2012

INCOME

2011-2012 FY Assessment Income	5,609,392
Prior Season Income	(42,011)
Investment Interest Income	37,229
Investment Dividend Income	22,542
Rent	,650
Citrograph Advertising	39,126
Conference Registration Fees	33,470
Outside Income	4,550
Grower Seminar Registration	83,595
Reimbursed Expenses	153,813
Lab Services	20,919
CPDPC Reimbursement Income	2,153,966
TOTAL FUNDS AVAILABLE	**8,118,241**

EXPENSES

RESEARCH PROGRAM

Production Efficiency

Unforbidden Fruits	14,277
Breaking Citrus Trade Barriers	32,858
Measuring Ozone Removal	55,583
Bio Sensor Development for Citrus Disease Diagnosis	120,113
Integrated Low Cost Nucleic Acid Analysis	153,810
Development, Validation & Deployment	297,000
Pre-Commercial Development of Portable Sensors	122,866
Citrus Cryopreservation	28,700
Total Production Efficiency	**825,207**

New Varieties

Factors Influencing Post Harv Qual Mandarins	63,903
Test Transgenic Carrizo Rootstock	50,000
Development of Cryotherapy	25,000
Founder Lines for Improved Citrus	142,748
Citrus Breeding & Evaluation-CORE	456,707
Total Plant Improvement	**738,358**

Vectored Diseases

Small RNA for HLB Plant Response	130,432
Identification of Spiroplasma citri	59,577
Avoiding Economic Losses in CA Citrus	54,035
Screening Citrus Germplasm	19,000
Detection of HLB – Secreted Proteins	62,196
Biomarkers for Detection of HLB	59,300
Total Vectored Diseases	**384,540**

Non-Vectored & Post Harvest Diseases

Evaluation of PH Treatments	56,000
New Technologies to Minimize PH Decay	46,500
Septoria Spot	49,000
Investigating Important Citrus Diseases	124,143
Rapid Identification of Unknown Citrus Virus	80,000
PH Microbial Food Safety	55,780
Assessment of Bacteriology	30,000
Total Non-Vectored & Post Harvest Diseases	**441,423**

Pest Management

Assessment of Systemic Neonicotinoid	112,524
Host Specificity Testing of Tamarixia	80,018
Preparation for Citrus Leprosis	13,304
Evaluation of Oils	5,532
ACP Attractants	177,475
Development of Pathogen Dispenser	114,400
Optimizing Chemical Control of ACP	80,941
Maintenance of Foundation ACP	64,688
Host Specificity Testing	58,097
ACP Genome	94,643
Evaluation of Three Lure Detection Trap	25,000
Release & Monitor Tamarixia	110,160
Hydrogen Cyanide Residues	10,000
Biological Control of ACP	101,517
CORE IPM Program	372,374
Total Pest Management	**1,420,673**

Research Administration

Salaries & Benefits – Research Admin	172,466
Travel	15,370
Total Research Admin	**187,836**
TOTAL RESEARCH PROGRAM	**3,998,037**

CRB COMUNICATIONS PROGRAM

Core Grower Education Program	20,790
Citrograph	134,763
Editorial Support	6,125
Website	818
Salaries & Benefits - Communications	135,346
Supplies	356
Travel	3,691
TOTAL CRB COMMUNICATIONS PROGRAM	**301,889**

CPDPP OUTREACH PROGRAM 749,676

CITRUS CLONAL PROTECTION PROGRAM

Core Citrus Clonal Protection Program	448,754
Supplies	2,031
LREC Positive Pressure Greenhouse	197,607
TOTAL CITRUS CLONAL PROTECTION PROGRAM	**648,392**

OPERATIONS PROGRAM

Data Management

Salaries & Benefits – Data Management	161,133
GIS Mapping Contract	54,699
Travel & Mileage	465
Information Services	142,714
Equip Repairs & Maintenance	685
Supplies	475
Phone	2,355
Total Data Management	**362,526**

Laboratory – Riverside & Visalia

Salaries & Benefits – Lab	167,192
Travel & Mileage	3,256
Equipment Repairs	30,177
Equip/Supplies/Repairs – Visalia lab	4,525
Supplies	210,518
Utilities	16,156
Phone	20,309
Postage	445
Rent	49,382
Total Laboratory – Riverside & Visalia	**501,960**

Field

Salaries & Benefits – Field	157,335
Contracts (Outside Personnel)	3,424
CASS Staffing	283,916
Trap Readers	77,056
Travel & Mileage	11,117
Fuel	115,973
Vehicle Repairs & Maintenance	42,316
Equipment Repair & Maintenance	3,770
Supplies	84,343
Phone	20,875
Postage	660
Total Field	**800,787**
Administrative Support	**110,000**
TOTAL OPERATIONS PROGRAM	**1,775,273**

PAYROLL EXPENSE –
Research, Comm, Operations, Admin 86,126

CALIFORNIA CITRUS QUALITY COUNCIL (CCQC)

CCQC Administration	309,861
Registration Projects	57,204
International Issues	74,912
Other Projects	16,440
TOTAL CALIFORNIA CITRUS QUALITY COUNCIL (CCQC)	**458,417**

SPECIAL PROJECTS

Conferences	59,164
LREC Packline	9,224
Riverside Lab Expansion	49,668
TOTAL SPECIAL PROJECTS	**118,056**

GENERAL AND ADMINISTRATIVE

Salaries & Benefits – Administration	401,106
Audit Fee	15,000
Equipment Repair & Maintenance	959
Equipment Rental	1,856
Information Services	47,850
Insurance & Bonds	25,754
Workman's Compensation Insurance	9,207
Office Supplies	20,371
Postage	10,128
Printing	14,949
Meeting Costs	34,619
Telephone	20,068
Travel & Mileage – Consultant	1,698
Travel & Mileage – Members	51,201
Travel & Mileage – Staff	55,623
Vehicle Maintenance & Fees	1,016
CDFA – Bureau of Marketing	59,849
CDFA – Fiscal Compliance Audit	15,000
CDFA – Handler Audit	12,084
Building Repairs	12,137
Property Taxes	66
Utilities	27,262
TOTAL GENERAL & ADMINISTRATIVE	**837,803**
DEPRECIATION	**197,978**
TOTAL EXPENSES	**9,171,649**
CURRENT ASSETS	**3,033,866**
TOTAL ASSETS (INCLUDING CURRENT ASSETS)	**4,148,798**
CURRENT LIABILITIES	**233,295**
RESERVE	**3,915,503**

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CRB picks Florida's Ken Keck as new CEO

Editor's Note: The news of Ken Keck's selection as incoming CRB President was announced with this press release from Nuffer, Smith, Tucker Public Relations.

CITRUS INDUSTRY VETERAN TO TAKE THE HELM AT CALIFORNIA'S CITRUS RESEARCH BOARD

Visalia, Calif. — April 8, 2013 — As California citrus growers continue to invest in needed research to aid the state's more than $2 billion citrus industry and battle threats such as the Asian citrus psyllid, citrus industry veteran Ken Keck will join the California Citrus Research Board as its new president on June 1.

Keck brings deep industry knowledge — including experience in fighting the Asian citrus psyllid and Huanglongbing (HLB) in Florida — having served as general counsel and executive director of the Florida Department of Citrus from 2006-2012. Prior to that, he served as the organization's director of government affairs and general counsel from 2002-2006, and director of legislative and regulatory affairs with Florida Citrus Mutual from 1999-2002. Having served in these roles, Keck has deep-rooted expertise representing citrus growers in a governmental, legal and regulatory framework.

Ken Keck

Keck will replace Ted Batkin, who served as the organization's president since 1993 and who will retire from this role in September. Under Batkin's leadership, the organization increased its research investment to a current level of more than $5 million. The primary focus of the program is detection of HLB disease and vector management of the Asian citrus psyllid.

"We thank Ted for his tremendous leadership and efforts on behalf of California citrus growers," said Earl Rutz, chairman of the CRB. "And while there are big shoes to fill, we believe Ken's track record, enthusiasm and alignment with the perspective of California growers will make him an excellent asset to the CRB.

"As an industry, we are facing some serious threats, most notably the continued spread of the Asian citrus psyllid and identification of HLB in our state. It's a complex and challenging time, but we believe Ken has the skills to take us forward."

Among Keck's accomplishments with the Florida Department of Citrus, he: secured an average of $7 million annually of federal and state appropriations for programs; commissioned a National Academies study, resulting in the establishment of a dedicated $10 million annual disease research, development and commercialization foundation; and achieved a range of $3-$5 return to growers for every marketing dollar expended. Keck has achieved these results not only because of his tireless work ethic, but also from his understanding of what citrus growers face.

"I am a third-generation grower in Florida, so I know the nature of the business. I know what it means to depend on the harvest each year. I know what it feels like to have your livelihood threatened, and I want to use this understanding — and my experiences in Florida — to benefit the California industry."

Keck holds a bachelor's degree in Spanish from Stetson University, and a juris doctorate degree in law from Widener University School of Law.

The Florida Citrus Department is a state agency charged with promoting Florida citrus products and is financed largely through a tax paid by growers on the annual citrus harvest. The Citrus Research Board administers the Citrus Research Program, a grower-funded and directed program established in 1968 under the California Marketing Act as the mechanism enabling the state's citrus producers to sponsor and support needed research.

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Bob Elliott

Viewing the pending 'grower GAPs' regulations in context

Those of us who have been part of the California citrus industry for the past few decades probably never expected that we would one day see the U.S. Food & Drug Administration preparing food safety regulations that would include citrus growing and harvest practices. Yet this year, FDA issued a Proposed Rule that would do just that.

In addition, citrus packinghouses can soon find themselves required to follow food safety programs similar to those standard in the processed food industry.

There has never been a reported outbreak of food-borne illness attributed to fresh citrus consumption. We have a low-risk product grown with low-risk practices. So how did we get here?

To answer this question, we need to consider it from within the framework of the larger produce industry, globalization, changes in food consumption patterns, consolidation of the retail industry, an active media, and new technologies available to authorities to identify and track the sources of outbreaks. All these have played a role.

Produce-associated food-borne illnesses

Outbreaks of food-borne illness associated with produce began to catch the attention of FDA in the mid-1990s when several were reported. Review of historical data showed that the proportion of total food-borne illnesses associated with produce had increased significantly over the previous 15 years.

In response to this, FDA released in 1998 a voluntary guidance: *Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables.*

Unfortunately, over the following years, reported outbreaks continued with more and more media attention. These were largely associated with sprouts, leafy greens, tomatoes, cantaloupes, green onions, and fresh herbs. FDA began a series of initiatives to push these industries to take action.

At the same time, U.S. retailers and foodservice buyers involved in outbreaks were facing very costly consumer lawsuits, and all felt pressured to protect themselves. New laws passed in Europe put responsibility on retailers to assure the safety of products they sold. U.S. and foreign buyers began requiring that suppliers implement documented food safety programs including third-party audits.

Fortunately, we have an excellent track record, low-risk product, scientific studies, and industry-developed GAPs to help bolster our position and steer this toward common sense.

California citrus packinghouses had to comply in order to maintain their markets. Growers of many commodities had to do the same, including most offshore citrus growers in regions dependent on the European market.

Despite all this, between 2006 and 2011 the news seemed to be filled with one report after another of an outbreak of food-borne illness attributed to produce or other foods, including several not previously associated with outbreaks.

Each of these led to consumer groups calling for more regulation and a growing belief by the public, and in Congress, that the system to protect the public health was failing and needed to be changed.

This led to the Food Safety Modernization Act becoming law in January 2011. FSMA mandates that FDA develop regulations for produce growing and harvesting as well as food facilities -- including those that pack produce.

So that brings us to where we are today. FDA has issued Proposed Rules, and we have the opportunity to respond and influence the final form the regulations will take.

Proactive steps by California citrus

Our industry hasn't been idle. Recognizing where this was likely to go, in 2009, CCQC organized a food safety working group to begin development of citrus-specific and practical guidance for food safety Good Agricultural Practices (GAPs) that reflect the low risk inherent in our product.

CCM joined in from the beginning along with Sunkist, several shippers, growers and harvest contractors. CCM coordinated several well-attended information sessions in 2012 to introduce these to the industry.

CRB has also been instrumental in this effort, funding research both at the packinghouse and grove levels to provide the science needed to address FDA's proposals and offer science-based alternatives where needed.

Current efforts are underway to review the lengthy FDA proposed rules and prepare comments that reflect the industry's interests. There are provisions within the Proposed Rules that we have reason to question, both as to their overall validity and applicability to fresh citrus.

Fortunately, we have an excellent track record, low-risk product, scien-

tific studies, and industry-developed GAPs to help bolster our position and steer this toward common sense.

The regulatory and market climates have changed significantly. We may call it farming, but Congress, FDA, and buyers now consider produce growers, harvesters and packers to be part of the food industry with documented food safety programs.

At first glance, this may all seem overwhelming and confusing. But actually, these are simple concepts and practices, many of which are already being done. And we now have industry-developed GAPs guidance to serve as a basis to move forward.

Since 2006, Bob Elliott has been Director of Food Safety for Sunkist Growers, where he has been on staff for 26 years. His efforts are focused on developing and implementing food safety programs for citrus growing, harvesting and packing. He earlier worked in Fruit Sciences managing technical programs in fresh fruit production, postharvest handling, phytosanitary requirements, and value-added product development.

California citrus group prepares comments on proposed rules

The group of CA citrus industry leaders on food safety who have been involved in developing the citrus food safety GAPs met in Lindcove April 11 to discuss and strategize industry comments to FDA on the two proposed sets of regulations released in January.

Proposed water standards and testing frequency dominated discussion on the Produce Rule. Ongoing University of California studies funded through CRB will be critical to the industry offering an alternative to FDA for citrus production.

FDA proposes that alternative water standards are acceptable provided growers can demonstrate an equivalent level of public safety. The industry will continue to provide evidence for the low-risk nature of citrus and our growing practices, but FDA is expecting scientific data presented as part of a quantitative risk assessment to support it.

Discussions on the proposed Preventative Controls Rule for packing facilities centered on the fact that the same standard is applied to produce packing as to processed food and fresh-cut facilities. The citrus industry will formulate comments to FDA specific to our operations. Additionally, a collaborative effort is underway with other commodities to strategize an effective response to FDA that addresses concerns of the entire industry.

Meanwhile, on April 18, FDA responded positively to an industry request, signed onto by CCQC, CCM and Sunkist, to extend the comment period. The deadline is extended by an additional 120 days to September 16, providing necessary time for thorough review and constructive comment.

– Bob Elliott

Leaders in key positions nationally

Anne Warring

As the Food and Drug Administration moves through the processes involved in implementing the Food Safety Modernization Act, the California citrus industry is represented by leaders who not only have a thorough understanding of the issues but are well positioned nationally.

On May 14, Bob Elliott, who is Sunkist's food safety director and a member of the board of the California Citrus Quality Council, will become chairman of the United Fresh Food Safety & Technology Council.

With more than 100 members -- including CCQC's president, Jim Cranney -- the Food Safety & Technology Council is the largest group within the volunteer leadership structure of the Washington, D.C.-based United Fresh Produce Association.

The FS&T Council is made up of technical representatives from over 65 United Fresh member organizations and, as described on UFPA's website (www.unitedfresh.org), deals with "all aspects of food security, food safety, and technology through the total supply chain."

The Council has been active in providing input into commodity guidance documents and the FDA's Produce Action Plan and in developing research proposals.

In addition to taking over the chairmanship of the Council, Elliott is separately serving on both of the special work groups formed by United specifically to review the two Food Safety Modernization Act proposed rules issued in January.

CCQC's Cranney also serves on those same United groups -- the Produce Rule Working Group and the Preventive Control for Food Facilities Working Group.

What's more, California Citrus Mutual president Joel Nelsen is a member of the Produce Rule Working Group, and CCM's Bob Blakely is a member of the Preventive Controls for Facilities group.

United Fresh will use the industry working group comments and assessments as an outline and focus for the Association's official comments to FDA.

A United representative indicated that they are coordinating efforts with the Produce Marketing Association (PMA) regarding the proposed rules and will be sharing information.

CCM's 2013 CITRUS SHOWCASE

California Citrus Mutual reports that "a larger crowd that ever before" attended the 2013 Citrus Showcase at the Visalia Convention Center March 7.

CCM estimates that some 800 people came to visit the trade show and participate in workshops, and over 600 were at the luncheon to hear keynote speaker Greg Calistro, the director of produce for Save Mart stores, share his perspective on the industry and consumer trends he calls "game changers."

It was standing room only for the breakout session "The ACP/HLB Partnership – Who is in Charge?" with Dr. Prakash Hebbar, coordinator of the national Citrus Health Response Program (CHRP), CDFA's Dr. Robert Leavitt, CPDPC chairman Nick Hill, and citrus entomologist and UC Extension Specialist Dr. Beth Grafton-Cardwell. The moderator was CRB vice chairman Dr. Etienne Rabe.

Also on the program were workshops offering presentations and Q&A discussion on water regulations and marketing.

2013 World Ag Expo

Every year, the CRB exhibit at the World Ag Expo has an IPM section presented by the Citrus Entomology Group from the University of California's Kearney and Lindcove Research and Extension Centers.

The display always includes fruits and leaves scarred by various pests, microscopes for viewing small insects, and publications. For obvious reasons, the focus was again on the Asian citrus psyllid, but this year's display also highlighted earwigs as a new pest of young citrus.

Across from the IPM section, the Research Board used a small pop-up greenhouse as a prop for describing how the parasitic wasp *Tamarixia radiata* will be reared in commercial-size greenhouses for release in areas with ACP infestations.

The educational outreach on ACP and huanglongbing (HLB) disease continued in Pavilion A where the Citrus Pest and Disease Prevention Program had its booth.

AG DAY AT THE CAPITOL

March 20 was California Ag Day in Sacramento. This annual event, which raises funds for Ag in the Classroom, is staged on the steps of the Capitol, providing an excellent opportunity for farm and ranch leaders from across the state to have "face time" with legislators and their staff members while also getting messages out to the general public.

This year, exhibitors included the Citrus Pest and Disease Prevention Committee (CPDPC) represented by the CRB's Ted Batkin and Louise Fisher along with Mark Olsen, the government relations specialist for the CPDPC outreach program, and Joel Nelsen and Alyssa Houtby from California Citrus Mutual, plus citrus industry consultant Jim Sebesta.

Event-goers were attracted to the CPDPC exhibit by a fresh fruit display and a give-away of fresh oranges, lemons, and mandarins.

The future nursery tree: what can we expect?

Bob Zuckerman

Editor's note: This article is based on a talk presented at the 2012 California Citrus Conference.

Increase budwood trees inside solid wall greenhouse. California regulations required approved insect-resistant structures for all citrus increase trees on Jan. 1, 2013. *Photos courtesy of B&Z Nursery.*

The goal of our commercial citrus nurseries is to provide clean citrus trees for California growers.

For years, we had a very successful voluntary registration program, but the commercial nurseries decided to pursue a mandatory program to better protect the industry from endemic and new invasive pests and diseases. It was an arduous, contentious, and often convoluted path, but what finally evolved was a mandatory program for citrus propagative materials.

"It is not enough that we do our best; sometimes we must do what is required."

— Winston Churchill

The regulations

The California regulations now require that all citrus propagative materials, specifically registered and increase trees, must be grown in CDFA-approved insect resistant protected structures.

The simplest way to describe the two sources of propagative materials is that buds from registered trees are used to propagate increase trees. Buds from increase trees are used to grow citrus nursery trees, also referred to as citrus nursery stock. Additionally, seedlings or rootstock used to propagate registered and increase trees also must be grown inside protected structures.

There likely will never be any specific California state regulations requiring nursery stock to be grown inside these structures. However, both state and federal quarantines for Asian citrus psyllid (ACP), huanglongbing (HLB) and Citrus tristeza virus (CTV) restrict the movement of citrus nursery stock.

Although currently, many citrus nurseries are continuing to grow outdoor nursery stock, the inevitable pest and disease pressures will likely compel all nurseries to produce trees under cover or risk being caught up in quarantine restrictions. We have now seen these vulnerabilities even in the San Joaquin Valley with the recently declared ACP finds in Tulare County.

So, to protect the trees and to be able to move trees to all customers even when quarantines are declared, many commercial citrus nurseries have already begun propagating their nursery stock inside protected structures.

Each nursery decides on the type of structure they will construct to meet the requirements. For most established citrus nurseries, this is an entirely new challenge for growing trees, and involves a time-consuming and expensive process of planning, preparing, constructing and learning to grow inside structures.

Once under cover, we no longer have the luxury of open ground to easily line out new seedlings or trees for new orders or speculative growing. We lose the flexibility of easily adding new blocks of increase trees for propagation. There won't be available space for holding over trees. Propagation and scheduling will be critical and constrained to terms of weeks and months rather than

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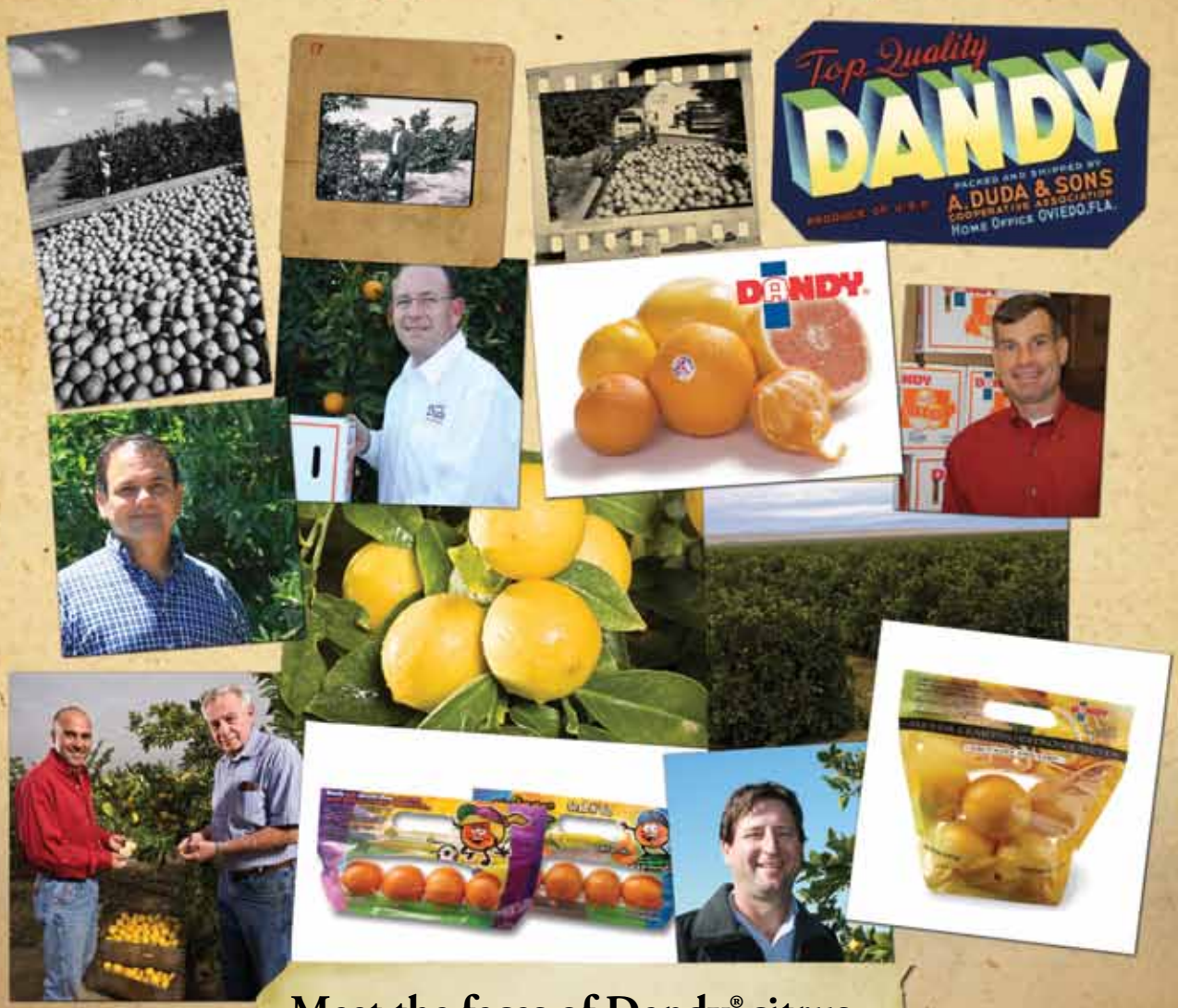

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seasons and years. Growing space will be in square feet rather than acres. All this has significant implications that will affect both nurseries and growers.

The trees

The days of the traditional ball and burlap trees are numbered. Some nurseries that typically grew outdoor container trees may continue to do so under cover. But to accommodate growing in structures, most trees will be in small containers, 4 to 6 inches in diameter, grown in soilless mixes, will be younger, more tender and more delicate to handle. They will require more careful handling because of their size and not having been grown under outdoor field conditions.

Growers will need to devote more attention to field preparation and planting because of the smaller root-ball and the disparity of the soilless mixes to the field soils. Initial irrigation and field establishment will be more demanding as well.

On the other hand, the trees will lend themselves to mechanized planting, high-density orchards, and adaption to advanced production systems such as open hydroponics. The intact and well-developed root systems will allow for an extended planting season and rapid establishment.

Overall, after the extra care necessary during planting and initial establishment, we would expect the indoor grown container nursery stock to be a vigorous, healthy and very successful tree for the growers.

Increase budwood.

"It is not the strongest of the species that survive, nor the most intelligent, but the ones most responsive to change."

— Charles Darwin

Nursery challenges

Nurseries need not only learn how to grow nursery trees inside structures but must also develop production scheduling to prepare, propagate and deliver trees, and then repeat the production cycle within the same growing space. They will need to time their crops to maximize the use of limited space while satisfying the needs for growers' planting schedules. Tree readiness will need to be integrated into the ordering and production cycles for each contracted order.

As the nurseries transition from outdoor to indoor production, they will have to learn how to modify their processes, procedures, and work force. To facilitate a successful transition, we will need a cooperative effort between nurseries and growers as we both adapt to the new realities of citrus nursery tree production.

More grower challenges

Planting and establishing the trees in your orchards may be a less significant challenge to growers than the challenges of organizing, planning and ordering trees.

In almost all cases, trees will need to be contracted at least a year in advance, even replants. Speculative growing by the nurseries may not be an alternative. Growers will also need to arrange their field preparations and planting schedules well in advance.

With strict limits on growing space,

Screenhouse for registered (mother) trees. All registered budwood source trees in California were required to be grown in approved protected structures starting Jan. 1, 2012.

nurseries will have a narrow window of time when trees will be available and when they will need to move trees out in order to grow the next crop of contracted trees.

With nurseries not necessarily able to hold over trees, growers will have to be prepared to take trees on a set schedule, determined a year in advance, when they contract for their trees.

Costs

Because of the significant capital and growing costs associated with growing in structures, more substantial deposits or ones timed with production stages will be required. Regulatory requirements for registered and increase trees, seedlings and seed add to the component costs of nursery stock.

During the transition, as outdoor trees are still available, I would expect only a moderate increase in tree prices, likely in the range of $1 to $2 per tree for 2013-2014 orders.

As ACP and/or HLB pressures force nurseries into structures, we may experience tree shortages and see higher prices. Once nurseries convert to growing in the protected structures, holding trees over and rescheduling deliveries will likely incur added costs because of the need for additional facilities and expenses to accommodate extra tree handling and storage.

Topworking challenges

An unexpected consequence of the regulations is the problem of being able to grow sufficient quantities of budwood suitable for topworking. There will be fewer and smaller registered trees to serve as a source for topworking buds. Space for increase trees will be limited and the increase budwood, managed for propagating nursery stock, will generally be smaller and unsuitable for topworking.

CTV quarantine regulations make it illegal to cut buds from unregistered trees. No one, not even a homeowner, can legally propagate from an unregistered source. Outdoor field trees can no longer be registered to use as a source of topworking buds.

While it might seem that you should be able to use any tree for a topworking source on your own property, the regulations are in place to protect the industry. The nurseries certainly never intended, nor have any desire to limit the availability of topworking buds, but that is the reality.

With advanced planning some varieties of topworking buds may be available, but there will be limited quantities and the cost for buds will be higher, so topworking may not always be an option.

"Coming together is a beginning; keeping together is progress; working together is success."

— Henry Ford

Growers and nurseries both have contributed significant time, effort and money in their resolve to keep the California citrus industry viable. No matter what obstacles confront us, either natural or contrived, with cooperative effort I expect that together we can successfully manage whatever challenges lie ahead.

Bob Zuckerman is Chair of the California Citrus Nursery Board (CCNB).

Bifenthrin trunk sprays as a strategy for Fuller rose beetle (FRB) field control in 2013

Fig. 1. The flightless adult female Fuller rose beetle must climb to reach the foliage and fruit.

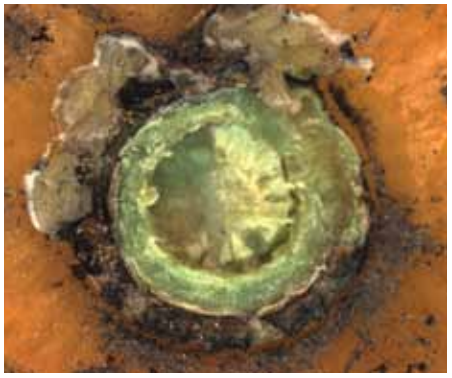

Fig. 2. Eggs of the Fuller rose beetle are deposited under the button of the fruit. Fig. 3. Larva (left) and pupa (right) of the Fuller rose beetle. These stages are found in the soil below citrus trees. *Photo by Jack Kelly Clark, courtesy of the University of California Statewide IPM Program.*

Joseph Morse and
Beth Grafton-Cardwell

Editor's Note: Work on Fuller rose beetle is now a part of CRB's core program of Integrated Pest Management research with Drs. Morse and Grafton-Cardwell as lead investigators.

Fuller rose beetle (FRB) (Figure 1) goes by many different names (synonyms) in the scientific literature including *Naupactus godmani* (Crotch) (most correct), *N. cervinus*, *Pantomorus cervinus*, *Asynonychus godmani*, and several others.

FRB is seldom considered a serious pest in California but has re-emerged as problematic because it is considered a quarantine pest in important citrus export markets such as Korea (see the sidebar on page 31).

The Fuller rose beetle has one generation a year. Eggs are laid in a mass of up to several dozen underneath the button of fruit, or in cracks and crevices in the tree (Figure 2). When eggs hatch, larvae drop to the ground and live in the soil where they feed on roots of citrus for 6 to 10 months (Figure 3).

They pupate in the soil, and adults emerge 1.5 to 2 months later. Peak emergence is July through September, but adults emerge from the soil year-round. For example, in the San Joaquin Valley, roughly 4.3% emerge in June, 14.5% in July, 53% in August, 17.3% in September, 3.7% in October, 2.6% in November, 2.8% in December, and 1.9% for the combined months of January through May.

Adults are all female and are flightless. They reach the canopy only by climbing up the trunk or branches that touch the ground or vegetation.

In past years, Korea has permitted blanket methyl bromide fumigation of citrus arriving in Korea as a means of ensuring that Fuller rose beetle is not introduced there.

The California citrus industry has been informed that Korea is not likely

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to allow the blanket fumigation starting with the 2013-14 shipping season. Instead, Korea will reject shipments with viable (unhatched) FRB egg masses if they are found on arrival.

To avoid severe impacts on the industry, it is suggested that growers with fruit likely to be shipped to this country reduce FRB levels in their groves to extremely low levels using a combination of skirt-pruning and trunk sprays as detailed below.

Meanwhile, research is continuing on FRB pre-harvest and postharvest management, and updates on control options can be found as they occur at the following two websites: http://ucanr.org/sites/KACCitrusEntomology/ and http://www.calcitrusquality.org/.

The ideal method of dealing with FRB would be an effective postharvest treatment that could be used only on loads of citrus destined for shipment to Korea. Postharvest research will continue, but at present we do not have an effective postharvest treatment that can be recommended for control.

FRB eggs are covered with a proteinaceous coating secreted by the female after eggs are laid. This coating protects the eggs from dessication, attack by many natural enemies, and also makes postharvest chemical control quite difficult.

A second strategy of control that has been evaluated is various treatments that might reduce the survival of larvae found feeding on the roots of citrus in the soil. Soil application of parasitic nematodes has been shown to be only somewhat effective in controlling FRB larvae. Based on discussions with PCAs, it also appears that post-petal fall soil applications of imidacloprid applied over a period of 4-5 years gradually lead to reduced FRB levels. Unfortunately, the level of control that is needed for the Korean export market is much higher than what can be obtained via these soil treatments.

Substantial research has been done using foliar sprays to control adult FRB. The bottom line is that these insects are ***very*** difficult to kill. Even the most effective materials are not extremely persistent, making re-application necessary if sustained control is expected of adult beetles which continue to emerge out of the soil over many months (June-November).

Check UC Pest Management Guidelines for updates (http://www.ipm.ucdavis.edu), but the most effective materials identified to date are cryolite, thiamethoxam, and carbaryl. *Unfortunately, MRLs are not established for cryolite in Japan or Korea suggesting that this material should not be used on export fruit (the PHI of 15 days is based on a U.S. tolerance of 7 ppm – see Table 1).*

Carbaryl might be used on export fruit only ***well in advance*** of harvest (contact the manufacturer for advice). The PHI of 5 days is based on a U.S. tolerance of 10 ppm which is 20-fold higher than the Korean MRL of 0.5 ppm.

Only with thiamethoxam is the MRL in export markets equal or higher than the U.S. tolerance, indicating that the label PHI should result in fruit residues below the MRL (PHI is 0 days but REI is 12 hours). The downside of thiamethoxam is the number of repeated foliar sprays needed for effective FRB control; likely 4-5 sprays applied at monthly intervals from June through harvest. If the 5.5 fl oz/acre rate is used, only 2 applications of thiamethoxam are allowed per year. Therefore, we suggest that skirt-pruning and bifenthrin trunk sprays are more effective strategies to manage FRB during 2013.

Table 1. Citrus MRL situation (ppm, FAS online database as of 1-16-13) for grapefruit, lemons, oranges, and tangerines.

Trade Name	Common Name	U.S. Tolerance	Codex MRL	Japan MRL	Korea MRL	PHI (days)
Brigade WSB[a]	bifenthrin	0.05	0.05	2	0.5	1
Sevin	carbaryl	10	15	7	0.5	5
Kryocide	cryolite	7	--	--	--	15
Actara	thiamethoxam	0.4	0.5	1	1	0

[a] Not registered for foliar use (do not allow fruit contact; see the trunk spray discussion below).

Fig. 4. Skirt prune the trees at least 24" from the ground and check the trees regularly to eliminate suckers and fruit touching the ground in order to prevent access to the fruit and foliage other than via the trunk.

Suggested strategy for 2013: skirt-pruning + bifenthrin trunk sprays

Research done to date suggests that an effective method of controlling FRB is skirt-pruning coupled with repeated trunk sprays of bifenthrin; Brigade WSB is the formulation shown to be effective in trials.

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To find out more about K-PHITE 7LP and K-PHITE 7LP Programs, contact your California Plant Food Systems Representative directly: Mark Brady – Western Marketing Manager 559 731-1267.

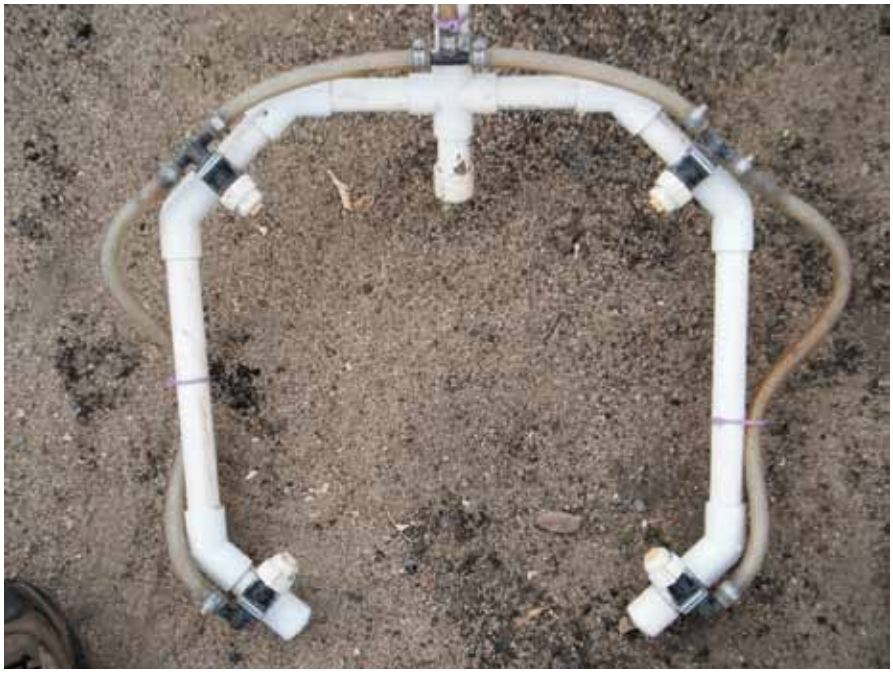

Fig. 5. Close-up of the business end of a home-built wand sprayer constructed using PVC tubing and fittings. Use a large nozzle and reduced spray pressure in order to eliminate drift to fruit or foliage. The butt of the wand rests on the ground and 4 nozzles apply the bifenthrin all around the trunk from a single entry into the tree. The opening of the U-shaped device must be wide enough to accommodate the largest trunk.

Fig. 6. Using the U-shaped wand to treat a citrus trunk. The lever is depressed to turn on the spray and one pass is made up from the soil surface to a height of about 18" and then one continues spraying back down (up and down ensures no surface of the trunk is missed).

should start in early June, just before adult beetles start to emerge in significant numbers out of the soil. Skirt-pruning alone will reduce FRB levels only to a limited degree.

It is critical that the skirt be pruned high enough initially so that when suckers grow or the weight of fruit bends branches downward, they do not contact the soil or weeds that have been allowed to grow in the grove (Figure 4). FRB adults have a habit of climbing upward and will rapidly find any "bridge" into the tree that allows them to bypass the repellent trunk sprays of bifenthrin. We suggest that initial skirt-pruning be done at a minimum height of 24" (higher is better and might save labor later in the season).

It is critical that the grove is walked every 4-6 weeks to touch up skirt-pruning and maintain weed control. If adult beetles bypass the trunk spray, then one has wasted time and the cost of the skirt-pruning and trunk spray.

The strategy of using pyrethroid trunk sprays originates from work done in California with carbaryl and azinphos-methyl trunk sprays when FRB was a problem for California citrus exported to Japan back in the late 1980s. This is no longer an issue because FRB has been found in commercial citrus groves in Japan.

Later research by R.D. Magarey (Sunraysia Horticultural Centre, Mildura) and co-workers in Australia showed that several pyrethroids were effective. Trunk sprays of lamda-cyhalothrin are now being used there for FRB control based on work by Greg Baker and Peter Crisp of the South Australian Research & Development Institute. Lamda-cyhalothrin is not labeled for use on citrus in the U.S. Our research comparing trunk sprays of lamda-cyhalothrin versus bifenthrin indicated that bifenthrin is a more effective FRB trunk spray.

The Brigade WSB 2ee label allows ***trunk*** application of up to 0.5 lbs AI (active ingredient) per acre. Unfortunately, bifenthrin applied in 1 application of 0.5 lbs or 2 applications of 0.25 lbs is not persistent enough to provide season-long control due to the prolonged period of time over which adults emerge out of the soil. The highest levels of soil emergence occur from July to September. Furthermore, adult

FRB kept in the laboratory lived an average of 110 days; even under field conditions, adult FRB will be quite long-lived.

If skirt-pruning and trunk sprays are applied too late in the season, adults that emerged earlier will already be in the canopy of citrus trees producing eggs that remain unhatched and could be detected on fruit at harvest.

Based on our FRB efficacy data and in cooperation with FMC Corporation and CCQC, we are working to obtain a 24c label allowing trunk application of a total of 1.0 lbs AI per acre (allowing an additional 0.5 lb AI per acre amount needed to make this strategy effective).

We are currently evaluating two strategies for Brigade trunk sprays, and results will be available prior to the first June treatment. These strategies include: (1) 4 applications of 0.25 lb AI/acre applied every 6 weeks (e.g., June 3, July 15, Aug. 26, and Oct. 7) versus (2) 2 applications of 0.5 lb AI/acre applied at an interval of 12 weeks (June 3 and Aug. 26).

Obviously, growers would prefer to put on two sprays at a higher rate rather than 4 sprays at the lower rate to save on application costs; however, our recommendation will depend on

Figure 7. A weed sprayer is used to power the wand. Three people (one driving, two spraying) can treat an acre in approximately 30 minutes using 5-10 gpa.

Maintaining access to Korean market

Korea's Quarantine Inspection Agency has advised the California citrus industry that they plan to eliminate methyl bromide fumigation of oranges on arrival in Korea beginning next season.

The California Citrus Quality Council (CCQC) is recommending that growers skirt prune their groves and use trunk applications to control Fuller rose beetle (FRB) so the industry can maintain access to the Korean market.

According to the CCQC's Jim Cranney, "Growers risk lower returns next season if they do not skirt prune and treat their groves for FRB." He said the California citrus industry ships approximately 10 million cartons of oranges to Korea each year, but the removal of blanket fumigation and poor FRB control could reduce that volume by a third or even by half.

Cranney said he is sympathetic to growers who will incur greater costs to skirt prune and make trunk applications, but he said growers also need to consider the impact that significant reductions in exports to Korea would have on prices. He said some fruit that is not sent to Korea can be diverted to other markets, but not large numbers.

Using the 10 million carton figure and assuming a one-third reduction in exports to Korea means the industry would have to divert approximately 3 million cartons to other markets that are already pretty well satisfied.

He said, "It's not likely that kind of volume could be moved on short notice without price reductions, and that includes the domestic market."

Cranney reports that CCQC is working with its University of California and USDA partners to provide as many FRB control options as possible.

UC Riverside's Joe Morse is leading the effort on FRB control using pesticide applications to the trunk, Lindcove Director Beth Grafton-Cardwell is screening foliar treatments, the Agricultural Research Service's Spencer Walse is evaluating phosphine fumigation, and UC Davis' Beth Mitcham and Veronique Bikoba are testing ethyl formate as an additional fumigation option.

However, Cranney added, "It's unlikely that any single option can fully control FRB. Unfortunately, this will be a multiyear process of defining the best control practices and then learning how to use them in the most efficient and cost-effective combinations.

"There are no easy answers" he said.

bifenthrin efficacy data we will have quite soon.

The first two applications of 0.25 lb AI/acre or the first application of 0.5 lb AI/acre are legal under the 2ee label. If a 24c Special Local Needs label is granted, an application of the second 0.5 lb AI/acre would be allowed (a total of 1.0 lb AI/acre, which is the amount shown by research to be effective).

It is critical that bifenthrin trunk sprays ***do not contact foliage and fruit*** because the current tolerance, which was originally established for a soil application, is quite low.

Concurrently, we are working with the IR-4 program to register a more practical method of bifenthrin application that we hope would allow contact with fruit and foliage; if successful, this will take 3 or more years.

At present, applications must be applied using a homemade "wand" similar to that depicted in Figures 5-7. This ***will be required*** on the 24c label, if it is approved. Each grower or PCA may have ideas on how to build their own wand applicator and/or to power the spray.

The key features of this strategy are: (1) the spray must contact only the trunk (soil runoff is ok but application to the trunk provides the best control); (2) the spray cannot contact the foliage or fruit; (3) to be effective and persistent, a high spray concentration is needed (5-10 gpa or less is ideal) applied to 12"–18" of trunk height all the way around the trunk; (4) it may be necessary to move irrigation emitters away from the trunk so they do not wash bifenthrin off the trunk (should know by the time of the April 22 FRB meeting at Lindcove); (5) at this con-

Summary of the Bifenthrin Trunk Spray Strategy:

1. Build a model wand sprayer ***by early May*** so you can test it and consider modifications.
2. Skirt-prune to a minimum height of 24" ***by early June***.
3. Treat with either 4 applications of 0.25 lb AI/acre bifenthrin spaced out every 6 weeks or 2 applications of 0.5 lb AI/acre applied 12 weeks apart. (Stay tuned for a California Citrus Quality Council [CCQC] advisory by early May advising which strategy is most effective).
4. 0.5 lb AI/acre is allowed under the Brigade WSB 2ee label. Legal use of the second 0.5 lb AI/acre (total of 1.0 lb AI/acre) depends on approval of CCQC's 24c application (CCQC advisory expected early August).
5. The trunk spray ***must be hand-applied using a home-built u-shaped wand***. Trunk sprays cannot be applied with a weed sprayer or other device that would allow the spray to contact foliage and/or fruit.
6. It is critical the first bifenthrin trunk spray be applied BEFORE significant emergence of adult beetles out of the soil occurs – get the spray on ***by early June***.
7. The grove must be patrolled every 4-6 weeks to make sure that weeds growing under trees or suckers/branches do not allow FRB adults to bypass the trunk.

centration, the bifenthrin will be a thick slurry – agitation of the spray solution is important; and (6) we suggest growers and/or PCAs build their own wand applicator well in advance (by early May) and test it out so as to consider possible changes or improvements.

Stay tuned for future developments which will be posted on the following two web sites: http://ucanr.org/sites/KACCitrusEntomology/ and http://www.calcitrusquality.org/.

Acknowledgements

We would like to thank Michael Rust and the many pest control advisors and growers who contributed ideas that led to the trunk treatment strategy for Fuller rose beetle control. Thanks are also due Alan Urena, Lindsay Robinson, Rachael Craig, and Janine Almanzor (in the Morse lab) and Sara Scott, Jennifer Ruvalcaba, and Jamie Nemecek (Grafton-Cardwell staff) who collected much of the data and helped put on trials that contributed to this evolving approach.

Thanks are also due Jim Cranney and the California Citrus Quality Council for setting up meetings dealing with Fuller rose beetle where the industry provided feedback and for help in exploring ways to register bifenthrin trunk sprays.

Also, appreciation goes to Dan Seymore of the Lindcove Research and Extension Center who built the hand wand application devices that were used in our field trials, and to the staff at UC Riverside Agricultural Operations who were of great assistance with skirt pruning trees used in trunk treatment evaluations.

We thank FMC Corp., NovaSource, Syngenta, and Gowan for providing chemicals that were used in field trials, the IR-4 Program (especially Becky Sisko) for input into fruit residue studies, and the Citrus Research Board which funds our research in part.

Dr. Joseph Morse is a Professor of Entomology and Dr. Beth Grafton-Cardwell is an Extension Specialist and Research Entomologist. Both are members of the Department of Entomology, University of California, Riverside.

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Fruit quality evaluations of introduced Satsuma selections for California

Tracy L. Kahn, Toni Siebert, Zongpeng Zheng and Karen Huaying Xu

Editor's Note: The work reported on here is part of a Citrus Research Board core program to develop and evaluate new citrus scion and rootstock cultivars suitable for California conditions.

Satsuma mandarins historically have been an important part of the mandarin group, holding an important place in the commercial market due to their general earliness.

In recent years, the focus on the mandarin market has been on clementine and other mandarin types, but there has been recent interest in introducing additional Satsuma varieties into California.

Most growers are familiar with the Frost Owari Satsuma or more recently the Okitsu Wase, but few understand how this group was introduced into California and the potential for introducing improved material.

Unshû Mikan and the orange of Wenzhou are unfamiliar Satsuma mandarin names in California but trace back to the ancient origins of Satsuma mandarin and the selections that arose from this cultivar.

Satsuma mandarin is thought to have been imported from Wenzhou, China, to Nagashima, Japan, where an original chance seedling became established sometime before 1600 AD. Unshû Mikan was the first known reference to Satsuma mandarin in Japan.

The origin of the name Satsuma is credited to the wife of a U.S. minister to Japan who sent trees to the United States in 1878 labeled with the former province name where Satsuma was believed to have originated, which is now called Kagoshima Prefecture on the southern tip of Kyushu Island (Hodgson, 1967).

Although the Satsuma mandarin was originally despised in Japan for producing seedless fruit due to the association with childlessness, seedlessness is now highly valued around the world (Mizutani, 2006).

A consumer survey conducted in grocery stores in nine cities in Alabama and Georgia to assess consumer preferences for external attributes of Satsuma found that low-priced, high-quality fruit that is larger, blemish-free, non-green and seedless were preferred (Campbell et. al. 2004).

Satsuma mandarins are also known for being very easy to peel and

Although the Satsuma mandarin was originally despised in Japan for producing seedless fruit due to the association with childlessness, seedlessness is now highly valued around the world.

the most cold tolerant of all commercially important mandarin varieties. Mature trees have been documented to survive minimum temperatures of 15-18°F in northern California and southern Alabama without serious damage.

Also, some selections are the earliest maturing commercial citrus in California due to low total heat requirement (Hodgson, 1967). Yet, despite the low total heat requirement of Satsuma mandarins, warm weather is needed during the growing season in order for the fruit to develop satisfactory quality.

Our laboratory (Kahn and Siebert) has been funded by the Citrus Research Board (CRB) since 1995 to provide initial fruit quality evaluations of new varieties introduced from outside California for their commercial potential.

For the first time during the 2011-2012 season, this project became incorporated into a larger core CRB program with the goal of developing and evaluating new citrus scion and rootstock varieties suitable for California entitled "Integrated Citrus Breeding and Evaluation for California."

Our initial evaluations of newly introduced cultivars into California permit us to screen 30 to 50 citrus cultivars for fruit quality traits and tree characteristics against commercial controls in the same cultivar class (i.e. Satsuma mandarins, navel oranges) in an efficient and cost-effective manner.

These evaluations are conducted for three to five years to determine commercial potential and whether

any should be considered for inclusion in multi-location, replicated trials that compare selected promising introduced varieties with those developed from the UCR breeding program.

Reducing the number: new Satsuma introductions with commercial potential

Early maturing seedless Satsuma selections having other high quality characteristics such as larger fruit size, smooth rind, and lower incidence of sunburn and granulation are important for the California citrus industry, especially since Satsuma mandarins are the earliest California citrus fruit to reach the market in the fall, typically in October.

Frost Owari has been the most commonly grown mid-season Satsuma selection in California, but in years when the market window of Frost Owari and Clementine maturation overlap, competition from the Clementine market makes it difficult to market Satsuma in the mass market.

Okitsu Wase is the second most planted Satsuma variety in California, and the fruit is earlier to mature than Frost Owari but its fruit size is small.

The desire for early varieties with better fruit quality characteristics was part of the motivation for the introduction of new Satsuma varieties for California.

During the past decade, over 40 Satsuma varieties have been introduced into California through the Citrus Clonal Protection Program (CCPP). Thomas Chao first reported on the performance of a number of Satsuma selections based on a topworked trial in Santa Paula from three-year-old trees. Based on data from the 2004 season, he found that Armstrong, Miyagawa, China S-9 and Xie Shan are early maturing Satsuma varieties (Chao, 2005).

We continued this project and have previously provided preliminary data on these varieties at field days and grower meetings and on the Citrus Variety Collection website (http://www.citrusvariety.ucr.edu).

In this article we present a summary of data collected on 19 newly introduced Satsuma varieties over a 7-year period (2005-2011) providing a comparison to the existing commercial varieties, Okitsu Wase and Frost Owari.

Although some of these introduced selections are very old varieties in their country of origin, they were not commercially available in California nor had they been previously compared to other Satsuma selections.

Background on Satsuma varieties included in this study

Below are short descriptions of each of the two Satsuma commercial standards and the 19 introduced selections included in this study along with their CCPP Variety Index (VI) numbers used by citrus nurseries to order budwood.

Budwood of all of the varieties listed below except for some of the Chinese selections is currently available from the CCPP.

Satsuma commercial standards in California

Frost Owari (VI 33): Frost Owari is a nucellar seedling selection of the original Owari variety introduction from Japan (See insert on nucellar seedlings). The original introduction of Owari is considered to be of ancient and unknown Japanese origin, and likely occurred more than 100 years ago. Frost Owari Satsuma trees are cold-hardy, productive, and vigorous-growing, and small in size at maturity with fruit that have a smooth, thin and easy-to-peel rind at maturity. The flesh is bright orange; the fruit are tender, juicy, seedless, and mild in flavor. Owari is a mid-season Satsuma, with its season of harvest starting in October in most areas of California. The fruit itself does not hold well on the tree, but it stores well after harvest.

Okitsu Wase (VI 389): Okitsu Wase is an early maturing nucellar seedling selection of Miyagawa by M. Kajiuera and T. Iwasaki at the Horticultural Research Station in Okitsu, Japan, made in 1940, and is a sister seedling of Miho Wase.

Newly introduced Satsuma selections

Aoshima (VI 584): Aoshima is an Owari bud mutation discovered by H. Aoshima in 1950 in Fukudaga Valley, Shizuoka Prefecture in Japan. It is

Table 1. Background Information on Chinese Satsuma Introduction from Citrus Clonal Protection Program (CCPP) Database and Information Provided by Dr. Huang

Current Name of Satsuma Selection	CCPP Variety Index (VI) Number	Current Availability From CCPP	Date Received at CCPP	Collection Location	Tree Vigor	Fruit Quality Rating*	Cold Hardiness Rating*
China S-2	635	Yes CCPP Screenhouse Budwood	6/5/1995	Sichuan	++	++	+++
China S-3	654	Yes CCPP Screenhouse Budwood	6/5/1995	Sichuan	+++	++	++
China S-5	714	Not Yet	6/5/1995	Data Not Available From Dr. Huang			
China S-6	640	Yes CCPP Screenhouse Budwood	6/5/1995	Hubei	++	++	++++
China S-7	641	Yes CCPP Screenhouse Budwood	6/5/1995	Hubei	++	++++	++++
China S-8	728	Not Yet	6/5/1995	Hubei	+++	++++	+++
China S-9	636	Yes CCPP Early Release Budwood	6/5/1995	Hubei	++++	+++	++++
China S-11	683	Not Yet	6/5/1995	Hubei	++++	+++	++++
China S-12	715	Not Yet	6/5/1995	Sichuan	++	++	+++
China S-15	729	Not Yet	6/5/1995	Data Not Available From Dr. Huang			
China S-17	730	Not Yet	6/5/1995	Sichuan	++	++	++
China S-18	716	Not Yet	6/5/1995	Hunan	+++	+++	+++
China S-20	755	Not Yet	6/5/1995	Sichuan	++	++	+++
China S-1	722	Not Yet	10/16/1998	Data Not Available From Dr. Huang			
China 6-15	732	Not Yet	10/16/1998	Data Not Available from Dr. Huang			
China 6-18	757	Not Yet	10/16/1998	Data Not Available From Dr. Huang			
China 6-21	769	Not Yet	10/16/1998	Data Not Available From Dr. Huang			
China 6-22	770	Not Yet	10/16/1998	Data Not Available From Dr. Huang			

*Tree vigor, fruit quality and cold hardiness ratings designated by Dr. H. Huang for the first group introduced were defined as ++++ = very good, +++ = good and ++ = acceptable. ** NA = Not applicable because no HU names were assigned for this second group.

one of the leading late-maturing Satsuma varieties in Japan. It is harvested from mid-December to early January, and the fruit is reported to store well (Mizutani, 2006).

Armstrong (VI 580): Also known as Armstrong Early, this selection was selected by California citrus nurseryman Albert Newcomb from the collection at Louisiana State University Citrus Research Station, Port Sulphur, LA. Armstrong Early has been grown for over two decades in south Alabama where the fruit of this cultivar matures 30 to 40 days earlier than Owari fruit (Nesbitt et. al., 2008). The cultivar Amstrong Early is grown on a limited scale due to production of fruit with thin rind and inconsistent fruit quality (Nesbitt et. al, 2008).

Chinese cultivars

The majority of selections evaluated between 2005 and 2011 were introduced from China. These Satsuma selections arrived in two groups, one in June 1995 and the other in October 1998 from three different locations in China (Table 1).

Dr. David Gumpf, the director of the Citrus Clonal Protection Program from 1998 to 2003, was instrumental in introducing many citrus varieties into California from around the world. Dr. Gumpf, in collaboration with Dr. William Dozier from Auburn University in Alabama and a Dr. Huang who was a graduate student from China at the time, made it possible to introduce a number of Satsuma selections into California and Alabama from regions in China that had recently been affected by a severe freeze (Table 1).

Three characteristics were used when Dr. Huang made the selections and rated these characteristics: cold hardiness, fruit quality, and tree vigor (Table 1).

The first group arrived as 21 individual bund1es of Satsuma budwood, each individually labeled S-1 through S-21. When grafted in 1995, they were identified as China S-1, China S-2 and so forth.

Of the 21 selections, 13 survived and are described in Table 1 with their CCPP VI number, current availability from the CCPP, date received from CCPP, HU number assigned by Dr. Huang, location, and performance rating data from Dr. Huang. Based on his conversations with Dr. Dozier, the HU numbers correspond to the S identifications for the surviving selections.

The second group received had five individual bundles of Satsuma budwood, also numbered in succession as China -1 to -5.

The China S-1 selection of the first group received in 1995 died, and Dr. Dozier was able to reacquire the selection known as China S-1 and sent it with the second batch of budwood. The remaining four selections of the second batch were given an identification prefix number 6, such as China 6-15 and China 6-18, to differentiate this batch from the first. Several of these selections listed in Table 1 are just now being evaluated or will be evaluated in future years (e.g. China S-20, China 6-18, China 6-21, and China 6-22).

Miho Wase (VI 585): Miho Wase originated in Japan as a nucellar selection derived from a controlled pollination of Miyagawa Satsuma. This variety is a sister seedling of Okitsu Wase but has some minor differences such as being a more vigorous tree and producing fruit with higher sugar content, lower acid content, and earlier in maturity in Japan. Compared to Owari, Miho Wase is reported to be slightly smaller and flatter with a less pronounced neck (Iwasaki, 1966).

Miyagawa (VI 612): Miyagawa originated as a limb sport in a tree of the Zairai cultivar in Japan and was named and introduced by Dr. T. Tanaka in 1923. Miyagawa is an early maturing Satsuma with harvest as early as mid-September in Japan, and stores well (Hodgson, 1966).

Xie Shan (VI 621): This variety, collected by Dr. Fred Gmitter, University of Florida, was imported from the Institute of Subtropical Crops of Zheijian Academy in China in 1992. Xie Shan is the Chinese translation of this cultivar that originally came from Japan. The original name was Wakiyama. Fred Gmitter communicated that Xie Shan is extremely early in maturity in

Frost nucellar seedling lines

Many varieties of Citrus are able to produce seeds with more than one seedling coming out of an individual seed. These additional seedlings, or nucellar seedlings, are produced asexually from the nucellar tissue which is part of the structure that later becomes the seed.

Nucellar seedlings. *Photos by Dr. Joseph Kepiro.*

Normally, seeds also produce a seedling that resulted from fusion of the sperm and egg cell through sexual reproduction called the zygotic seedling. Nucellar seedlings differ from the zygotic seedlings in that nucellar embryos are genetically similar to each other and produce trees that resemble the "mother" tree or the tree that the fruit and seed developed from.

Yet W. T. Swingle's discovery that nucellar seedling lines from old citrus varieties were different from the parent lines led H. B. Frost and others in the 1920s to conduct research that demonstrated that nucellar seedling lines eliminated viruses, produced temporary juvenile characteristics, and sometimes resulted in genetic variation.

Prior to the development of techniques such as thermal therapy and shoot-tip-micrografting used by the CCPP to eliminate disease pathogens from the budline, nucellar lines were an important way to produce vigorous, higher yielding, virus-free lines.

Howard Frost utilized knowledge on nucellar budlines to develop many nucellar lines that we still grow today such as Frost nucellar navel, Frost nucellar Eureka and Frost nucellar Owari Satsuma.

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China (maturing in mid-September) in comparison to other Chinese Satsumas.

Evaluating fruit quality

Fruit of the 19 new introduced Satsuma cultivars were randomly harvested three times a season from two to four trees at the Lindcove Research and Extension Center (LREC) in Exeter, CA (fruit either from the demonstration orchard or the CCCP Foundation Block), and from two trees at the UCR Citrus Variety Collection (CVC) in Riverside, CA.

The trees varied in age because we initiated multi-year evaluations as soon as trees began producing fruit, but trees of the commercial standards were older, more established trees.

Most of the trees were grown on either Carrizo or C-35 citrange rootstocks, but two of the trees used in this study were grown on Troyer (two Okitsu Wase and two Frost Owari trees at LREC) and Rich 16-6 trifoliate (one tree each of Xie Shan and Miyagawa at CVC).

The samples of ten randomly collected fruit per tree were brought to Riverside. The following fruit characteristics were measured: fruit width, length, weight, rind color and texture (based on a correlation to standard color and texture charts), flesh color, seed number, juice weight, presence of granulation and sunburn, soluble solids, and percentage acidity based on citric acid.

Juice was extracted from the ten fruit samples with a Sunkist extractor, and an Atago PR-100 digital refractometer was used to determine the percentage of soluble solids. The percent acid was determined based on citric acid by titration of a juice aliquot to pH 8.3. The data were used to calculate soluble solids to acid ratio and average fruit count per packed carton size designation.

For each variety, the data were aggregated together for the seven years for each location separately to permit comparison of the variety within each location and the patterns between locations.

For seed number, data for all sample dates were grouped for each variety.

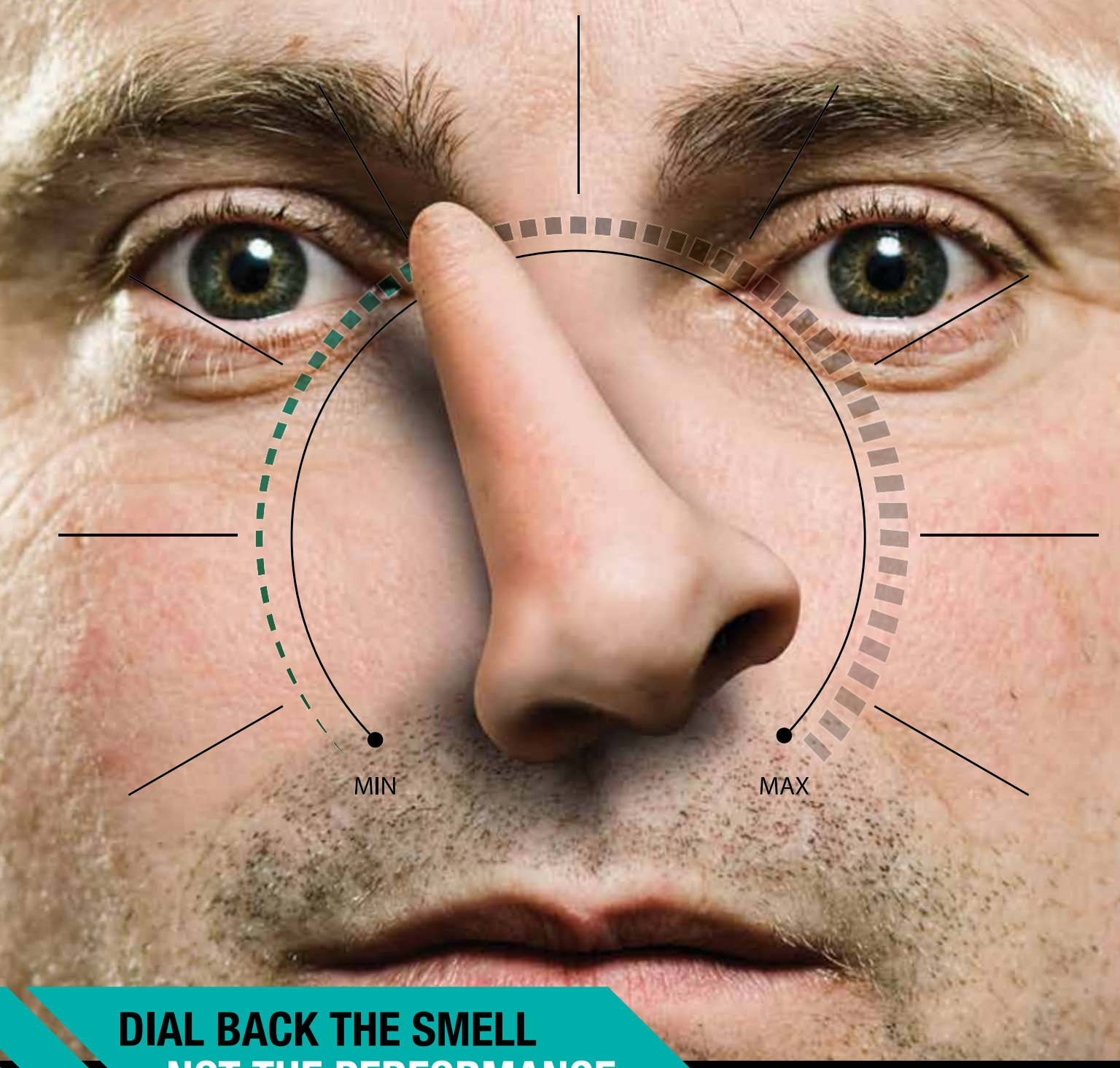
For characteristics associated with maturity and other characteristics, data were grouped separately for each of the same sample periods each year: September 28-October 6, Oct.17-21 and Nov.9-11.

For particular characteristics associated with maturity, seed number and fruit width, we used the MIXED procedure in SAS (Statistical Analysis System, provided by SAS Institute Inc.) to statistically analyze the data from first sample dates and used LSMEANS statement with PDIFF option to made pairwise comparisons between any two cultivar selections for selected characteristics.

Evaluating a large number of selections from a small number of trees for multiple years from two locations permits us to narrow down which of these selections may have commercial potential in California and would be worth including in multi-location replicated trials with larger numbers of trees of fewer varieties.

Maturity-related characteristics

Varieties that produce the earliest maturing fruit generally yield the highest financial returns. In California, the



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legal minimum maturity standard for mandarins and tangerines, including Satsuma mandarins, requires fruit to have at least 6.5 parts soluble solids to 1 part acid. This is calculated based on citric acid in the juice -- which is quite low, and fruit are very tart.

Multiple packinghouses in California use higher initial standards of 10 to 1 or 12 to 1 soluble solids to acid as a minimum standard. Louisiana legally requires a 10 to 1 soluble solid-to-acid ratio for Satsuma mandarins before they can be sold (Ebel, et. al, 2004).

The soluble solids-to-acid ratio is used as a legal standard because the soluble solids and acidity based on citric acid are closely associated with the quality of fruit. As the fruit matures, the soluble solids concentration, which is predominately sugars, gradually increases and acidity decreases.

Assessing varieties for soluble solids and acidity separately is useful since two fruit can have similar ratios but differ in flavor at least partially due to different combinations of soluble solids and percent acid based on citric acid.

Although consumers differ in what they like in regards to sweetness and tartness, Satsuma fruit with total soluble solids of 11.3 and percent acid around 0.9 is likely to be more flavorful than one with low soluble solids of 7.5 and acidity of 0.6 since when the acid level drops as the fruit mature, the fruit is likely to taste bland.

For the first sampling period (Sep. 28-Oct. 6) from the Exeter location, 12 of the selections (Miyagawa, Xie Shan, Armstrong, China S-5, China S-9, Miho Wase, China S-17, China S-1, Okitsu Wase, China 6-15, China S-18 and China S-11) had fruit with soluble solids-to-acid ratios above the legal maturity of 6.5 to 1(Figure 1).

Using the ratios utilized by a number of packinghouses, none of the cultivars had average soluble solid-to-acid ratios above 10 to 1 for the first sample period.

Five of these selections, Miyagawa, Xie Shan, Armstrong, China S-5 and China S-9, had fruit with significantly higher soluble solids-to-acid ratios than China S-11, China S-6, Aoshima, Frost Owari, China S-7, China S-3, China S-2, China S-12, China S-15, and China S-8 but not from each other.

Fruit of Miho Wase, China S-17, and China S-1 did not have significantly higher soluble solids-to-acid ratios than each other or the cultivars with the highest ratios (Miyagawa, Xie Shan, Armstrong, China S-5 and China S-9), but had fruit with significantly higher solids-to-acid ratios than fruit of China S-6, Aoshima, Frost Owari, China S-7, China S-3, China S-2, China S-12, China S-15 and China S-8 (Figure 1).

The early maturing commercial standard, Okitsu Wase, produced fruit with significantly higher solids-to-acid ratio than fruit of China S-6, Aoshima, Frost Owari, China S-7, China S-2, and China S-8 but not any of the other cultivars (Figure 1).

The remaining selections had fruit with lower solids-to-acid ratios for that first sample period (China S-6, Aoshima, Frost Owari, China S-7, China S-3, China S-2, China S-12, China S-15 and China S-8), and the ratios were not significantly different than each other.

For this same first sampling period (September 28-October 6), fruit of most of the varieties evaluated from Riverside had solids-to acid ratios above the legal maturity of 6.5 to 1. The only ones that had not reached legal maturity by this period in Riverside were China S-7, China S-6, China S-8, China S-2 and China S-12.

Those selections with the highest average solids-to-acid ratios were, in order: Miyagawa, Miho Wase, Okitsu Wase, China S-9, Xie Shan and China S-1. Of these six selections, all had solids-to acid ratios above 10 to 1 when

Fig. 1. Average Soluble Solids to Acid Ratio for Fruit of Varieties Harvested from Exeter 2005-2011

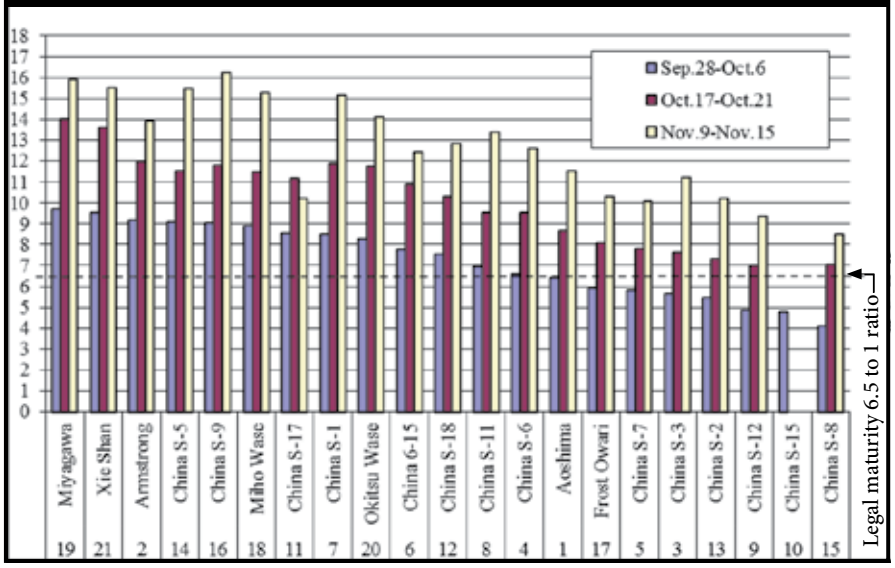
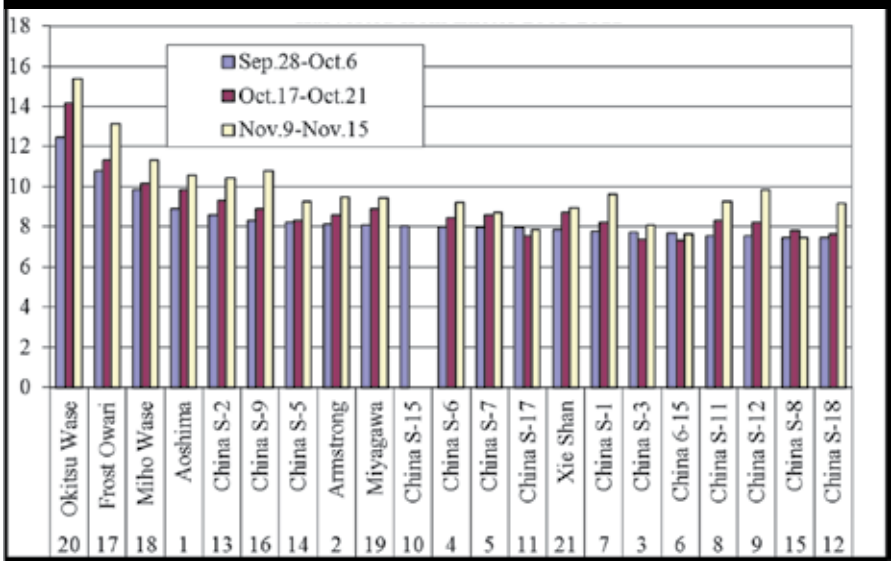


Fig. 2. Average Percentage Soluble Solids for Fruit of Varieties Harvested from Exeter 2005-2011



sampled for this first period in Riverside except China S-1. The ratios for the fruit of these selections were not significantly higher than each other but were significantly higher than most of the other selections.

The order from highest to lowest for the fruit of the different selections for solids-to-acid ratio differed between fruit sampled at Exeter and Riverside, but of the six selections with the highest ratios at both locations, four of them, Miyagawa, Miho Wase, Xie Shan, and China S-9, were the same.

To get a clearer picture of how these varieties differ from each other in terms of maturity, a comparison of the average soluble solids and percentage acidity based on citric acid provides additional information on these differences.

For the first sample period of fruit harvested in Exeter, Okitsu Wase fruit had the highest average soluble solids even though Okitsu Wase fruit was not among the varieties with the highest soluble solids-to-acid ratios for that sample period (Figure 2).

Okitsu Wase, Frost Owari and Miho Wase also had significantly higher average soluble solids from each other and all of the other varieties evaluated (Figure 2).

Aoshima fruit from the same location and time period had significantly lower average soluble solids than Okitsu Wase, Frost Owari, Miho Wase, and higher than Xie Shan, China S-1, China S-3, China 6-15, China S-11, China S-8 and China S-18, but not significantly different from any of the other selections (Figure 2).

China S-2 fruit from the same location and time period also had significantly lower average soluble solids than Okitsu Wase, Frost Owari, Miho Wase, but higher than China S-11 and China S-18 (Figure 2).

The soluble solids of fruit of all of the other selections (China S-9, China S-5, Armstrong, Miyagawa, China S-15, China S- 6, China S-7, China S-17, Xie Shan, China S-1, China S-3, China 6-15, China S-11, China S-12, China S-8, China S-18) harvested from Exeter at these first sample date were not significantly different from each other (Figure 2).

Even though the average soluble solids levels of fruit increased from one sample date to the next for most of the varieties, Okitsu Wase, Frost Owari and Miho Wase still had the highest average soluble solids for the last two sample dates (Figure 2).

For the first sample period in Riverside, Miyagawa had the highest average soluble solids followed by, although not significantly different from, Okitsu Wase, Frost Owari, Miho Wase and Aoshima.

Miyagawa and Okitsu Wase had significantly higher average soluble solids of all cultivars except for several with lower average soluble solids that were not significantly lower, perhaps because they have been evaluated for fewer years and had smaller sample sizes.

Fruit sampled from Riverside from most of the selections also had increased average soluble solids for each of the later two sample dates. However, by the last sample period (November 9-15), Miyagawa, Miho Wase, Aoshima, Xie Shan and China S-9 had the highest average soluble solids.

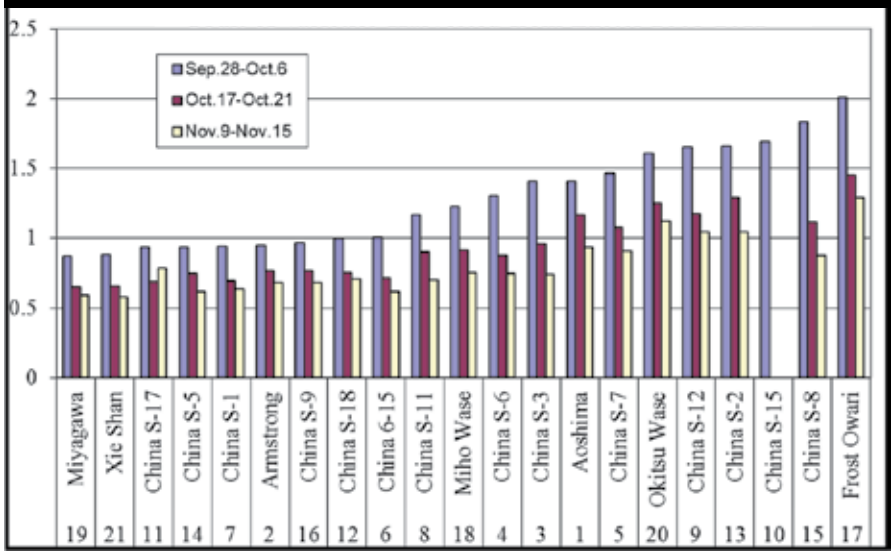
The comparison between the two

sampling locations demonstrates both similarities and differences between these Satsuma varieties for soluble solids. Overall, Frost Owari and Miho Wase fruit had high average soluble solids or sugars at both locations. Differences among the fruit of the other selections may reflect performance differences between these two locations for these selections.

Fruit of eleven of the selections (Miyagawa, Xie Shan, China S-17, China S-5, China S-1, Armstrong, China S- 9, China S-18 and China 6-15, China S-11 and Miho Wase) harvested during the earliest period (September 26-October 6) in Exeter had an average percent citric acid below 1.3 (Figure 3) .

All of these selections, except China S-11 and Miho Wase, had significantly lower percent citric acid than the other nine varieties (China S-3, Aoshima, China S-7, China S-7, Okitsu Wase, China S-12, China S-2, China S-15, China S-8, and Frost Owari) at this first sample time but were not significantly different from each other (Figure 3).

Fig. 3. Average Percentage Acid based on Citric Acid for Fruit of Varieties Harvested from Exeter 2005-2011



Miyagawa and Xie Shan fruit had the lowest average percent citric acid for this first period (Figure 3). On the other hand, Frost Owari and then China S-8 fruit had the highest average percent citric acid with Frost Owari fruit having significantly higher average percent citric acid than all other varieties except China S-12, China S-15 and China S-8 (Figure 3).

By the second and third sampling times, eight of the selections (Miyagawa, Xie Shan, China S-5, China S-1, Armstrong, China S-9, China 6-15 and China S-11) had acidity at or below percent citric acid 7.0, indicative of being past maturity (Figure 3).

In contrast, fruit of four varieties (Okitsu Wase, China S-2, China S-12 and Frost Owari) still had average percent citric acid above 1.0, which indicates that these four cultivars, and especially Frost Owari, are the latest maturing of the selections evaluated (Figure 3).

Fruit of these 21 selections sampled in Riverside during the first sample period had a different ranking from lowest to highest average percentage acid than fruit sampled from Exeter the same period, but Miyagawa had the lowest average percent citric acid at both locations.

Miyagawa fruit and fruit of seven other varieties (China S-1, Miho Wase, China 6-15, China S-5, Okitsu Wase, China S-9 and Xie Shan) did not have significantly different average percent citric acid from each other, but each had significantly lower average percent citric acid than five of the other varieties (Frost Owari, China S-6, Aoshima, China S-7 and China S-2).

Twelve of the selections had average percent citric acid content near or below 1.3 at the earliest sample period

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(Miyagawa, China S-1, Miho Wase, China 6-15, China S-5, Okitsu Wase, China S-9, Xie Shan, and China S-11, China S-17, China S-8 and China S-3).

By the last sample period, fruit of all selections harvested in Riverside had average percent citric acid below 1.0. Frost Owari and China S-2 fruit had the highest average percent citric acid when sampled in mid-November. These two selections also had the highest average percent citric acid when fruit were harvested in Exeter, indicating that these two are the latest maturing of the 21 selections evaluated.

Peel color is another characteristic associated with maturity, yet the development of peel color does not necessarily coincide with internal quality.

For example, Owari Satsuma mandarins can have a solids-to-acid ratio of 10:1 when the peel still has green patches (Ebel et. al. 2004). So, typically in California and other parts of the world, Satsuma mandarins are harvested when the external peel is green and commercially degreened after harvest by exposing fruit to ethylene for a few days. However, degreening can have detrimental effects on external fruit quality. Accordingly, the comparative peel color for the sample period can indicate which Satsuma mandarin varieties have greater early color development and may require less degreening.

Rind color was rated based on a correlation to standard color charts on a scale from 3 to 13 (Figure 4). Rind with a color rating of 3 is dark green, and rind with a color rating of 5 is at color break when the rind is partially orange. A rind rating of 13 is reddish orange, which is not typical of Satsuma mandarins.

None of the varieties harvested from Exeter during the first sample period had rind color at or past color break. The varieties with the highest peel color ratings for the first sample period from Exeter were Okitsu Wase (4.2) followed by Miyagawa (4.1) and Miho Wase (4.1), then Armstrong (3.9), Frost Owari (3.8), Xie Shan (3.8) and China S-9 (3.7). The rind color ratings for Okitsu Wase, Miyagawa and Miho Wase were not significantly different from each other, but those ratings for Miho Wase and Okitsu Wase fruit were significantly higher than those for Armstrong, Frost Owari, Xie Shan and China S-9 fruit.

There was a slightly different rind color pattern for fruit harvested from Riverside. The varieties with the highest peel color ratings for the first sample period from Riverside were China S-9 (4.5) followed by Miyagawa (4.3) then Okitsu Wase (4.1), Miho Wase (4.1), Xie Shan (4.1), Armstrong (4.1) and China S-1 (3.9). None of these ratings were significantly different from each other. Figure 5 illustrates the rind color of all of the Satsuma varieties from Riverside during the week of October 22, 2012.

Peel color is another characteristic associated with maturity, yet the development of peel color does not necessarily coincide with internal quality.

Other fruit characteristics of commercial importance

Satsuma fruit are usually considered to be seedless. Satsuma mandarins are reported to have very low levels of pollen capable of causing fertilization and seed set. However fruit of the different Satsuma selections can produce a low number of seeds.

When fruit was harvested from Exeter, Aoshima fruit had the highest average seed number (1.8) and had significantly higher seed numbers than all other selections evaluated. Six other varieties had the next highest average levels of seediness: China S-8(0.84), China S-3 (0.81), China S-15 (0.8), China 6-15 (0.77), China S-2 (0.67), and Frost Owari (0.65).

The seediness rankings among the varieties of fruit harvested from River-

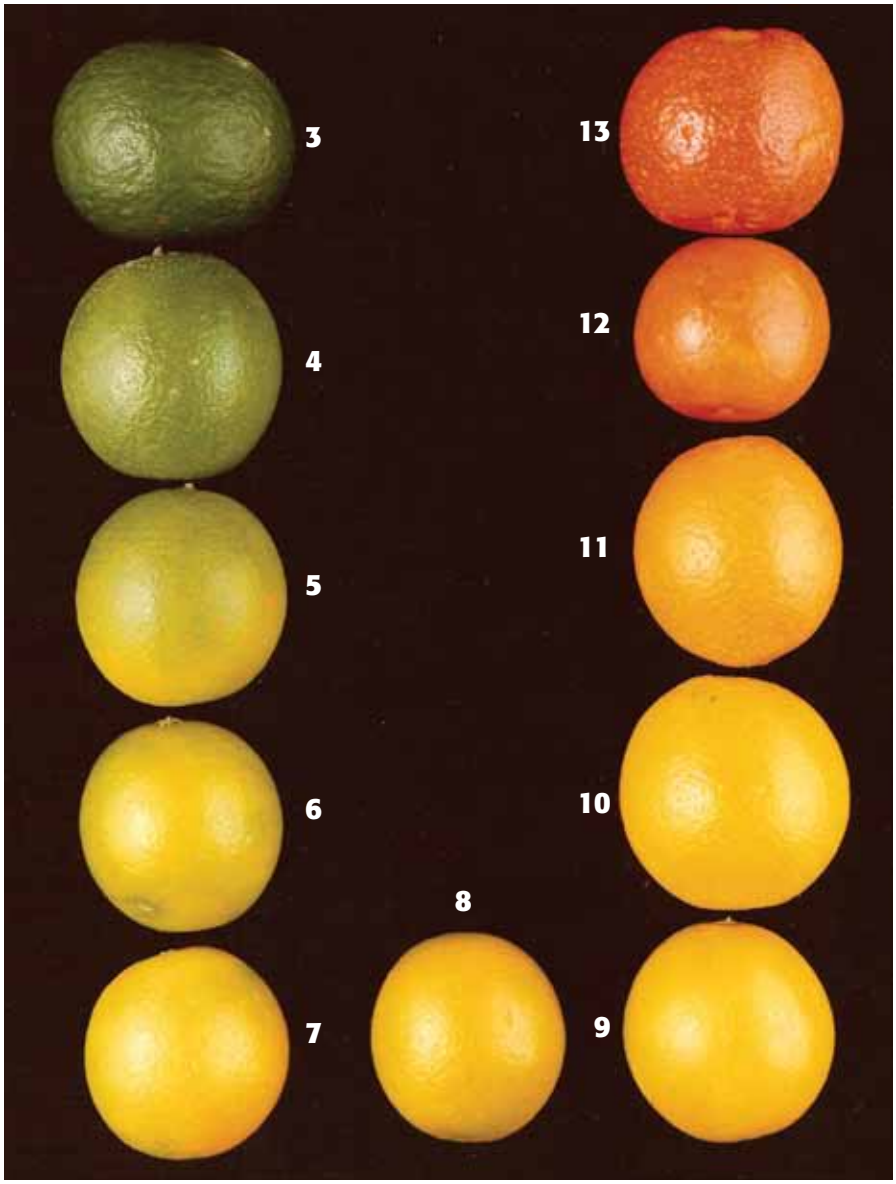

Fig. 4. Standard Color Chart.

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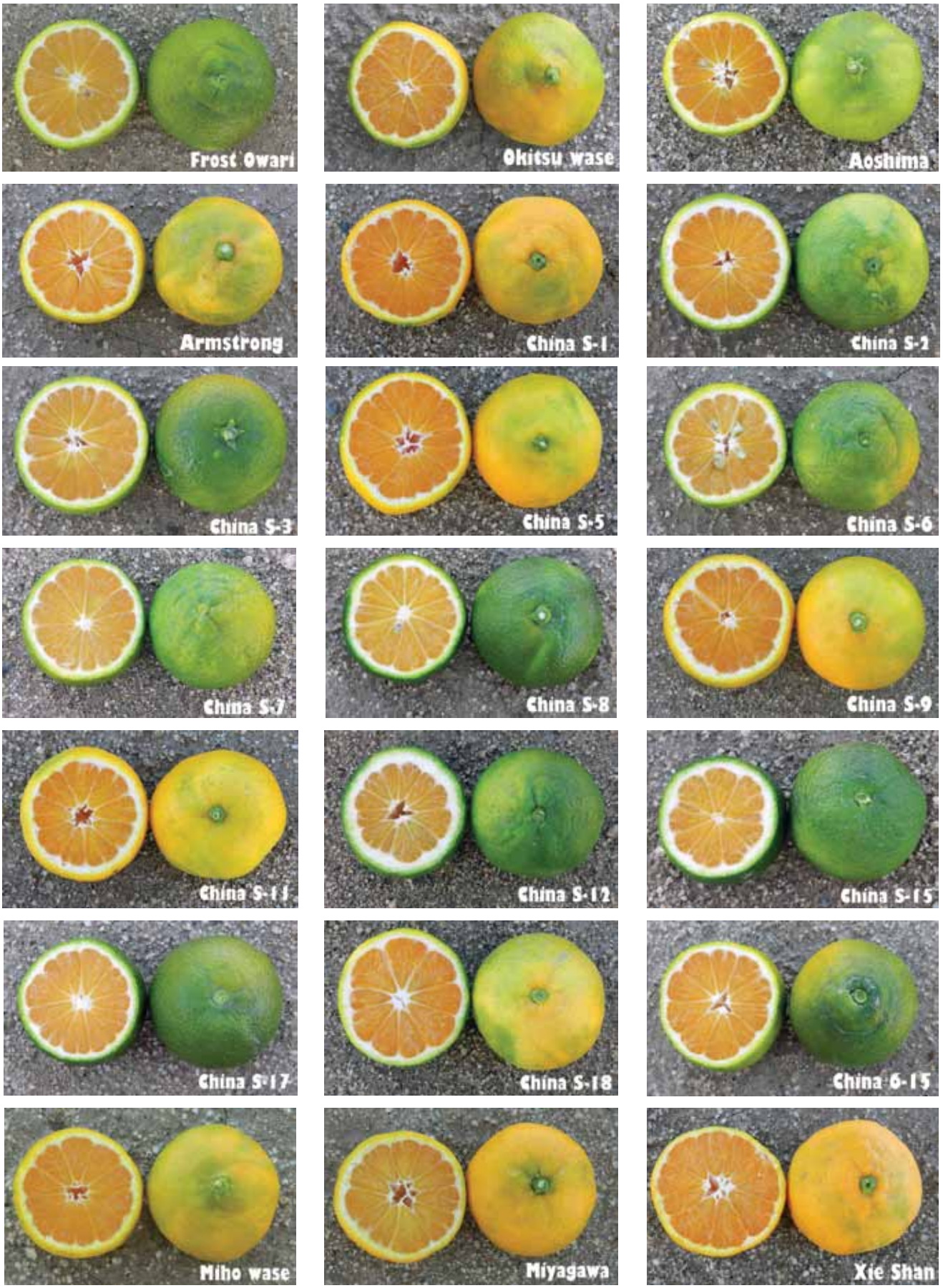

Fig. 5. Photographs of the Satsuma varieties from Riverside during the week of October 22, 2012. *Photos courtesy of UC Riverside Citrus Variety Collection.*

side differed slightly from those sampled from Exeter. Frost Owari (3.79) and Aoshima (2.82) had the highest and second highest average seed number, and each was significantly higher than each of the other selections evaluated. Other selections with high average seed numbers and in some cases significantly higher included China S-6 (2.18), China S-3(1.79), Xie Shan (1.75), Okitsu Wase (1.52), China S-2 (1.3), Miho Wase (1.25), China S-9 (0.99) and China S-12 (0.99).

Varieties with average seed numbers less than 0.25 when harvested from Exeter included China S-18 (0.05), China S-11 (0.10), Miho Wase (0.11), Armstrong (0.20), China S-5 (0.2), and China S-17 (0.21) but seed numbers for these varieties were not significantly different from each other.

Varieties with the lowest average seed number when fruit was harvested from Riverside included China S-15 (0.03), China S-18 (0.09), China S-5 (0.22) and China S-11 (0.23), although the seed numbers for these varieties were also not significantly different from each other.

Blocks such as the Exeter and Riverside locations used for this study have many varieties so the amount of pollen available would be much higher than a commercial grove and would vary between the locations. In addition, differences in the timing of flowering and year to year, and variation in pollen availability may also influence some of the rankings of seediness at each location.

Yet despite these possible influences on seed number, it was interesting to note that Aoshima, China S-2, China S-3 and Frost Owari fruit had higher average levels of seediness at both locations.

Fruit size is an important commercial characteristic for the marketing of Satsuma mandarins. Commercially in California, Satsuma mandarins are packed and sold based on either one of two size categories.

One system, which is also utilized for Clementine and other mandarins, is based on number of fruit in a five-pound box or bag, and the size categories based on fruit diameter range from size 14 for the largest fruit to size 40 for the smallest diameter fruit.

The other system is based on the old olive nomenclature. In this system, fruit are sized based on the diameter ranges of fruit in categories ranging from small to super colossal.

Table 2 summarizes the average fruit width and fruit size based on both systems for each variety for each sample period at each location.

When fruit was harvested over 2005-2011 from the Exeter location for the first sample period, China S-9 had the largest fruit, followed by Miyagawa, Xie Shan and Aoshima but they were not significantly different in size from each other (Table 2).

On the other hand, Okitsu Wase followed by Frost Owari had the smallest average fruit for this first sample period. Okitsu Wase fruit were significantly smaller than all other varieties and the only variety classified as small and a 40 when harvested from Exeter at the first sample date (Table 2).

When fruit was harvested from Riverside for all years from the first sample period, China S-5 fruit had the largest average fruit width followed by Aoshima, China S-2, China S-12, China 6-15 and China S-11. None of these varieties had significantly larger fruit than

Table 1. Average fruit width data and two mandarin size categories for each variety at each of the sample dates for 2005-2011.

Satsuma Variety	Exeter Location: Average Fruit Width (cm) / Mandarin size categories assigned based on average fruit width for each sampling period.									Riverside Location: Average Fruit Width (cm) / Mandarin size categories assigned based on average fruit width for each sampling period.								
	Sep.28-Oct.6			Oct.17-Oct.21			Nov.9-Nov.15			Sep.25-Oct.3			Oct.17-Oct.24			Nov.6 - Nov.13		
Aoshima	6.61	20	Jumbo	7.22	15	Mammoth	7.37	15	Mammoth	6.38	24	Large	6.74	20	Jumbo	7.25	15	Mammoth
Armstrong	6.44	24	Jumbo	6.68	20	Jumbo	6.98	18	Jumbo	5.54	32	Medium	5.75	28	Large	6.44	24	Jumbo
China S-3	5.96	28	Large	6.63	20	Jumbo	7.13	15	Mammoth	5.70	32	Large	6.18	24	Large	6.57	20	Jumbo
China S-6	5.88	28	Large	6.22	24	Large	6.60	20	Jumbo	5.47	36	Medium	6.04	28	Large	6.33	24	Large
China S-7	5.83	28	Large	6.33	24	Large	6.55	20	Jumbo	5.37	36	Medium	5.65	32	Large	6.06	28	large
China 6-15	5.73	28	Large	6.61	20	Jumbo	5.81	28	Large	6.22	24	Large	6.40	24	Jumbo	6.70	20	Jumbo
China S-1	6.18	24	Large	6.53	20	Jumbo	6.63	20	Jumbo	5.74	28	Large	5.93	28	Large	6.03	28	Large
China S-11	6.49	20	Jumbo	6.86	18	Jumbo	7.04	18	Mammoth	6.21	24	Large	6.35	24	Large	6.28	24	Large
China S-12	5.99	28	Large	6.48	20	Jumbo	6.85	18	Jumbo	6.27	24	Large	6.79	18	Jumbo	7.05	18	Mammoth
China S-15	6.10	24	Large	NA	NA	NA	NA	NA	NA	6.00	28	Large	6.34	24	Large	6.55	20	Jumbo
China S-17	6.24	24	Large	6.74	20	Jumbo	7.47	15	Mammoth	5.94	28	Large	6.43	24	Jumbo	6.45	24	Jumbo
China S-18	6.45	24	Jumbo	7.26	15	Mammoth	6.68	20	Jumbo	6.02	28	Large	6.62	20	Jumbo	6.62	20	Jumbo
China S-2	6.49	20	Jumbo	6.97	18	Jumbo	7.32	15	Mammoth	6.33	24	Large	6.64	20	Jumbo	6.97	18	Jumbo
China S-5	6.24	24	Large	6.65	20	Jumbo	6.69	20	Jumbo	6.61	20	Jumbo	6.65	20	Jumbo	5.72	28	Large
China S-8	5.77	28	Large	5.93	28	Large	6.04	28	Large	5.46	36	Medium	5.97	28	Large	6.04	28	Large
China S-9	6.86	18	Jumbo	7.12	15	Mammoth	7.44	15	Mammoth	5.83	28	Large	6.02	28	Large	6.00	28	Large
Frost Owari	5.38	36	Medium	5.73	28	Large	6.05	28	Large	5.21	36	Medium	5.55	32	Medium	5.97	28	Large
Miho Wase	6.02	28	Large	6.50	20	Jumbo	6.70	20	Jumbo	5.69	32	Large	5.99	28	Large	6.06	28	large
Miyagawa	6.76	18	Jumbo	7.17	15	Mammoth	7.54	15	Mammoth	5.93	28	Large	6.08	28	Large	6.05	28	Large
Okitsu Wase	4.97	40	Small	5.15	36	Medium	5.43	36	Medium	5.24	36	Medium	5.62	32	Large	5.83	28	Large
Xie Shan	6.73	20	Jumbo	6.99	18	Jumbo	7.14	15	Mammoth	5.62	32	Large	5.64	32	Large	5.81	28	Large

NA: Insufficient data for this variety at this location to provide sizing information.

the other varieties or each other except that China S-5 fruit were significantly larger than China S-2 fruit.

When harvested at this first sample date from Riverside, the varieties with the smallest fruit width which were classified as medium and 32 were Frost Owari and Okitsu Wase. Frost Owari and Okitsu Wase fruit had significantly smaller fruit width than all other selections except Xie Shan, Armstrong, China S-6, China S-8, and each other. Although those varieties with the largest fruit width differed between the two locations, Okitsu Wase and Frost Owari had the smallest fruit widths at both locations.

Rind texture or the smoothness of rind was evaluated for each 10-fruit sample based on how the rind for each sample correlated with a standard texture chart for each sample period on a scale of 1-8 with a score of 1 being the smoothest and a score of 8 the roughest (Figure 6).

Ratings for samples of fruit harvested from Exeter ranged between 1.0 and 5.5, whereas the ratings for samples from Riverside ranged from 1.0 to 5.0.

Over the 7 years, for the first sampling period at Exeter, three varieties (China S-18, China S-5 and Miho Wase) had average ratings below 2.0, and four others (China S-3, Miyagawa, Armstrong and Xie Shan) had slightly less smooth rind with average ratings between 2.0 and 2.25.

For this same sampling period at Riverside, two varieties (China S-1 and China S-3) had average ratings below 2.0, and three others (Miho Wase, China S-11, China S-18 and China S-5) had average ratings between 2.0 and 2.25. The rind of all other varieties had higher average ratings for this sample period, and the average ratings increased with each sampling period as the fruit continued to mature.

Sunburn and granulation

Each fruit from the 991 separate random 10-fruit samples collected from both locations was evaluated for the presence of sunburn and granulation, an internal physiological disorder characterized by enlarged, hardened and nearly colorless juice vesicles (Erickson 1968). The presence of both of these conditions reduces the number of marketable fruit.

Of the 21 varieties, the six varieties with the most number of fruit with one or both of these conditions from both locations were China S-18 followed by China S-9, Miho Wase, China S-1, China S-17, and Armstrong.

Trends

Of the 21 different Satsuma varieties evaluated for fruit quality traits from 2005 through 2011, those that stood out as early maturing varieties based on the highest average solids-to-acid ratios from fruit harvested from Exeter included: Miyagawa, Xie Shan, Armstrong, China S-5 and China S-9, Miho Wase, China S-17, China S-1 and Okitsu Wase.

In contrast, the fruit of these cultivars sampled from Riverside with the highest average solids-to-acid ratios were Miyagawa, Miho Wase, Okitsu Wase, China S-9, Xie Shan and China S-1.

Based on the soluble solid or sweetness component of the ratio for those cultivars listed above with early high

soluble-solids to acid ratios, Okitsu Wase and Miho Wase had highest sugar levels when fruit was sampled from Exeter. Miyagawa, Okitsu Wase, and Miho Wase had highest sugar levels when fruit was sampled from Riverside.

Further, the varieties with high soluble solids-to-acid ratios had acceptable acidity percent below 1.3 from both locations include Miyagawa, Xie Shan, Armstrong, China S-5 and China S-9, Miho Wase, China S-17, and China S-1 and Okitsu Wase. Of these selections, only China S-9, Miyagawa, Okitsu Wase, Miho Wase, Xie Shan, Armstrong and China S-1 had high peel color at the first sample period at either location. Miho Wase, Armstrong and China S-5 had less than 0.25 seeds per fruit at one or both locations.

Of these early maturing varieties, Miho Wase, Miyagawa, Armstrong and Xie Shan and China S-1 had smooth rind texture when harvested from either one or both of the locations.

Considering fruit size of these early maturing varieties evaluated so far, Okitsu Wase had the smallest average fruit width and smallest fruit size categories of all of the varieties. This suggests that these other introduced early maturing varieties may have promise over the current early maturing commercial standard.

Our results indicated China S-9, Miho Wase, China S-1 and Armstrong varieties had the highest number of fruits with granulation and/or sunburn among all fruit sampled, but for most varieties this was based on fruit harvested from young trees and may not be an issue for fruit of mature trees since young vigorous trees are more likely to develop granulated fruit than older trees (Erickson 1968).

Based on these characteristics of these early maturing cultivars collectively, both Miho Wase and Miyagawa had high soluble solids-to-acid ratios, high sugar levels, acceptable acidity levels, high early rind color, and smooth rind texture.

Both Miho Wase and Miyagawa are currently included in multi-location replicated trials which are part of the CRB-funded Integrated Citrus Breeding and Evaluation for California core program.

These trials were designed to systematically evaluate the most promising new scion cultivars from introduc-

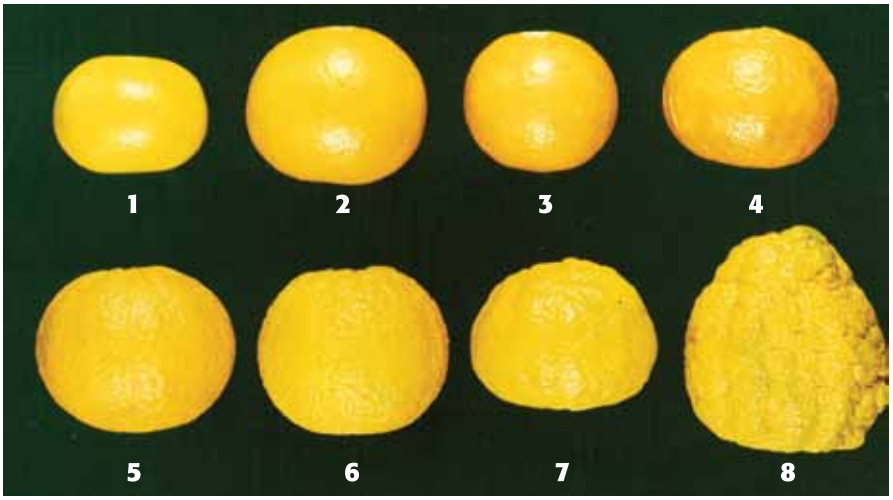

Fig. 6. Standard Rind Texture Chart.

What's in a name?

Scientific names help differentiate and organize biological organisms like the ones we think of as orange, mandarin, pummelo, grapefruit, lemon, lime, sour orange and citron.

In 2011, the International Code of Nomenclature http://www.iapt-taxon.org/nomen/main.php) made significant changes in the rules governing what has long been termed botanical nomenclature.

These rules for naming algae, fungi and plants such as citrus are based on ranks with kingdom on the top and species on the bottom. Yet each species must have two names, both a genus and species name such as *Citrus sinensis* for sweet oranges including navel oranges and blood oranges.

There are many other rules that govern how the genus and species name is written, with the first letter of the genus name being capitalized and the first letter of species name not capitalized but both are in italics.

What's in a name is even more complicated because there have been different taxonomic systems used throughout history.

Many of us think about citrus based on a system of taxonomy developed by Walter T. Swingle in the 1940s, but his is not the first or the most recent taxonomic system proposed. However, Swingle's system is the one that gave us names like *Citrus reticulata* for common mandarins.

Another taxonomist named Tyozaburo Tanaka from Japan was what is called a "splitter" taxonomist and assigned what Swingle thought of as mandarin into a number of different named species including naming Satsuma mandarin as *Citrus unshiu*. Even to this day, you will see some refer to Satsuma as *C. unshiu* and other as *C. reticulata*.

To make things even more confusing, a cultivar or horticultural variety (sometimes shortened to variety although not exactly the same) refers to a named group of cultivated as opposed to wild plants within a species. A cultivar that developed from a budsport or nucellar seedling is referred to as a selection.

Names are also important for identification. The Citrus Clonal Protection Program (CCPP) facilitates the introduction of pathogen-tested citrus cultivars from outside California which may have commercial potential. The CCPP provides a comprehensive process of testing for graft-transmissible pathogens, shoot tip grafting, thermal therapy and release of varieties from quarantine for distribution to the industry.

Once a cultivar is selected for the final indexing by the CCPP, this index of a cultivar is given a VI or variety index number that is used by nurseries to order budwood of that particular cultivar from the CCPP. There are cases where a particular cultivar has been indexed more than once at different times, so the VI number provides identification for both the cultivar and variety index.

tions and selections from the breeding program together in five locations that represent the main citrus production zones in California (Exeter, Riverside, Arvin, Santa Paula, and Thermal).

The first sets of multi-location replicated trials were planted in summer 2012 at four locations appropriate for Satsuma and Clementine mandarins (Exeter, Riverside, Arvin, and Santa Paula). These trials also include two additional Satsuma varieties (China S-9 and Okitsu Wase) and three Clementine varieties (Sidi Aissa, Nour, and Clemenules) which will be compared against three releases from the UCR breeding program (Daisy SL, Fairchild LS and Nova LS).

Based on the results of this project, and the positive attributes of Xie Shan, Armstrong, China S-1 and China S-5, these four additional Satsuma varieties will be included in a future set of multi-replicated trials.

These multi-replicated scion trials will make it possible for us to evaluate small numbers of varieties on three established rootstocks for tree performance including tree health and size, fruit quality, yield, packout, postharvest quality, and consumer acceptance in later years of a 10-year cycle.

We are currently evaluating a number of additional Satsuma varieties, some of which are reported to be early maturing varieties in Japan (China 6-18, China S-20, China 6-21, China 6-22, Iwasaki, Miyamoto and Nichinan Ichigo). Results of these initial evaluations of introduced varieties will be posted on the Citrus Variety Collection website http://www.citrusvariety.ucr.edu and presented at field days.

We plan to continue our goal of evaluating of newly introduced cultivars and conducting multi-location replicated trials to provide the industry with the data needed to make informed decisions about which varieties best serve the California citrus industry.

Acknowledgements

We would like to thank the Citrus Research Board for funding to support this research to evaluate new introduced varieties for commercial potential. Drs. Dozier, Huang and the late Dr. Gumpf are greatly appreciated for their efforts in introducing these new cultivars into California.

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Research Project Progress Report

Classical biological control of Asian citrus psyllid with *Tamarixia radiata* in urban Southern California

Mark S. Hoddle and Christina D. Hoddle

A biological control program for Asian citrus psyllid (ACP), *Diaphorina citri*, in Southern California was initiated in September 2010 when the authors visited the University of Agriculture in Faisalabad Pakistan to assess the feasibility of using this campus as a home base for foreign exploration efforts to find and collect ACP natural enemies (see *Citrograph* Sept/Oct. 2010, page 30-33 for more on this initial trip).

In the intervening two years, a lot has been accomplished with cooperators in Pakistan (especially Vice Chancellor Iqrar Kahan [a UCR alumnus] and Dr. Mohammad Jalal Arif), colleagues at UC Riverside (in particular the Stouthamer Lab), with the citrus industry, the California Department of Food and Agriculture, USDA, and homeowners with ACP-infested citrus in Los Angeles, Orange, Riverside, and San Bernardino Counties.

***Tamarixia radiata* is a parasitoid that attacks fourth and fifth instar Asian citrus psyllid nymphs. This parasitoid from Pakistan is being released for the classical biological control of Asian citrus psyllid in California.** *Photo by Mike Lewis, Center for Invasive Species Research, UC Riverside.*

This article provides the latest updates on the ACP biocontrol program in California with *Tamarixia radiata* (Hymenoptera: Eulophidae) a host-specific parasitoid imported into Southern California from the Pakistan Punjab. Punjab was selected for natural enemy collections for two major reasons: (1) it has a climate similar to California, and (2) it is part of the area of origin for ACP.

The prevailing climate in the Pakistan Punjab has about a 70% match with major citrus production areas in California. Biological control theory states that natural enemies preadapted to the climate of the area into which they are to be introduced should perform better than strains or biotypes of the same species that come from areas with a poor climate match. We considered a 70% climate match between California and the Pakistan Punjab to be very good for this project.

Pakistan is thought to be part of the evolutionary center of origin for ACP. If this assumption is correct, biological control theory suggests that biocontrol agent diversity would be highest here because natural enemies attacking ACP have had the longest time to evolve and diversify into new species on this pest. As you move away from the pest's evolutionary center of origin, towards the margins of its natural range, it is generally thought that natural enemy diversity declines as a result.

So the Punjab of Pakistan, if it is the center of the area of origin for ACP, could offer the greatest chance of finding several different species of natural enemies for use in a classical biological control program in California.

Working with Pakistani researchers

The first major collecting trip to Pakistan for ACP natural enemies was 10 March to 11 April 2011. During this time several major tasks were completed. First, we recruited and trained a Master of Science (MS) student, Mr. Shouket Zaman Khan, under the supervision of Dr. Mohammad Jalal Arif, from the Department of Agri-Entomology at the University of Agriculture (UAF) in Faisalabad.

Zaman's MS research has focused on medium-term population monitoring of ACP (weekly surveys over a 2-year period), parasitism rates, and natural enemy diversity on two types of citrus, Kinnow mandarin and sweet orange at two different research sites at UAF (Square 9 and the Postgraduate Agricultural Research Site [PARS]) (Figure 1).

He has also been responsible for clearing a malaise trap (Figure 2) each week that has been set up in citrus at Square 9. These malaise trap collections provide important information on insect biodiversity associated with citrus in Pakistan, which could reveal new pest and natural enemy species that we are currently unaware of.

Zaman has surveyed other native Pakistani species of *Diaphorina* (the genus to which ACP belongs) to determine how diverse the parasitoid fauna associated with these native psyllids is and whether or not there is overlap in parasitoid species attacking different *Diaphorina* species in the Punjab (Figure 3).

Zaman has also been instrumental in preparing the groundwork, taking care of logistics, and proactively scouting collection sites in advance of collecting trips by the authors. The value of this work cannot be overstated as Zaman's efforts have saved a lot of time and greatly increased the success of collecting trips.

As part of this UCR-UAF collaborative program on ACP, Zaman completed a four-week training period in the Hoddle Lab in September-October 2012. This visit allowed him to be trained in all aspects of the ACP biological con-

trol program operating at UCR. Needless to say, it was very exciting for Zaman to work with parasitoids sourced from our collecting trips to Pakistan both in the lab at UCR and at various field sites in Southern California. He also made many new friends during his visit, which undoubtedly was a great thing for building positive Pakistan-USA ties.

Second, during the March-April 2011 visit, Mark Hoddle (MH) and Christina Hoddle (CH) scouted citrus production areas in Sargodha, Gujranwala, Toba Tek Singh, and Faisalabad (Figure 4) with collaborators from UAF who had strong connections to the citrus producing community in these major Punjabi production areas.

A basic field day would consist of an early start (often around 5:30 a.m.), scouting fields in search of ACP-infested trees, and collecting ACP-infested stems to return to the lab for processing that night (Figure 5). Lab work was challenging, especially at night, because load shedding (a euphemism for Pakistan's unpredictable electricity supplies; we were getting an erratic six-hour supply a day) would knock out lights and fans and this meant working with headlamps and flashlights (Figure 6), and sometimes temperatures in the lab would surpass 125°F – this makes you sweat a lot!

Once processed, stems from collection sites were isolated in bugdorms that were labeled by locality and collection date, and parasitoids that emerged were kept separate according to the bugdorm into which they emerged.

Fig. 1. Shouket Zaman Khan and Christina Hoddle conducting weekly Asian citrus psyllid and parasitism surveys at the Postgraduate Agricultural Research Site (PARS), University of Agriculture Faisalabad, Punjab Pakistan.

Fig. 3. Christina Hoddle and Shouket Zaman Khan collecting *Diaphorina aegyptiaca* nymphs from *Cordia myxa* in a cemetery in Faisalabad Pakistan to rear parasitoids to determine if Asian citrus psyllid parasitoids attack other species of *Diaphorina* in Pakistan.

Fig. 2. Saif-ur-Rehman (right), Christina Hoddle, and Shouket Zaman Khan with the malaise trap set up in a block of Kinnow at Square 9, University of Agriculture, Faisalabad Pakistan. The first Kinnow trees were donated to Pakistan in 1940 by the University of California Riverside. This mandarin was developed by H.B. Frost and released for commercial cultivation by the Citrus Experiment Station in 1935. Kinnow accounts for 85% of citrus production in Pakistan, and fruit are exported internationally.

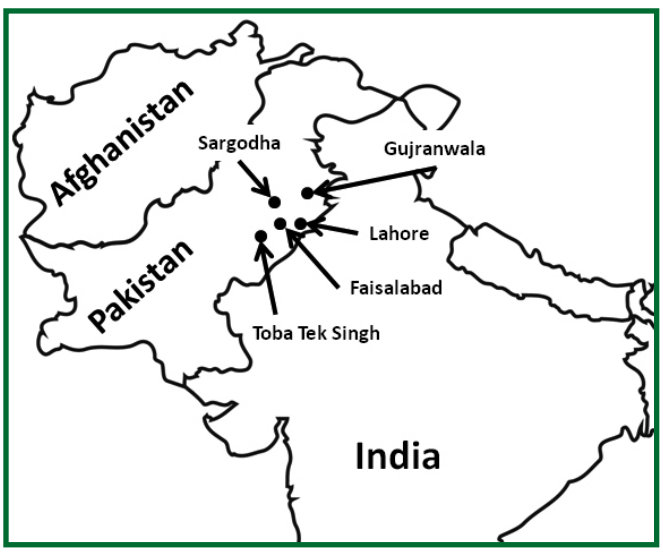

Fig. 4. A map of Pakistan indicating the major citrus growing areas (Sargodha, Toba Tek Singh, Gujranwala, and Faisalabad) that were scouted for Asian citrus psyllid natural enemies. The major point of entry into the Pakistan Punjab is the Allama Iqbal International Airport in Lahore.

Consequently, parasitoids were not mixed across localities or collection dates, and they were hand-carried under USDA-APHIS permits in carefully labeled vials back to the Insectary and Quarantine Facility at UCR. Strict adherence to this collection protocol enabled the establishment of isocage lines of *Tamarixia* on ACP in Quarantine at UCR.

Preserving genetic diversity

Because each parasitoid isocage line represented a unique collection site and date, parasitoids from isocages were never mixed in Quarantine. The idea (promoted by Richard Stouthamer, professor of Entomology at UCR) behind these isocage lines was to preserve as much genetic diversity as possible by inbreeding parasitoid populations in each cage.

This isocage line approach differed significantly from what has been done traditionally, where all parasitoids collected from different locations and times are commingled and allowed to mix freely and cross breed inside mass production cages.

Studies with *Drosophila* (i.e., vinegar flies routinely used in genetics studies) suggested that more genetic variation is preserved with isocage lines because it prevents random matings. As a result of continuous mass random matings, genetic variation decreases as populations uniformly become more and more adapted to prevailing Quarantine conditions.

Fig. 5. Christina Hoddle collecting citrus twigs infested with parasitized Asian citrus psyllid nymphs in Sargodha Punjab Pakistan. Cuttings were returned to the lab for processing.

Although some genetic variation is lost with isoscage lines, it is more easily increased again when inbred isocage lines are allowed to cross with each other in a "mongrel" breeding cage. Reconstitution of genetic diversity is achieved via hybrid offspring production that results from crosses by adults from different isocages. It is these genetically diverse "mongrel" or "hybrid" offspring that are released from Quarantine for the biological control of ACP (see Figure 7).

After the March-April 2011 trip, three more trips to collect parasitoids from Pakistan were made; 4-13 June 2011, 28 October – 4 November 2011, 2-5 June 2012 (see Table 1 for a summary of the ACP parasitoids collected in Pakistan).

Fig. 6. Mark Hoddle processing parasitized Asian citrus psyllid nymphs inside Bugdorms in the laboratory at the University of Agriculture Faisalabad (A) and then the electricity goes out, headlamps are turned on, and the temperature goes up … fast! (B).

These collecting trips and Zaman's MS research were supported, in part, by funds issued by the California Department of Food and Agriculture (CDFA), via the Citrus Health Response Program (CHRP). After each of these collection trips, new isocage lines were established in Quarantine at UCR, and a total of 17 lines resulted.

In addition to *Tamarixia*, other parasitoid species attacking ACP were collected, and these included *Diaphorencyrtus aligarhensis* (Hymenoptera: Encyrtidae), and *Psyllaphycus diaphorinae* (Hymenoptera: Encyrtidae). Four isocage lines of *D. aligarhensis* were established in Quarantine, but *P. diaphorinae* colonies were not set up because this parasitoid was collected too infrequently to be considered an important ACP parasitoid.

Two species of hyperparasitoid, that is parasitoids parasitizing ACP parasitoids, were reared out in Quarantine, these being *Marietta leopardina* (Hymenoptera: Aphelinidae) and *Aprostocetus* (*Aprostocetus*) sp. (Hymenoptera: Eulophidae) (Table 1). Careful studies by CH in Quarantine conclusively demonstrated that these two hymenopteran species were not ACP parasitoids, and they readily attacked and emerged from ACP mummies that were parasitized by *Tamarixia* or *D. aligarhensis*. Consequently, all *Marietta* and *Aprostocetus* were killed off in Quarantine once their reproductive biology was understood and it was clear that they were hyperparasitoids.

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Starting in March 2010, Dr. Raju Pandey (a post-graduate researcher in the Hoddle Lab) started safety evaluations for the Pakistani *Tamarixia* (these parasitoids were sourced from the Department of Primary Industries in Florida for these studies and ***none*** of them have been released in California), and this work was supported by the CDFA's Specialty Crops Program and the Citrus Research Board.

Stringent, mandatory safety tests

These safety tests were mandatory and required for review by USDA-APHIS. The issuance of a permit by USDA-APHIS to release *Tamarixia* from Quarantine would only occur if it could be demonstrated that this natural enemy posed no undue risk to California's environment. After about 18 months of work in Quarantine, the safety testing for *Tamarixia* was completed. This allowed the preparation of a 60-page Environment Assessment Report (EAR) for USDA-APHIS to review.

The EAR provided the rationale for a classical biological control program against ACP in California using *Tamarixia*, the selection criteria for seven test species of psyllid (see Table 2 for psyllid species tested and their selection criteria) to determine their suitability as hosts for *Tamarixia*.

A major component of the test psyllid selection process was made possible because of work funded by the Citrus Research Board to develop a checklist of native and introduced psyllid species in California, an area of research that had been neglected for over 20 years (see Percy et al., 2012 Zootaxa 3193: 1-27 for this checklist).

The EAR also covered the design and execution of three different experiments (sequential no choice, static choice and no choice experiments) to determine the host range of *T. radiata* when exposed to the seven test psyllids, and analyses

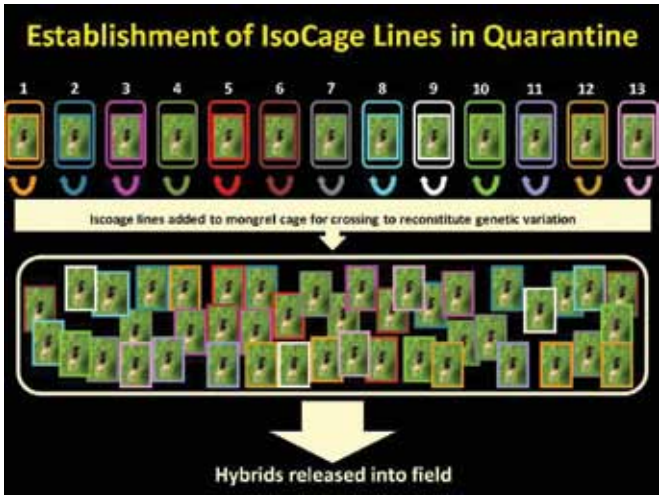

Fig.7. This schematic shows 13 of the 17 isocage lines of Pakistani *Tamarixia radiata* set up in Quarantine at UC Riverside. Offspring produced in each isocage are recycled back into the isocage from which they were derived. Genetic theory suggests that maintenance of these isocage lines helps preserve greater levels of genetic diversity. Diversity is reconstituted when isocage lines are introduced into a mass sting cage where individuals from different lines can freely interbreed. The "mongrel" offspring are expected to have greater genetic diversity because isocage "hybrids" result from random matings. It is these hybrid Pakistani parasitoids with increased genetic diversity that are released against Asian citrus psyllid in California.

of the results of exposure experiments to ascertain the risk *Tamarixa* posed to non-target psyllid species in California.

The results of this painstaking and difficult work clearly demonstrated that *Tamarixia* posed no undue risk to native California psyllids, and it was concluded that this parasitoid was safe to release and establish for the biological control of ACP.

The EAR was submitted to USDA-APHIS on 15 November 2011, and USDA-APHIS issued the release permit (P526P-11-04159) for *Tamarixia* on 7 December 2011. The first release of *Tamarixia* occurred on 20 December 2011 at the citrus Biocontrol Grove at UCR (see *Citrograph* Jan/Feb. 2012, page 11 for more on this initial release).

This was not the first time *Tamarixia* had been released in the USA; it was first deliberately established in Florida for the biological control of ACP in 1999, and the parasitoid is self-introduced into Texas and Mexico.

Extensive survey work in Southern California, especially urban citrus in Los Angeles County, indicated that ACP nymphs were not parasitized and that it was likely that this pest was benefiting, to some degree, from natural enemy-free space.

Establishment of Pakistani *Tamarixia* in heavily infested areas would exert much needed "top-down" pressure on ACP which has the potential to not only reduce pest population densities but to also lower the probability of ACP finding citrus infected with huanglongbing (HLB) (see *Citrograph* May/June 2012 pages 8-9 for more on the HLB find in Los Angeles County.)

Table 1. Summary of parasitoids (*Tamarixia*, *Diaphorencyrtus*, and *Psyllaphycus*) and hyperparasitoids (*Marietta* and *Aprostocetus*) reared from Asian citrus psyllid nymphs collected from four different trips to the Pakistan Punjab.

Collection Date	No. of *Tamarixia* collected	No. of *Diaphorencyrtus* collected	No. of *Psyllaphycus* collected	No. of *Marietta* collected	No. of *Aprostocetus* collected
10 March – 11 April 2011	80	70	5	0	0
4-13 June 2011	406	25	0	0	0
28 Oct. – 4 Nov. 2011	1012	20	22	52	4
2-5 June 2012	238	164	1	24	3
Grand Total	1736	279	28	76	7

Since the initial release of 281 *Tamarixia* into the Biocontrol Grove at UCR, a total of 39,934 (30,788 females and 9,146 males) Pakistani *Tamarixia* reared at UCR have been released at 210 sites across 46 cities in urban areas in Los Angeles, Orange, Riverside, and San Bernardino Counties (see Table 3 for more release details.)

These parasitoids have been produced from two Citrus Research Board projects that are supporting the mass production of *Tamarixia* at UCR (Dr. Anna Soper and Lisa Forster in the Stouthamer lab) and monitoring the impact and spread of *Tamarixia* in urban areas (Ruth Amrich and Allison Bistline in Hoddle lab and Grace Radabaugh with the CDFA).

Confirmed parasitoid activity

Of the 210 sites that have received *Tamarixia*, at least 49 (~23%) of them have evidence of parasitoid activity, mean-

Table 2. The five selection criteria and selected species of non-target psyllids used for host specificity testing of *Tamarixia radiata* in quarantine at the University of California Riverside (UCR). These tests were conducted to determine how broad a host range *T. radiata* would have in California. Ideally a safe and effective natural enemy has a very narrow host range, and therefore poses little undue threat to non-target species, especially native and beneficial psyllids.

Selection criteria	Selected species	Source of test psyllids
Target pest species	*Diaphorina citri* Kuwayama (Liviidae: Euphyllurinae)	USDA-APHIS-PPQ-CPHST Mission Laboratory, Edinburg, TX (certified HLB-free)
1) Close phylogenetic relatedness to D. citri	*Diclidophlebia fremontiae* (Klyver) (Liviidae: Liviinae) (native)	Wrightwood, San Bernardino Co., CA
	Euphyllura olivina (Costa) (Liviidae: Euphyllurinae) (self-introduced pest)	Temecula, Riverside Co., CA
2) Close native host plant relatedness to citrus (Rutaceae: Sapindales)	*Calophya californica* Schwarz (Calophyidae: Calophyinae) (native)	UCR botanical garden, Riverside Co., CA
3) High probability of occurrence in native vegetation surrounding citrus groves	*Heteropsylla texana* Crawford (Psyllidae: Ciriacreminae) (native)	UCR botanical garden, Riverside Co., CA
	Heteropsylla sp. (Psyllidae: Ciriacreminae) (native)	UCR botanical garden, Riverside Co., CA
4) Common native pest psyllid	*Bactericera cockerelli* (Šulc) (Triozidae: no sub-family classification is available for Triozidae) (native)	Trumble Laboratory, Dept. of Entomology, UCR
5) Beneficial psyllid attacking a noxious weed, and functioning as a weed biocontrol agent	*Arytainilla spartiophylla* (Foerster) (Psyllidae: Psyllinae) (self-introduced exotic infesting broom, *Cytisus scoparius*)	El Dorado Co., CA

ing we have recovered ACP nymphs with *Tamarixia* inside them ***and*** we have found ACP nymphs with exit holes from which adult *Tamarixia* have emerged.

This is almost certainly an underestimate of the number of sites *Tamarixia* is likely to have established at, as many release sites have not had repeat visits to assess *Tamarixia* establishment since the initial release. Work this summer is planned to rectify this.

Additionally, following inspection of neighboring properties around these 49 confirmed sites, we have found an additional 19 properties with *Tamarixia* activity, indicating that the parasitoids are moving into neighboring properties without our assistance (again this is likely an underestimate because follow up studies have not yet been made).

In fact, some recoveries have been made up to 7.5 miles from release sites which could indicate that this tiny parasitoid has the ability to spread quickly and over long distances without human assistance (this was seen in the Caribbean and South America).

Dr. Paul Rugman-Jones (Stouthamer lab) has conducted DNA analyses on the parasitoids we have found in the field, and his results provide two very important pieces of information: (1) the DNA confirms that the parasitoids we are finding are of Pakistani origin because their DNA is similar to that analyzed from the colonies in Quarantine at UCR, and (2) there are fairly high levels of genetic diversity in the recovered parasitoids which justifies the efforts that have gone into maintaining isocage lines in Quarantine.

Initial stages 'very encouraging'

The initial stages of this ACP biocontrol program are very encouraging. *Tamarixia* has been cleared from Quarantine and released in Southern California, and it appears to be establishing and spreading on its own. This is remarkable given that relatively few parasitoids have been released so far (< 40,000), releases were made at just over 200 sites, and recoveries have been made at sites where releases were made during the winter, a less than optimal time of year for establishing natural enemies.

The next big steps for the urban monitoring project are to assess the impact *Tamarixia* is having on ACP and what role ants are playing in parasitoid establishment and parasitism rates.

There is also a lot interest in ramping up the production of *Tamarixia*. The USDA is currently working with the Citrus Research Board on the feasibility of this objective, and private insectaries also want to be included in mass production efforts.

Host safety testing for *D. aligarhensis* is currently underway at UCR, and it is anticipated that by Fall 2013 this parasitoid will be cleared for release in California for the biological control of ACP.

Finally, one more collecting trip to Pakistan is being made in April 2013. These collections will add additional *Tamarixia* and *D. aligarhensis* isocage lines in Quarantine, and this new genetic stock could further help to bolster the genetic diversity of these parasitoid populations in California.

An Extension Specialist in biological control, Dr. Mark Hoddle is the director of the Center for Invasive Species Research, University of California Riverside. Christina Hoddle is an Assistant Specialist in the Department of Entomology, UC Riverside.

CRB research project reference number 5500-194.

Table 3. Summary of *Tamarixia* releases in southern California for the classical biological control of Asian citrus psyllid over the period 20 December 2011 to 14 March 2013.

Cities	Counties	No. sites *Tamarixia* released at	No. sites with *Tamarixia* establishment	No. sites with confirmed spread	Total females released	Total males released
Azusa	Los Angeles	8	7	4	1889	716
Beaumont	Riverside	4	0	0	705	140
Bellflower	Los Angeles	3	0	0	439	130
Bell Gardens	Los Angeles	11	9	3	2497	928
Cabazon	Riverside	1	0	0	136	40
Calimesa	Riverside	3	1	0	643	203
Chino	San Bernardino	7	4	0	1672	478
Colton	San Bernardino	1	0	0	145	32
Compton	Los Angeles	5	0	0	874	164
Covina	Los Angeles	1	0	1	23	8
Downey	Los Angeles	10	0	0	1093	280
Duarte	Los Angeles	1	0	0	99	28
Fontana	San Bernardino	9	4	3	1641	550
Fullerton	Orange	4	0	0	662	249
Hemet	Riverside	4	0	0	680	105
Irvine	Orange	2	0	0	295	40
La Habra Heights	Los Angeles	3	0	0	488	92
La Mirada	Los Angeles	3	0	0	459	68
La Puente	Los Angeles	12	4	0	981	251
Long Beach	Los Angeles	6	0	0	424	117
Los Angeles	Los Angeles	17	4	0	3327	1229
Lynwood	Los Angeles	1	0	0	171	44
Menifee	Riverside	1	0	0	234	101
Mira Loma	Riverside	1	0	0	90	18
Montclair	San Bernardino	1	0	0	194	55
Moreno Valley	Riverside	8			1311	245
Norwalk	Los Angeles	3			267	84
Ontario	San Bernardino	3	0	0	288	81
Pico Rivera	Los Angeles	9	4	8	496	217
Pomona	Los Angeles	9	5	0	750	284

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California Citrus Spurred Colonization

From Butte County to the border of Mexico… 1919…The California Citrus Rush... Explosion...

Richard H. Barker

Colonization just did not magically come together. It was a collaborative effort of many different motivations and factions. This synergistic energy built communities. Here are just a few influences.

In 1900, the Southern Pacific Passenger Department came out with a one-way fare to California. This plan ceased in 1916, though 795,000 passengers had accepted the "colonist rate" (per Richard J. Orsi, in his book *Sunset Limited - the Southern Pacific Railroad and the Development of the American West 1850-1930)*.


COLONIST TICKETS
TO CALIFORNIA
WILL BE SOLD
EVERY TUESDAY
FROM FEBRUARY 12TH TO APRIL 30TH
From Chicago : : : : $30.00
From St. Louis, New Orleans or Memphis 27.50
From Kansas City, St. Joseph, Council Bluffs, Omaha or Sioux City : : 25.00
CORRESPONDING RATES FROM OTHER POINTS IN THE EAST
THE GREATEST OPPORTUNITY
Ever Offered to Secure
HOMES IN CALIFORNIA
For full information concerning Weekly Excursions in new vestibuled gas-lighted, upholstered excursion cars, for literature concerning California and for tickets, berth reservations, etc., apply to any agent
SOUTHERN PACIFIC COMPANY

As the story unfolds, about 50,000 annually travelled to California under the "colonist rate." This does not imply the choice for all users of the Southern Pacific system, for some women and children came by coach, and the father and sons rode in a freight car to care for their horses and mules, and additionally to guard their belongings.

Santa Fe further offered a competitive choice. They chose to advertise using pictures of outstanding scenes and promised a pleasant journey to California plus Fred Harvey meals. The photo in their "orange groves" ad shown here offers proof of the scant popula-

tion in the peripheral, exurban areas. Just to add a comparison, in 1910 the City of Los Angeles had a population of 319,200.

The reader may raise the question of the alternative, the motor vehicle. This mode of travel was really pioneering! The conveniences offered to serve the motorist were next to nonexistent. One camped at night off the road without plumbed water. The traveler had to carry his own drinking water and water for the engine, and a hand pump to inflate the tires. There were very few fuel outlets, and the roads were in poor condition (you felt each rut).

In 1919, the writer's mother came to California in a new car from Nebraska, and her stories of the trip were very vivid. Nothing was simple! If you registered in a hotel a member of the family had to protect your car by sleeping in it. Theft of automobiles was high all over the western states.

In 1898, Southern Pacific Company launched the Sunset Magazine to stimulate tourism and create the image that California was really a "*health resort*". This magazine covered the subjects of "scientific farming" by printing work of the University of California, small-scale farming, stories on cooperatives, and examples of successful colonization.

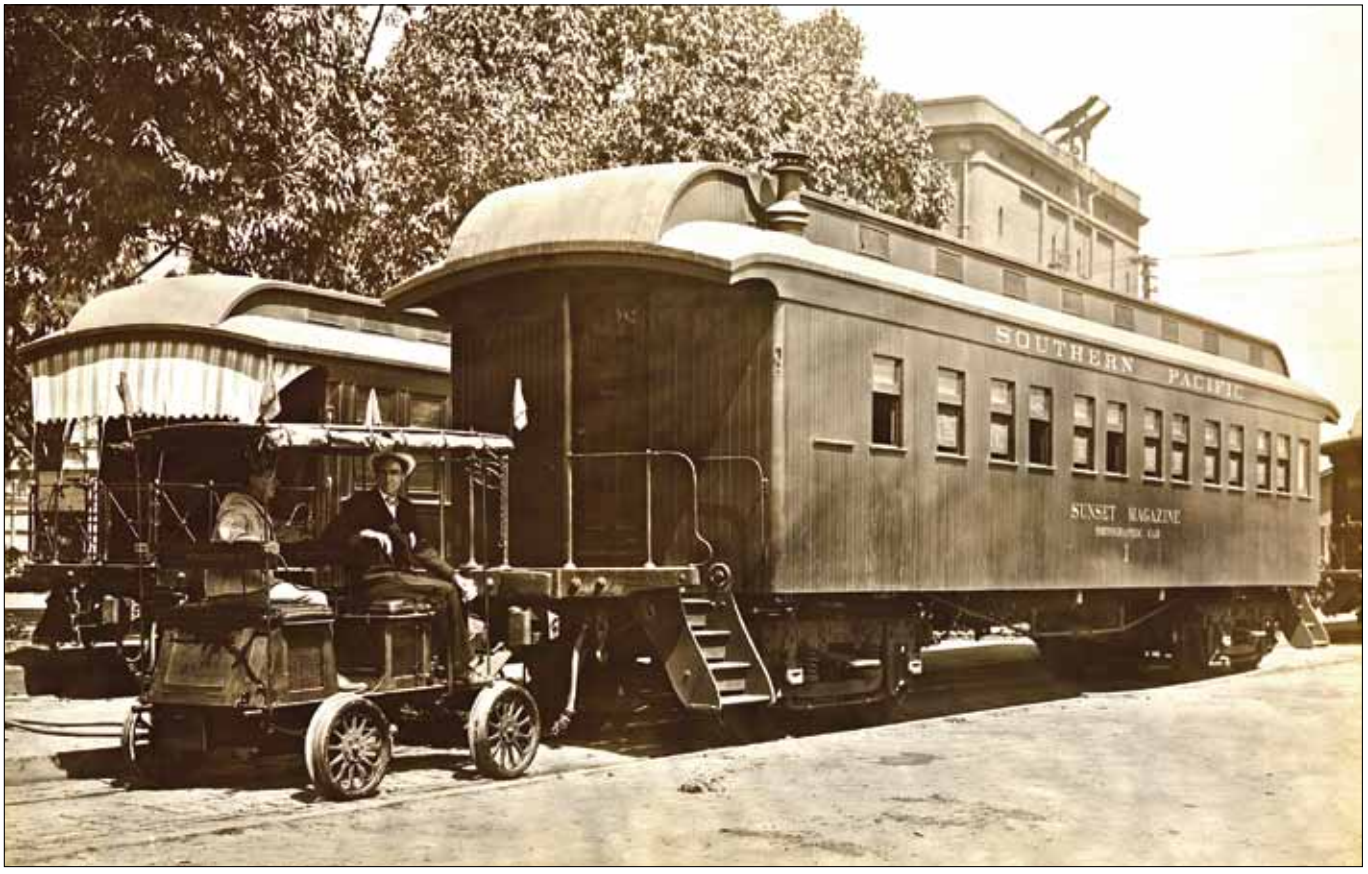
This Sunset Magazine Special Photography car made the route covering "Scenic Spectaculars", promoting the wonders of California and the economic opportunities including the citrus industry.

In the September 1904 issue, William R. Staats of Pasadena (which had a population of 20,000 in 1906) wrote that, "from Pasadena to Los Angeles will be a solid phalanx of homes within a few years."

He was correct, and this action was at the forfeiture of the citrus industry. We will explore this in the "Boom of 1920s" (in the May/June 2013 issue). But for now, one can clearly determine the influences and synergism of many diverse powers which pushed further the "*citrus rush*."

Now relative to the January/February issue, we covered the California Fruit Growers Exchange's preeminent ad-

Board of Directors, California Fruit Growers Exchange, 1919. (Left to right): President F.Q. Story, representing Semi-Tropic Fruit Exchange; General Manager G. H. Powell; First Vice President P.J. Dreher, representing San Antonio Fruit Exchange; A.E. Bennett, Orange County Fruit Exchange; C.A. Brown, Duarte Monrovia Fruit Exchange; C.C. Teague, Ventura County Fruit Exchange; R.C. Merryman, Lindsay-Merryman Fruit Exchange; E.W. Hart, San Dimas Fruit Exchange; J.S. Edwards, Redlands-Highlands Fruit Exchange; W.M. Griswold, Covina Fruit Exchange; W.E. Sprott, Tulare County Fruit Exchange; H.E. Swan, Ontario-Cucamonga Fruit Exchange; N.T. Edwards, Northern Orange County Exchange; A.S. Holden, Riverside Fruit Exchange; G.H. Merrifield. Central California Citrus Exchange; J.D. McGregor, San Bernardino County Fruit Exchange; C.S. Whitcomb, Azusa, Covina, Glendora Fruit Exchange; C.C. Arnold, Arlington Heights Fruit Exchange. Absent: F.J. Mueller, Queen Colony Fruit Exchange, and J. Mills, Sr., Superior California Citrus Exchange.



This Sunset Magazine Special Photography car made the route covering "Scenic Spectaculars", promoting the wonders of California and the economic opportunities including the citrus industry.

vertising of a perishable food product – a first, which was targeted for a selected area, and saturated with marketing material. It was a great success, and because of its success others followed in more than one way.

For this issue, let's focus now on the California Fruit Growers Exchange cooperative's organizational structure.

For the reader who is interested in their many attempted efforts expended to organize the growers, may I suggest you read my book, *Selling the Gold, History of Sunkist and Pure Gold*. My thoughts were why try to rewrite the work of one who was the corporate secretary of the California Fruit Growers Exchange. She witnessed from the beginning every success and bump. I obtained permission and republished Rahno Mabel MacCurdy's award-winning book which was printed in 1925, and I commenced my contribution after that year.

On March 27, 1905, thirteen men, each representing a different, specific citrus growing district sales exchange, signed the corporate charter establishing the California Fruit Growers Exchange. The board of directors met each Wednesday at 10:00, and all growers were cordially invited to attend, for they were mutually united. (This is a differing circumstance from a public corporation, for the board meetings are closed to the shareholders. In public corporations the Annual Meeting is open, and following this public gathering the board convenes in the usual closed session.)

By 1919, packinghouses had been modernized by electric motors and most were hooked up to electric power that carried the fruit along conveyer belts for washing, waxing, sizing and grading. From there the fruit moved into

From the archives of the L.A. County Agricultural Commissioner

CALIFORNIA FRUIT GROWERS EXCHANGE

DISTRICT EXCHANGE & ASSOCIATION MANAGERS

May 1, 1919.

Exchange or Association	Manager	Address
A. C. G. FRUIT EXCHANGE	C. C. HILLIS	AZUSA
Azusa Citrus Association	F. M. Kuhry	Azusa
Azusa Foothill Citrus Company	C. A. Griffith	Azusa
Azusa Orange Company	M. H. Goslin	Azusa
Duarte Orchards Company	S. B. Miles	Duarte
Duquesne Fruit Company	E. H. McHann	Charter Oak
Glendora Citrus Association	John Brunjes	Glendora
Glendora Hts.Or.& Lem.Grs.Assn.	G. B. Gordon	Glendora
Griffith Fruit Assn.	E. B. Griffith	Azusa
Irwindale Citrus Association	~~L. R. Topham~~	Irwindale
Sierra Madre-Lamanda Citrus Assn.	M. Morgan	Lamanda Park
ARLINGTON HTS. FRUIT EXCHANGE	H. A. LYNN	RIVERSIDE
Alta Cresta Groves	J. H. Yerkes	Riverside
Arlington Hts. Fruit Company	F. A. Little	Riverside
Sierra Vista Packing Assn.	J. H. Urquhart	Riverside
Victoria Avenue Citrus Assn.	J. T. Redman	Riverside
CENTRAL CAL. CITRUS EXCHANGE	A. S. RIDER	LINDSAY
Balaam & Beinhorn	C. F. Balaam	Exeter
Craig Y Nos Orchards	J. N. Reynolds	Lindsay
Drake Citrus Association	W. C. Merwin	Lindsay
Exeter Orange Growers Assn.	C. W. Preston	Exeter
Kaweah Lemon Company	J. R. Arthur	Lemon Cove
Lemon Cove Association	T. A. Pogue	Lemon Cove
Lindsay Fruit Association	R. E. Eddy	Lindsay
Lindsay Packing House Company	R. E. Eddy	Lindsay
Lindsay Producers Association	B. Prior	Lindsay
Northern Tulare Citrus Assn.	E. Barris	Dinuba
Ohio Lemon Company	F. Foreman	Lemon Cove
Paloma Citrus Association	C. A. Ferrin	Woodlake
Pogue, J. E.	J. E. Pogue	Lemon Cove
Rocky Hill Citrus Assn.	T. A. Pogue	Exeter
Sequoia Citrus Association	Frank Finch	Lemon Cove

COVINA FRUIT EXCHANGE	W. M. GRISWOLD	COVINA
Covina Citrus Association	W. W. Bennett	Covina
Covina Orange Growers Assn.	C. E. Crawford	Covina
Riley Fruit Co., J. M.	Henry Damerel	Covina
DUARTE-MONROVIA FRUIT EXCHANGE	D. E. BROWN	DUARTE
LINDSAY-MERRYMAN CITRUS EXCHANGE	R. H. SHOEMAKER Jr.	LINDSAY
Black & White Company	L. G. White	Lindsay
Craig Y Nos Packing House Co.	E. L. Tobin	Lindsay
Dungan, A. C.	A. C. Dungan	Exeter
Elderwood Packing House Company	M. R. Whiffen	Visalia
Gundelfinger, Emil	Emil Gundelfinger	Seville
Gillette Orchard	King G. Gillette	Lindsay
Hersey Citrus Groves	M. R. Hersey	Lindsay
Johnson Orchard, Katie E.	M. McKee	Lindsay
Klink Citrus Association	Steele	Klink
Lancashire, F. H.	F. H. Lancashire	Woodlake
Lindsay Citrus Association	K. H. Plate	Lindsay
Lindsay District Orange Co.	H. O. Mason	Lindsay
Lindsay Orange Growers Assn.	W. S. Cairns	Lindsay
McIndoo, William	Wm. McIndoo	Lindsay
McLees Bros.	Martin McLees	Lindsay
Merryman Fruit Land & Lumber Co.	R. C. Merryman	Exeter
Mutual Orange Growers Company	Chas. K. Towt	Lindsay
LINDSAY-MERRYMAN EXCH. (Cont'd)	R. H. SHOEMAKER, Jr.	LINDSAY
Navelencia Citrus Association	Roy P. Matthews	Navelencia
Orange Cove Citrus Association	C. E. Ray	Orange Cove
Orosi Foothill Citrus Association	E. B. Brigham	Orosi
Stevenson, G. F.	G. F. Stevenson	Laughlin Bl Los Angel
Woodlake Hts. Fruit Co.	E. M. Hills	Woodlake
NO. ORANGE COUNTY CITRUS EXCH.	DALE R. KING	FULLERTON
Anaheim Citrus Fruit Assn.	W. H. Schureman	Anaheim
Anaheim Orange & Lemon Assn.	G. W. Sandilands	Anaheim
La Habra Citrus Assn.	C. L. Crumrine	La Habra
Placentia Mutual Orange Assn.	Chas. Fuller	Placentia
Placentia Orange Growers Assn.	Abe Pritchard	Placentia
Yorba Linda Citrus Association	S. E. Skidmore	Yorba Linda
ONTARIO-CUCAMONGA FRUIT EXCHANGE	D. E. MYERS	Uplands
Alta Loma Hts. Citrus Assn.	C. E. Roberts	Alta Loma
Alta Hillside Groves	Miss I. Demens	Alta Loma
Citrus Fruit Association	B. F. Webber	Ontario
Cucamonga Citrus Frt.Gws.Assn.	H. H. Petty	Cucamonga
Etiwanda Citrus Fruit Assn.	D. R. Foss	Etiwanda
Hanson Fruit Company, G. A.	G. A. Hanson	Uplands
Lemon Growers Exchange	L. R. Bradley	Uplands
Mt. View Fruit Association	L. F. Woods	Uplands
Stewart Citrus Association	W. K. Beattie	Uplands
Upland Citrus Association	P. H. Norton	Uplands
Upland Hts. Orange Assn.	E. C. Rosenberger	Uplands
West Ontario Citrus Association	Wm. Hartley	Ontario
ORANGE COUNTY FRUIT EXCHANGE	L. D. PALMER	ORANGE
Central Lemon Association	E. B. Collier	Orange
David Hewes Realty Company	D. Eyman Huff	Orange
Garden Grove Citrus Assn.	E. M. Dozier	Garden Grove
Golden West Citrus Association	Geo. B. Shattuck	Tustin
McPherson Heights Citrus Assn.	C. W. Post	Orange
Olive Hts. Citrus Assn.	B. H. Cole	Olive
San Joaquin Fruit Company	J. A. Bray	Tustin
Santiago Orange Growers Assn.	W. G. Mumper	Orange
Tustin Hills Citrus Association	B. A. Crawford	Tustin
Tustin Lemon Association	Roy Runnels	Tustin
Villa Park Orchards Assn.	H. D. Nichols	Orange
QUEEN COLONY FRUIT EXCHANGE	A. E. LANG	CORONA
Call Estate, A. F.	R. L. Willits	Corona
Corona Citrus Association	F. J. Mueller	Corona
Corona Lemon Company	R. L. Willits	Corona
El Cerito Ranch Company	E. T. Brink	Corona
Jameson Association, W. H.	Joy G. Jameson	Corona
Orange Hts. Fruit Assn.	F. H. Roberts	Corona
REDLANDS-HIGHLANDS FRUIT EXCH.	H. W. SEAGER	REDLANDS
Bryn-Mawr Fruit Growers Assn.	N. B. Hinckley	Bryn-Mawr
Crafton Orange Growers Assn.	E. D. Higginbotham	Mentone, Box
Crown Jewel Groves	J. D. Langford	Redlands
Gold Buckle Association	J. S. Edwards	E. Highlands
Highland Exchange Association	R. S. Thompson	Highland
Highlands Fruit Growers Assn.	John Gorwin	Highland
Highland Orange Association	Clark Roberts	Highland
Mission Citrus Association	J. D. Black	Bryn-Mawr
Redlands Co-operative Fruit Assn.	N. Leo Lelean	Redlands
Sunshine Heights Association	Ed. Hawes	Mentone
West Highland Citrus Assn.	R. F. Hosking	Highland
RIVERSIDE FRUIT EXCHANGE	H. A. LYNN	RIVERSIDE
Monte Vista Citrus Association	L. D. Barnes	Riverside
Riverside Hts. Orange Grs.Assn.	T. E. Anderson	Riverside
San Jacinto Packing House	E. H. S. Knapp	Arlington
SAN ANTONIO FRUIT EXCHANGE	R. L. KNOX	POMONA
Claremont Citrus Association	F. W. Ford	Claremont
College Hts.Or. & Lemon Assn.	H. B. Jones	Claremont
El Camino Citrus Association	L. C. Bell	Claremont
Indian Hill Citrus Association	F. W. Knight	N. Pomona
La Verne Or.& Lemon Gwrs.Assn.	D. G. Arbuthnot	La Verne
Pomona Fruit Growers Exch.	H. E. Walcott	Pomona
Walnut Fruit Growers Assn.	J. Wolstenoroft	Walnut

SAN BERNARDINO CO. FRUIT EXCH.	JOHN I. CUMMING	RIALTO
Bloomington Fruit Association	A. G. Burch	Bloomington
Colton Fruit Exchange	W. F. Sharp	Colton
Fontana Citrus Association	Jas. D. McGregor	Fontana
Hemet Orange Growers Assn.	C. G. Hamilton	Hemet
Highgrove Fruit Exch.	A. B. Cumming	Highgrove
Rialto Heights Association	A. H. Morgan	Rialto
Rialto Orange-Lemon Association	G. T. Nicholls	Rialto
Rialto Orange Company	J. T. Canaday	Rialto
Rialto Packing Company	J. C. Boyd	Rialto
SAN DIMAS FRUIT EXCHANGE	H. O. FOSTER	SAN DIMAS
Charter Oak Citrus Association	Wm. Hoogendyke	Charter Oak
San Dimas Lemon Association	T. Roe Hobbs	San Dimas
San Dimas Orange Association	E. M. Wheeler	San Dimas
SEMI-TROPIC FRUIT EXCHANGE	C. H. GRASSLY	LOS ANGELES
Alhambra Orange Growers Assn.	A. G. G. Collins	Alhambra
Ball & Tweedy Ass'n.	J. Tweedy	Downey
Bradbury Estate	E. R. Canterbury	San Gabriel
Cahuenga Valley Lemon Ass'n.	T. C. Bell	Santa Monica Blvd., L. A.
Chapman Estate,	A. B. Chapman	431 Security Bldg., L. A.
Duffill Estate Co.	H. P. Haskell	Cons. Realty Bldg., L. A.
East Whittier Citrus Ass'n.	L. B. Williams	Whittier
El Ranchito Citrus Ass'n.	Chas. Robinson	Rivera
Hubbard Fruit Co., C. D.	A. D. Olney	Carpenteria
Leffingwell Rancho, Inc.	H. A. Schuyler	Whittier
McNally Ranch	R. C. McGill	La Mirada
Murphy Oil Company	J. T. F. Baeyertz	Whittier
Ojai Orange Ass'n.	Samuel Brown	Nordhoff
Pasadena Orange Growers Ass'n.	W. H. Beckman	Pasadena
Piru Citrus Ass'n.	Cecil Bell	Piru
Rivera Fruit Ass'n.	J. Shanker	Rivera
Ross Association, E. M.	Lester Jones	Federal Bldg, LA
San Fernando Fruit Ass'n.	F. A. Pomeroy	San Fernando
San Fernando Lemon Ass'n.	F. G. Webber	San Fernando
San Marino Growers Packing Assn.	Archie Smith	San Gabriel
Tapo Citrus Association	H. R. Zander	Santa Susana
Whittier Citrus Association	Lou Brundidge	Whittier
Whittier Select Citrus Groves	C. W. Hightower	Whittier
Whittier Orange & Lemon Ass'n.	O. Schuermann	Whittier
SUPERIOR CALIFORNIA CITRUS EXCH.	M. L. BIDWELL	SACRAMENTO
Bates, Geo. E.	J. F. Fitzgerald	Palermo, Cal.
Currey Orchard	C. B. Phillips	Dixon
Fairoaks Fruit Co.	W. W. Hinsey	Fairoaks
Mills Orchard Corporation, Jas.	James Mills	Hamilton City
Orangevale Fruit Growers Exch.	Vey Cramer	RFD Fairoaks
Palermo Citrus Assn.	Geo. C. Post	Palermo
Whitney Estate Company	H. J. Lorentsen	Rocklin
TULARE CO. CITRUS FRUIT EXCH.	W. E. SPROTT	PORTERVILLE
Antelope Heights Orange Co.	W. B. Robb	Union Oil Bldg., Los Angeles.
Boydston Bros.	Chas. Boydston	Porterville
Edison Orange Growers Assn.	W. W. Worden	First Nat.Bank, Bakersfield
TULARE COUNTY (Cont'd)	W. E. SPROTT	PORTERVILLE
Mid-California Citrus Assn.	F. L. Kennedy	Porterville
Plano Packing House Co.	W. S. Shippey	Porterville
Porterville Citrus Assn.	J. A. Milligan	Porterville
Strathmore Fruit Growers Assn.	W. S. Shippey	Porterville
Strathmore Orange Growers Assn.	F. L. Kennedy	Porterville
Strathmore Packing House Co.	A. W. Swain	Strathmore
Sunland Packing House Co.	W. S. Shippey	Porterville
Sunnyside Citrus Assn.	W. L. Hemphill	Porterville
Tulare Co.Lem.& Grapefruit Assn.	W. S. Shippey	Porterville
Tule River Citrus Assn.	Frank Wilson	Porterville
Zante Citrus Assn.	D. R. Jamison	Porterville
VENTURA COUNTY FRUIT EXCHANGE	C. P. FOSTER	SANTA PAULA
Blanchard Investment Co., N.W.	N.W. Blanchard, Jr.	Santa Paula
Limoneira Company	C. C. Teague	Santa Paula
Teague-McKevett Company	C. C. Teague	Santa Paula

DIRECT CONTRACT SHIPPERS:

Barnard Company, E. S.	E. S. Barnard	Ventura
Butte County Citrus Assn.	Oscar Warner	Oroville
Chula Vista Citrus Assn.	S. M. Wildes	Chula Vista
Crocker-Sperry Company	Frank Kahles	Santa Barbara
El Cajon Valley Citrus Gwr.Assn.	H. E. Maydole	El Cajon
Escondido Citrus Union	H. E. Crenshaw	Escondido
Escondido Fruit Growers Assn.	R. G. Beck	Escondido
Fallbrook Citrus Association	C. E. Dunbar	Fallbrook
Fillmore Citrus Fruit Assn.	F. M. Erskine	Fillmore
Johnston Fruit Company	Jas. Birss	Santa Barbara
Keen & Company	Frederick F. Keen	La Mesa, Cal.
Lemon Grove Fruit Grow. Assn.	A. V. Jester	Lemon Grove
Loveless Fruit Co.	E. J. Loveless	Escondido
Mupu Citrus Association	C. E. Whipple	Santa Paula
Oxnard Citrus Association	W. C. McCully	Hueneme
Rancho Sespe	W. H. Fleet	Sespe
San Diego Land Corporation	S. M. Wildes	National City
Santa Paula Citrus Fruit Assn.	C. L. Sheldon	Santa Paula
Sweetwater Fruit Company	R. C. Allen	Bonita

accumulation bins for wrapping (with a treated tissue) and packed in the 75-pound wooden crates.

It took 190 packinghouses to handle the production. Through colonization, the California Fruit Growers Association had grown to 10,000 members, and they represented about 75 percent of all California citrus production. The annual generated revenue had grown to approximately $70 million, making it California's second largest income generator next to oil. It was this growth that led the Fruit Growers Supply Company to build a second lumber mill in 1921 at Susanville, California.

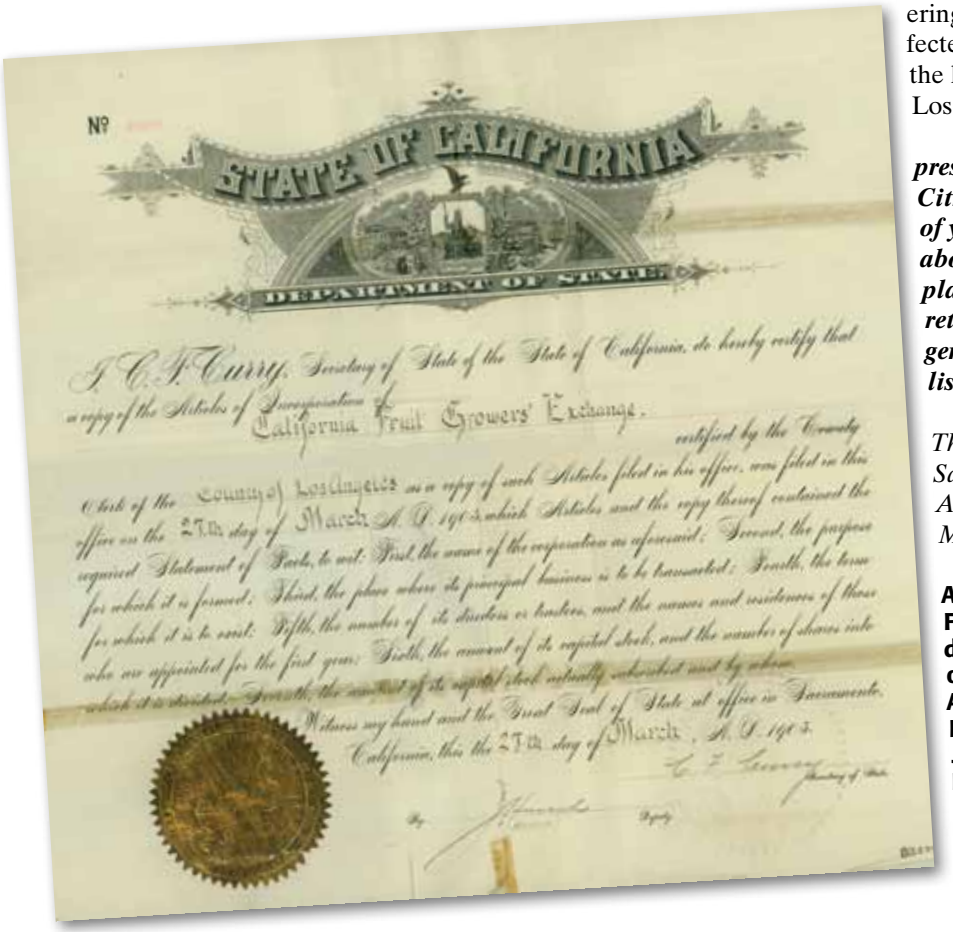
Shipments of shook to the member packers amounted annually to 15 million crates.

This 1919 uncommonly viewed photo showing 17 of the 19 directors of the California Fruit Growers Exchange coincides very appropriately with the list of 190 member packers in gaining a better understanding of this cooperative organization.

The reader will note the expanse or stretch from Butte County all the way down to National City (next to the Mexican border). This list the writer found in the papers of the luminary, long-serving Harold Ryan, who was Commissioner of Horticulture of Los Angeles County.

Wherever colonization went, and the climate was congenial, citrus was planted... a very compelling fruit... the "California citrus rush"continued to compound!

In the May/June 2013 issue, we will have the privilege of reading a masterpiece, written in 1927 by Harold Ryan, covering the "Boom of the 1920s" and how it affected the California citrus industry. Primarily, the loss of citrus acreage was localized within Los Angeles County.



Richard H. Barker is the founder and president of the Citrus Roots-Preserving Citrus Heritage Foundation. For a number of years, he has been leading a drive to bring about a higher awareness of the role citrus played in developing California. Dick is a retired investment banker and was a third generation Sunkist grower. He has published four volumes on citrus heritage.

Photos and other material courtesy of: The Barker Collection; Huntington Library, San Marino, CA; County of Los Angeles Agricultural Commissioner/Weights and Measures; Sunkist Growers, Inc

Articles of Incorporation for the California Fruit Growers Exchange. The first directors, who signed the original articles on March 27, 1905, were: F.Q. Story, Alhambra; A.P. Harwood, Upland; W.R. Powell, Glendora; S.J. Beals, Orange; A.P. Johnson, Riverside; W.H. Young, Duarte; D. Felsenthal, Los Angeles; W.E. Sprott, Porterville; H.E. Cheseboro, Covina; P.J. Dreher, Pomona; W.G. Fraser, Riverside; Frank Scoville, Corona; and E. F. Van Luven, Colton.

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‘It’s an amazing ingredient in the kitchen’

Executive chef and co-owner Michael Shackelford will tell you straight out that there is one thing you will never see at his Trelio restaurant in Old Town Clovis and that’s a foodservice supplier’s delivery truck.

In Chef Michael’s kitchen, virtually everything is made by hand with only the freshest and the finest ingredients. He personally selects all of the meats and fish he serves, and he sources nearly all of his produce locally by buying direct from growers and by frequenting the several (excellent) farmers’ markets in the area.

At Trelio restaurant in Old Town Clovis, Mike Shackelford, executive chef, and Chris Shackelford, sommelier, who are the co-owners with their father, Jim. *Photo by Jonathan Carr.*

Mike fully appreciates how fortunate he is to be a restaurateur in Fresno County where farmers produce some 350 different commodities. “It’s the seeing, smelling, tasting crops right out of the field,” he says, “that stimulates a chef’s creativity.”

“Our ever-changing menu (with the date printed at the bottom) allows me and my team to remain inspired and passionate, to continually learn, try new things, stay in tune with the seasonality of local products, and it keeps the cuisine at Trelio refreshed and exciting.”

About working with citrus, he says, “The flavor that this family of fruit delivers is unparalleled. Fresh, vibrant, and sensational are all adjectives I would use to describe it.

“There are three components that make it so versatile in the kitchen, and they are acidity, sweetness, and aroma. While the balance of sweet and sour makes the fruit so delicious, I believe it’s the aromatic qualities that make it exceptional. It’s an amazing ingredient in the kitchen.”

Mike and his business partners -- brother, Chris, the sommelier and “front of the house” host, and their father, Jim -- have set some very high standards for themselves at their restaurant, which is fine dining in a small, quiet, romantic setting. They are open for dinner Tuesday through Saturday.

Trelio had been operating under various owners for a number of years when the Shackelfords took it over in 2006. “We set out to develop one of the Central Valley’s most intimate yet inviting restaurants,” Mike says. The dining room “was gutted to the cement floor and two-by-fours and completely re-designed. We wanted an ambiance that was not too modern, without pretension, that said ‘upscale, classic, and refined’.”

The cuisine is Regional American, with Chef Michael’s interpretation being heavily influenced by his experiences on the Eastern seaboard and the Gulf of Louisiana in addition to his time in the kitchen at the five-star. five-diamond Erna’s Elderberry House in Oakhurst.

Classically trained, he took his formal schooling at the New England Culinary Institute and then perfected his technique -- (and his plating artistry) -- during two internships that had him working with nearly a dozen Certified Master Chefs from across the country.

Incidentally, Mike and Chris were raised in the Santa Ynez Valley, but their grandfather worked with citrus packinghouses in Ventura County hauling products fruit to the processing plant. “I grew up making lemonade, and fresh orange juice was a staple,” Mike recalls.

“And who can forget the beloved Sunkist Fruit Gems candies that Grandpa used to bring on the week-ends…”

Citrus Salad with Cara Cara and Blood Oranges, Meyer Lemon-Poppy Seed Dressing, Goat Cheese and Roasted Almonds

Meyer Lemon-Poppy Seed Dressing

- ¼ ea. Yellow Onion, sliced thin
- 5 ea Meyer Lemons, zest
- 5 ea Meyer Lemons, juice
- ¾ cup Lemon Juice
- 1 tbsp Dijon Mustard
- ¼ cup Honey
- ½ cup Blended Oil
- ¼ cup EV Olive Oil
- Salt and Black Pepper to taste
- 4 tbsp Poppy Seeds, toasted

Place the onions, lemon zest, juice of Meyer and regular lemon, and honey into the blender and puree until smooth. Slowly drizzle in the oils while continuing to puree until emulsified. Season to taste with salt and pepper.

Mixed greens to include some nice hearty winter varieties such as Mustards, Kales, Swiss chard etc., tossed with the Meyer lemon-poppy seed dressing, garnished with supremed segments of Blood orange, Cara Cara orange, Meyer lemon, and any other nice seasonal citrus supremes, crumbled goat cheese and toasted almonds.

Food photography by Teresa Ferguson

White Wine and Citrus Braised Bacon Wrapped Belgian Endive, French Lentils, Pomegranate Molasses

White Wine-Citrus Braised Bacon Wrapped Endive

- 2 tbsp Blended Oil
- 1 tbsp Butter
- 4 ea Belgian Endive
- 4 ea Bacon Slices
- ½ cup Chardonnay, or other dry white wine
- ¾ cup Fresh Mandarin Juice, reduced to ¼ cup (Orange Juice Concentrate to Substitute)

Fresh Pomegranate Molasses

- 2 cups Pomegranate Juice
  Reduce the pomegranate juice by three quarters over low heat in a heavy bottomed saucepan. Chill and place into a squeeze bottle.
- 1 cup Prepared Braised Lentils
- ¼ cup Pomegranate Arils
- 2 ea Mandarins, peeled and separated (remove any seeds)

Cut the endive in half lengthwise and remove the core, leaving enough of the core intact to hold the endive together. Wrap each half in a piece of bacon and weave a toothpick through the bacon to hold it in place. Heat a heavy bottomed sauté skillet over medium-high heat and add the oil. When the oil starts to lightly smoke, add the butter; then place the bacon wrapped endive pieces, toothpick side down, into the foaming butter.

Cook until the bacon is browned, turn over and brown the other side. Add the white wine and reduce by half; then add the reduced mandarin juice, turn the heat to medium-low, cover the pan and simmer for five minutes. Turn the endive over and simmer covered for an additional five minutes. Remove from the heat and reserve.

Place two endive pieces over the braised lentils (toothpicks removed), and garnish the plate with mandarin segments, pomegranate arils and pomegranate molasses.

Moroccan Preserved Lemon Risotto and Chardonnay-Citrus Beurre Blanc to accompany Seared Scallops

Moroccan Preserved Lemons

- 5 ea Lemons, quartered
- ¼ cup Kosher Salt
- 1 ea Cinnamon Stick
- 3 ea Cloves
- 5 ea Coriander Seeds
- 4 ea Black Peppercorns
- 1 ea Bay Leaf
- Enough squeezed Lemon juice to cover

Toss the lemons in a large mixing bowl with the salt, cinnamon stick, cloves, coriander, peppercorns, and bay leaf until the lemons are well coated and ingredients are mixed. Begin packing the lemons and other mixed ingredients into an appropriate sized jar packing the lemons down until all of the lemons are packed to the top of the jar. Poor enough lemon juice over the lemons to take up any leftover space in the jar; then screw the lid on tightly. Some juice should run out as the lid seals. Rinse and dry the outside of the jar and place in a dark cabinet of the kitchen for one month. After one month, the preserved lemon is ready to use and can be refrigerated.

Preserved Lemon Risotto

- 1 ea Minced Shallot
- 2 tbsp Unsalted Butter
- 1 tbsp Minced Preserved Lemon
- 2 cups Blanched Arborio Rice
- ½ cup Chardonnay or Dry White Wine
- 3 ½ cups Vegetable or Chicken Broth
- 1 tbsp Chopped Parsley
- Salt and Pepper to taste

Bring a large pot of salted water to a boil over high heat on the stove. Pour the Arborio rice in and boil as you would with pasta, ensuring to stir the rice to keep it from sticking together. Cook for five minutes stirring periodically, then pour through a colander. Immediately cool the rice thoroughly and reserve.

In a medium saucepan on medium high heat, sweat the shallots in butter until translucent. Add the white wine and reduce by half. Add the blanched Arborio rice and stir until the rice is coated. Add the preserved lemon and broth and continuously stir until the rice absorbs all of the liquid and becomes tender. Stir in the parsley, salt and pepper to taste. Serve immediately.

Chardonnay-Citrus Beurre Blanc

- 1 cup Chardonnay, or other dry white
- 2 ea Zest and Juice of Orange
- ¼ cup Orange Juice Concentrate
- 1 ea Minced Shallot
- 2 tbsp Heavy Cream
- ½ lb Unsalted Butter
- Salt and Pepper, Squeeze of Lemon

Put the juice, zest, wine, shallots and concentrate in a sauce pan on medium high heat. Cook until it reduces to a syrupy consistency. Add the cream and simmer. On low heat, whisk in the butter continuously, 1 tbsp at a time. Butter and cream are the emulsifiers for this sauce; slowly add the butter, continuously stirring, until the sauce achieves a silky smooth texture. Add salt and pepper to taste and a squeeze of lemon.

INVITATION

Friends Day

Friday, May 3, 2013 • 9am – 2pm

- Trade Show
- Tours
- Presentations
- Wine Tasting
- Lunch

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