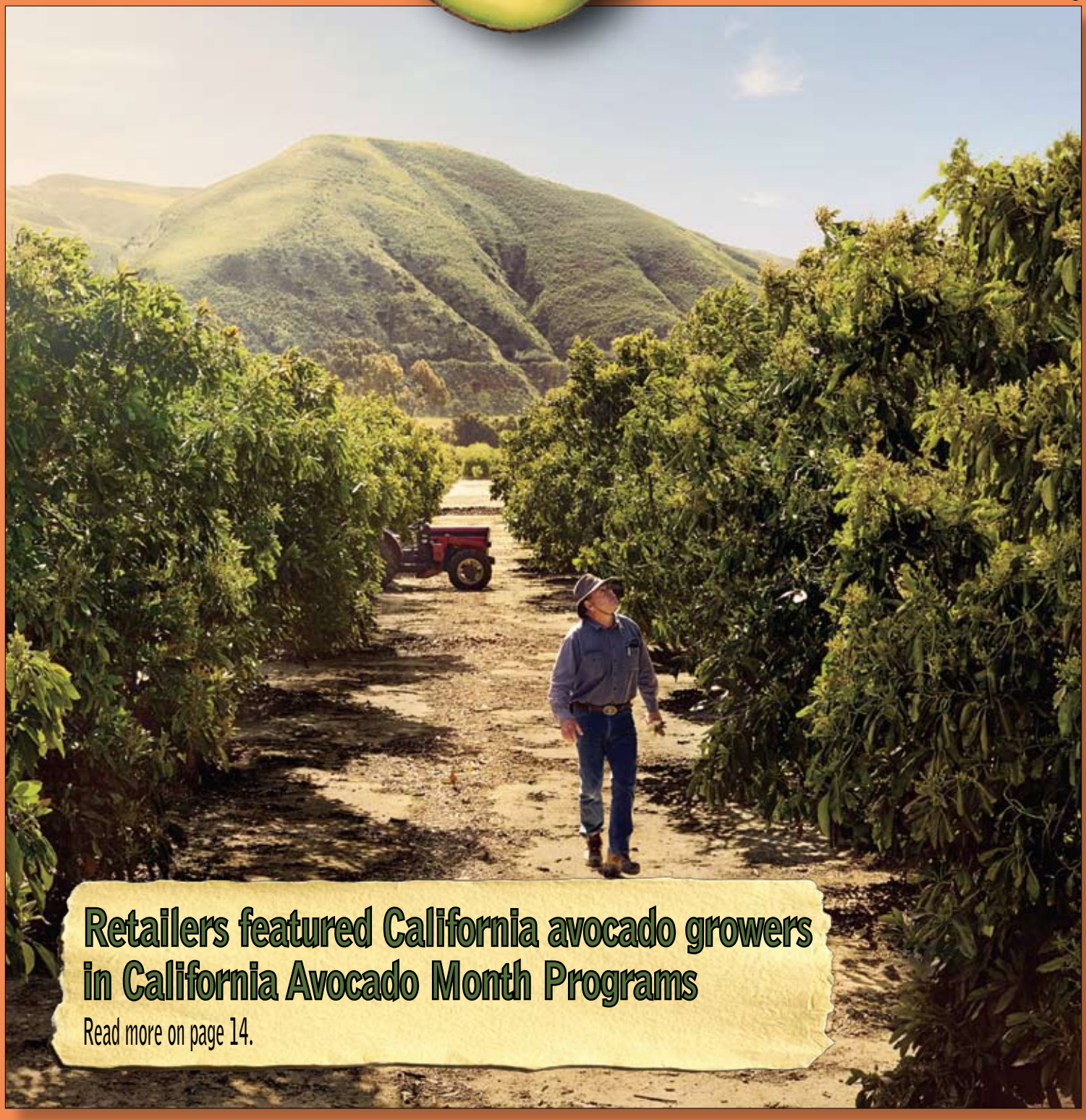
Fall 2015

# From the Grove

The Latest News from the California Avocado Industry



## Retailers featured California avocado growers in California Avocado Month Programs

Read more on page 14.

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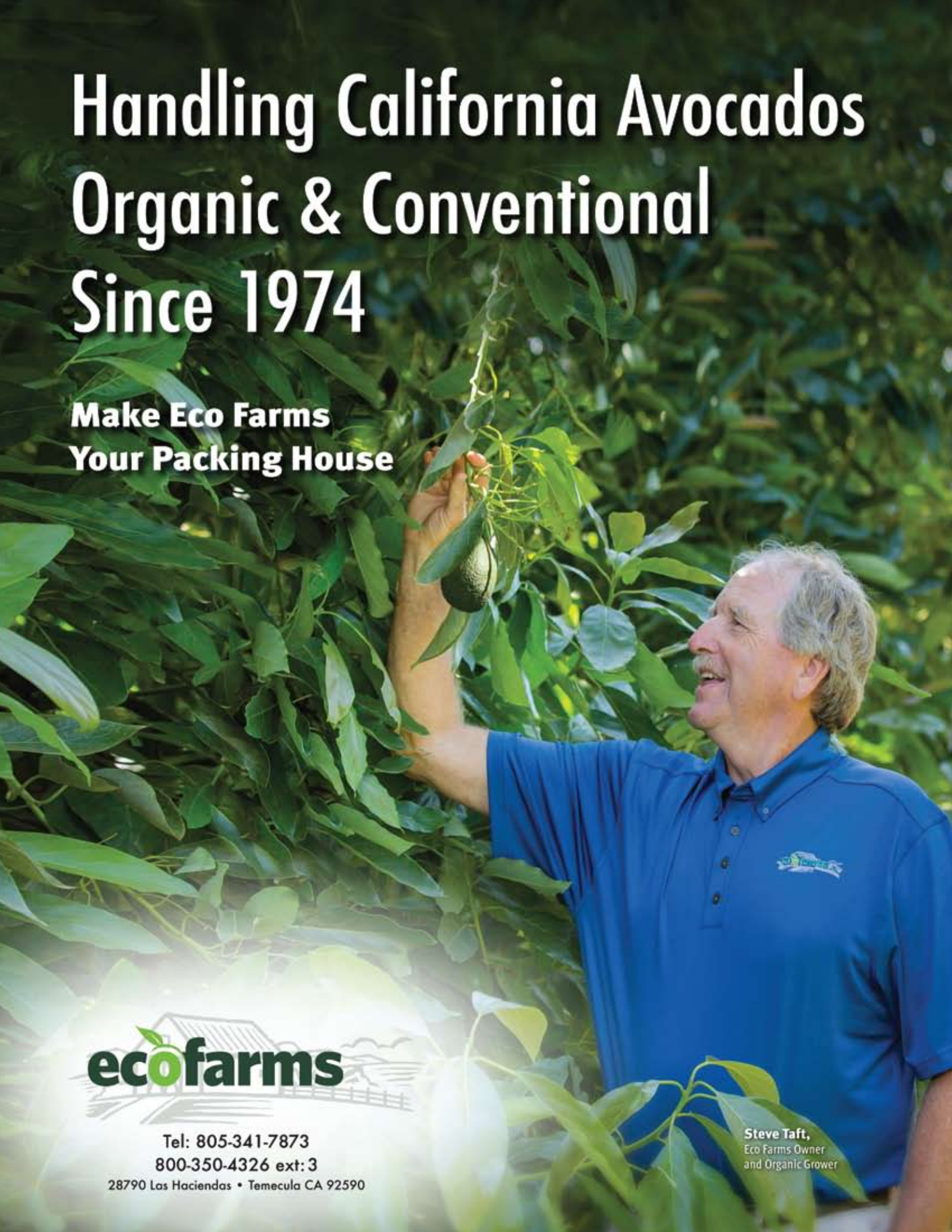

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**Steve Taft,**
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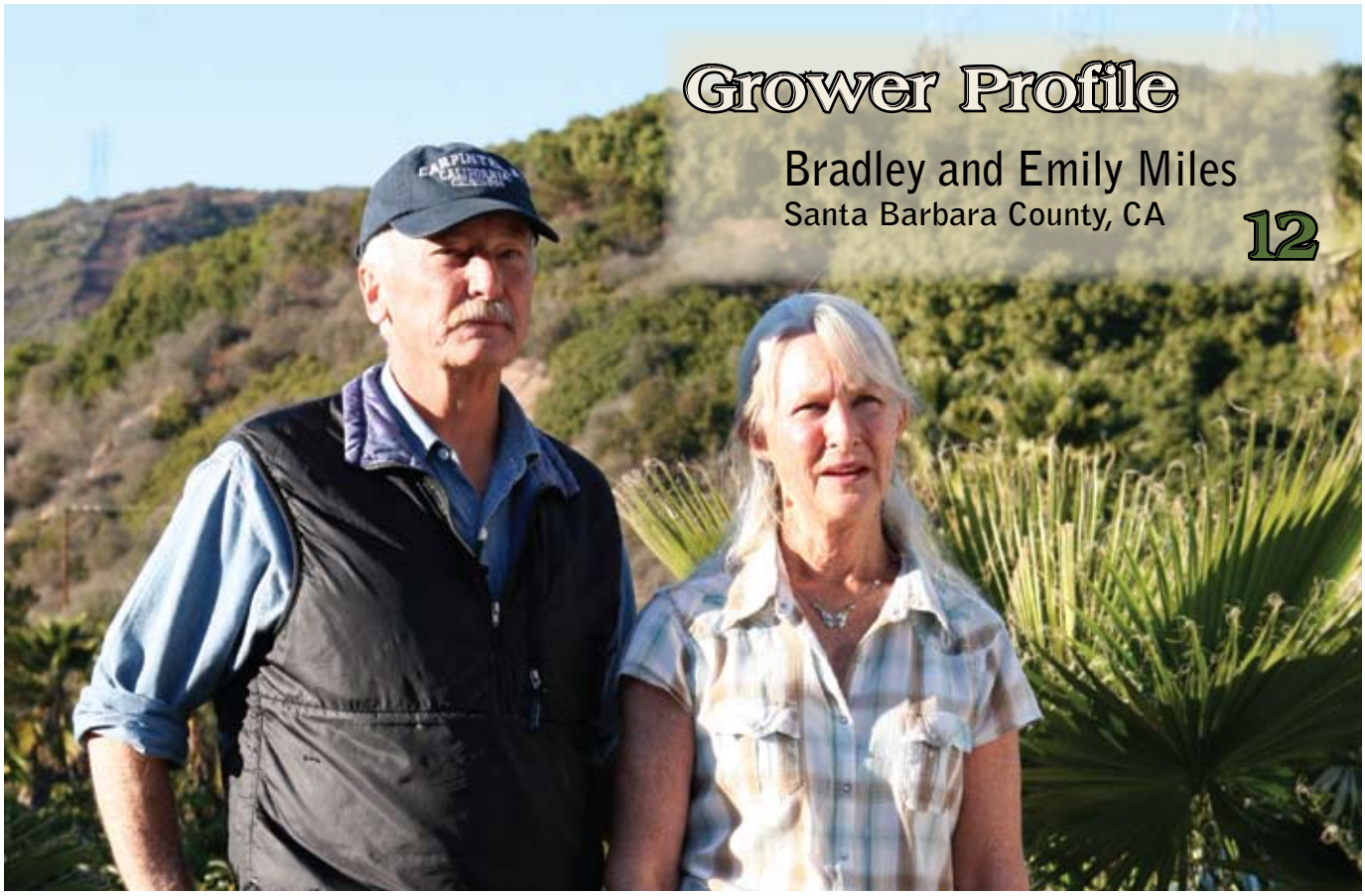

# Grower Profile

## Bradley and Emily Miles
Santa Barbara County, CA

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From the Grove

Volume 5
Number 3

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Fall 2015

# In This Issue



## Departments




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# Message from the President

*Tom Bellamore*

## Introducing Mullen Lowe Group LA + Mediahub

In April, the California Avocado Commission (CAC) set out to make some changes in our marketing agencies line-up. Our advertising agency of record, DGWB of Santa Ana, CA, kept California avocados on the leading edge for years with the Hand-Grown in California campaign. And our online agency, Red Door Interactive of San Diego, helped us achieve a prominent presence in the digital realm.

But it was time for a change. The demographics of our target consumer are changing, media is being consumed in new ways, and our competition is outspending us five-to-one in the marketplace. Sustainability of the California avocado brand has never been more critical and it could only be secured by becoming smarter, more creative and efficient as possible across all our marketing communications.

On August 20, 2015, we introduced our new agency, Mullen Lowe Group LA + Mediahub, to the Commission board. Mullen Lowe will serve as the Commission's lead marketing agency, integrating advertising and digital capabilities under one roof. Boston-based Mullen Lowe U.S. was founded in 1970 and has a penchant for representing challenger brands or underdogs. With more than $1 billion in client billings, they have represented FAGE yogurt, JetBlue, Patron, Einstok, Naked Juice, IZZE and a host of other brands. The LA team is a blend of northeastern dogged determination and Southern California creativity, with a strong dose of brand strategy expertise thrown in. Mediahub brings access to a dazzling array of resources, including the Emerging Media Lab in New York, and unparalleled media savvy. Together, this "hyperbundled" agency, as they like to call themselves, is a powerhouse that stands among the most decorated in the business. And now we have them putting their minds to work on California avocados.

In the intervening months between April and August, a robust screening process unfolded that tapped some of the best agency talent in the United States. Starting from a long list of 26 contenders — and with the help of Select Resources International (SRI), a search firm adept at agency-client matchmaking — Commission management went through a series of steps to narrow the field to four prospective agencies. Representing the Commission throughout the process were Vice President of Marketing Jan DeLyser, Director of Finance and Administration Monica Arnett, Online Marketing Manager Zac Benedict, and myself. As we neared the finish line, we were joined by CAC Chairman Doug O'Hara of Somis Pacific and Marketing Committee Chairman Bob Lucy of Del Rey Avocado Company.

The process was comprised of a steady stream of interactions with the contending agencies. These included chemistry checks to assess the "fit" between the CAC team and the agency teams, briefings and Q&As, "tissue sessions" where preliminary creative concepts were shared, and final pitches at each agency's shop where integrated campaigns were presented in polished form. SRI then called for compensation proposals from each of the four finalists and conducted detailed comparative analyses against industry standards to prepare the CAC team for contract negotiations. The process culminated with the August 20 announcement at the Commission board meeting.

From the very beginning, Mullen Lowe distinguished themselves as a force to be reckoned with, among a field of extremely talented competitors. Early in the process, all of the agencies were provided with a tremendous amount of information about CAC, the avocado industry and the competitive situation fac-

ing California avocados. The team at Mullen Lowe decided to supplement this information with their own proprietary research, which led them to meticulously dissect and understand our communications target — those people we absolutely have to reach in order for us to sustain a premium position in the market. They also went out and spent the day with northern avocado grower Randy Axell — not a bad thing to do if you are trying to win the California avocado account! The entire CAC selection team realized it was dealing with an agency that was passionate about the avocado assignment, highly creative, and ready to solve our marketing challenge in dynamic, and in some cases, radical new ways.

At the core of Mullen Lowe's approach to promoting the California avocado brand is a "show and share" strategy that recognizes the importance of the emotional connection to a product, the human predilection for visual content — wherever it might be encountered — and our willingness to share positive, uplifting ideas and content with others. If that sounds like we are strengthening our presence online — you're correct. But there's more to the strategy.

It also involves an increased use of all types of visual media. If that sounds like something that might appeal to millennials, again you are correct. And, again, there's more. A recent article in *Advertising Age* notes how various psychological studies have shown that "all people — not just millennials — are happier when their money is spent on living, rather than on having," leading marketers to define "experiential consumers" as those who believe experiences are paramount to enjoyment. Millennials are "proving to be cultural trailblazers for older and younger generations," declares *Advertising Age*. So look around at the visual world, take a deep breath, and prepare to experience some "sticky," impactful and shareable content from Mullen Lowe when the California avocado brand emerges from its makeover.

At the end of September, Commission staff will host two informal grower barbecues, one at Pine Tree Ranch in Santa Paula and one at the Grand Tradition in Fallbrook, to hear what industry members think about the 2016 crop, the overall state of affairs at CAC and the proposed spending plan for the next fiscal year. We will be joined by several members of the Mullen Lowe team and we invite you to meet them. The immediate future of the California brand rests, in large part, in their exceptionally talented hands.


# Chairman's Report

# The Peaks & Valleys of Growing Avocados

*Doug O'Hara*

As every season winds down I find it useful to look back and reflect on the year and the events that shaped the season — good or bad. There are so many variables that affect our avocado season and I think it is important to explore each one of them and see how we, as an industry, can improve our future and continue to be successful.

In my mind, this year's high point was the increased demand for California avocados we experienced in February, directly after the Super Bowl. All of us industry veterans know that for the past 10 years or so picking before or directly after the Super Bowl was not a good economic practice because of the large amount of import fruit in inventories. This season, I was surprised and excited to see that packing houses needed the fruit because the retailers were asking for California avocados. Not only was I able to sell my fruit for a good price, but I was able to get fruit off the trees early and help with the coming bloom.

Why did this happen? More importantly, why did this happen when there was approximately 30 million pounds of import fruit in inventory? My first response is to say it's because our fruit is grown in California, but the real answer is our marketing. I have to commend Jan DeLyser and her team on their extraordinary efforts this – and every – season. She took a focused approach by targeting key accounts that were loyal to us and it worked! It worked so well that at times there was not enough California fruit to meet the demand. This was definitely the case at the end of the season when some accounts were willing to pay a premium for California avocados. Again, we all should commend Jan and her team for their hard work and dedication.

Once again, there seemed to be more negative events during the season than positive. The first obvious challenge was the water situation. Minimal rain, continuing drought and water allocations have affected all of us in some manner. The growers that were lucky enough to have a reliable water supply saw their costs increase dramatically. Although Mother Nature always seems to throw us a curveball, as farmers we seem to muddle through. We all know the only solution is rain and lots of it. The upcoming anticipated El Niño won't be enough; we need years of adequate rainfall to replenish our dwindling supplies.

Another current and future challenge is the polyphagous shot hole borer (PSHB) that has been found in commercial avocado groves in San Diego County. We still do not know what the future holds concerning this pest, but I am confident that CAC staff, the board and industry researchers will continue to monitor the situation and find ways to keep the PSHB population from increasing. On a positive note, the spread of PSHB has slowed significantly and cultural methods are being used in groves to help reduce existing populations. Keep your eyes open for email updates and articles in *From the Grove* and the GreenSheet for the most current PSHB news.

Let's switch gears and look ahead to the 2016 season. From what I see and hear, we should all enjoy a larger crop in 2016. The final crop estimate has not been released, but I have heard of estimates ranging between 350-450 million pounds. I have talked with many growers who say they expect 2016 to be the best crop since the 2013 season, and I personally agree. Also, because of the high demand for California Hass – and the possibility of an earlier than normal start to the season – I am confident we will enjoy good returns even with the larger crop. Jan and her marketing team are already working on next year's programs in anticipation of the large harvest and things look positive!

Finally, I want to mention El Niño. If you are like me, you read everything and anything regarding the El Niño predictions. I recently read that there is an 85 percent chance

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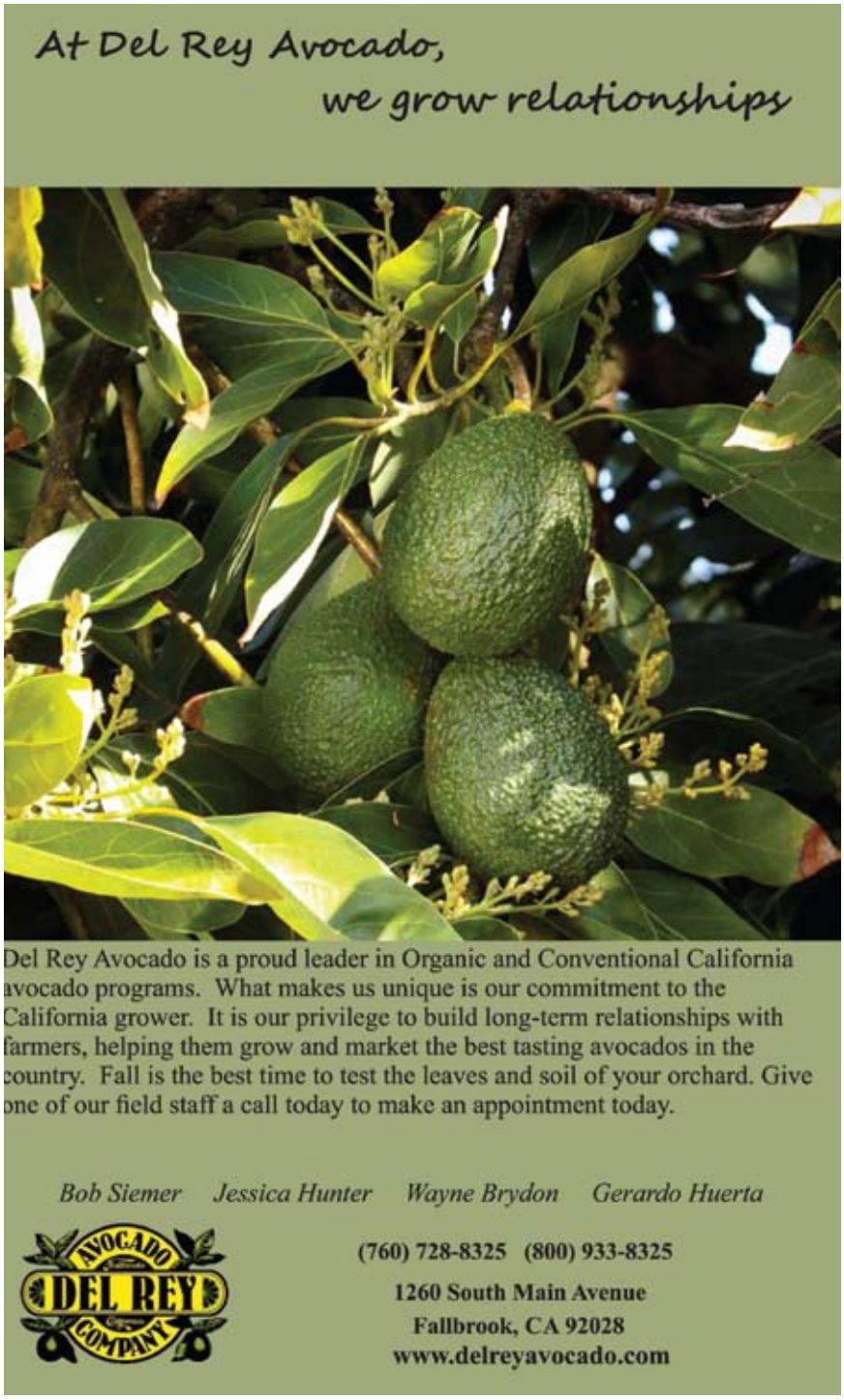
of an El Niño weather pattern occurring during the fall of 2015 into the winter and spring of 2016. Not only is the entire avocado industry anxiously awaiting its arrival, so is the entire state of California. Let's prepare our groves by repairing and cleaning drainage and utilizing erosion mitigation measures.

I want to thank Tom Bellamore and his entire CAC staff for a great season and for making this first-time Chairman's job so easy. It is difficult to understand how much these 13 people do for the growers, but as Chairman I see it first hand and it is amazing. Rest assured, they have and always will have, our best interests at heart and I personally appreciate it.

Let's all pray for rain and enjoy continued success with California avocados!



California AVOCADO COMMISSION

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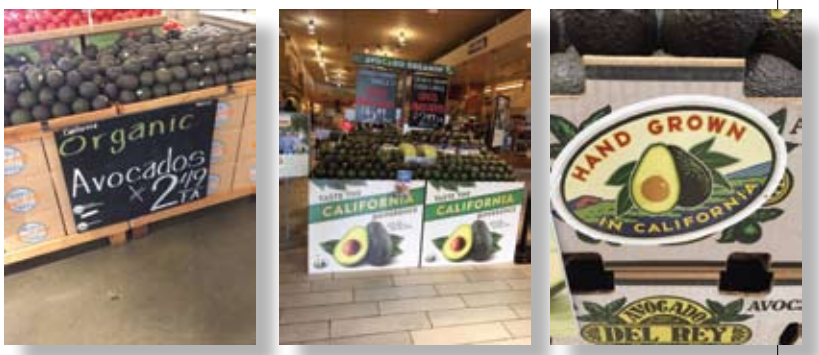
# Retail Research Offers Insights

This season the California Avocado Commission (CAC) conducted retail surveys using a third-party local software platform that provides real-time observations about retail execution. There were three objectives for these surveys: to gauge the implementation of the California avocado label at retail, to measure California avocado and imported avocado distribution at retail and to obtain visual confirmation of CAC merchandising material and California avocado brand identification at retail in key markets.




*Photos from the retail surveys showed California avocado displays and signage.*

There were three waves of surveys. The first was launched as retail distribution started market-wide, between April 13 and 22. The second was conducted pre-Memorial Day, from May 21 through 29, and the last was held around 4th of July from June 28 to July 5. The first two surveys were conducted in 250 stores in Northern and Southern California. For the third survey Portland was added. For each wave, results were observable at both the market level and the individual store level.

The research is a crowd-sourced information service that uses consumers to take pictures and record information on their smart phones in order to provide businesses with information they need. By using independent consumers to conduct surveys, the cost tends to be lower than conventional survey research. The Commission provided direction on the information they wanted collected as well as input regarding the photos they wanted taken.

Thousands of data points and pictures were collected during the retail surveys, from which CAC's marketing team and retail marketing directors could learn and create presentations for retailers on their actual merchandising conditions. The surveys provided confirmation that in both Southern California and Northern California, California avocados were the dominant origin at retail for all three survey periods.

Portland was added to the third survey in order to measure whether continuing advertising through the 4th of July was warranted. The survey confirmed it was. Eighty percent of the stores surveyed in Portland carried at least one size of California avocados for the week leading into 4th of July.

Observations for all markets surveyed confirmed that distribution of avocados from Peru was limited to a minor presence in the third wave (June 28 – July 5). The surveys provided information about display activity and point-of-sale as well, with visual confirmation of CAC display bins and point-of sale materials being merchandised at retail. Based on survey results, retailer-specific California signage seems to get the most wide-spread usage. The surveys confirmed what was working and also provided CAC's marketing team with ideas for improvement — for example, an opportunity to step up signage for American Summer Holidays / 4th of July.

One of the objectives of conducting the surveys was to gauge the presence of California avocado labels on the fruit, and photographs showed that significant progress has been made. About 50 percent of California avocados had a PLU label with clearly identified California branding on the fruit. About five percent had the California brand label plus a handler label. It is possible that the percentage of avocados with two labels is understated, however, because the photos only showed one side of the fruit.

*Visual confirmation of California avocado labels on the fruit at retail.*

CAC's marketing team concluded that surveys such as these provide valuable information to validate program implementation and also to provide insight for program improvement.

By Ken Melban
Vice President of Industry Affairs

# Drought, the Media, and "Premium Californians"

As the 2015 California avocado season finishes up, most growers would like to plan for some well-deserved time off. Unfortunately, in light of the challenges facing the avocado industry, the saying "there's no rest for the weary" seems all too apropos.

This definitely applies to your Commission's Industry Affairs staff. We work year-round to advocate on your behalf on a plethora of issues, ranging from the invasive polyphagous shot hole borer (PSHB)/Fusarium Dieback pest complex that threatens California's avocado production to the Food and Drug Administration's pilot program testing fresh avocado for bacterial contamination. But one issue continues to overshadow all others — the lack of water.

Fortunately, from an issues management perspective, the fact that the drought's impact reaches beyond farming is "good" in that it has generated a level of unparalleled societal awareness concerning the importance of a stable water supply. There also seems to be increasing public support for improving our state's water storage and conveyance systems. (If we could just get the same support from our state and federal legislators!)

Unfortunately, this increase in societal awareness has also resulted in a pointed public policy debate concerning the amount of water used by agriculture as compared to residential and environmental usage. Depending on how the data is calculated, statewide average water use is roughly 50 percent environmental, 40 percent agricultural, and 10 percent urban (Public Policy Institute of California). Water use calculations that do not count the environmental flows for the preservation of endangered species report that agriculture uses 80 percent of the water. We strongly disagree with this model and refute it whenever possible.

In my opinion, two prominent factors are driving this debate. First is the incorrect public impression that agricultural water users were given a "pass" on mandatory water reductions. In April, Governor Brown issued a statement asking Californians to reduce water use by 25 percent. In May, the State Water Resources Control Board issued a mandatory — up to 36 percent — emergency water use reduction for all residential and business customers. The Control Board's decision appeared to exclude agricultural customers, although those who are customers of water agencies that serve residential and industrial customers have to comply with the mandatory reductions. The only agencies exempted from the emergency order were those that are solely agricultural water agencies.

Second, there are pockets within California's central valley that do not have running water. That's right – California, a state in one of the most prosperous countries in the world, has residents living in third-world conditions. This commands tremendous public attention and causes people to pause and realize they could end up in the same situation.

As long as mandatory emergency water-use restrictions remain in place and experts continue to claim this is the worst drought in history, some communities have to exist without running water and media coverage will remain intense. Over the last few months we've seen multiple attacks on agriculture's water use, with some stories specifically listing avocado production. We are contacted by reporters (print, radio and television) an average of 10-15 times a month asking questions like, "How is the drought impacting California avocado farmers?" and "How much water does it take to grow an avocado?" or "Will this result in either a shortage of California avocados or an increase in price?"

Obviously water use in agriculture is more complicated than simply

boiling it down (pun intended) to "X" number of gallons are needed to produce "Y" pounds of fruit, but that is the extent of most media reports. What isn't mentioned is that water for agriculture also helps recharge ground supplies, provides jobs, preserves open space and helps improve air quality. And let's not forget that agriculture feeds people!

Media coverage of this topic can be extremely frustrating and we understand the impulse to respond with more accurate information. But how would that clarification be portrayed by the media and how would it be interpreted by the public? How will people respond to the fact that avocados only need 50 gallons of water per pound instead of 150 gallons? Although that may be the case, trying to clarify the information will only likely result in perpetuating the story. So we look to redirect the focus. Our message is clear, "Although the drought has impacted some of the farmers, overall the industry is coping and maintaining its productivity." We explain that this "season's supply is somewhat typical based on alternate bearing and that we do not anticipate supply problems or drought-related price impacts for next season."

Yes, you heard right. We intentionally mention the price of California avocados and even note the increasing price is not related to the drought. As you know, the Commission has been diligently working to establish California avocados as the premium avocado. But premium comes at a price and it's important our customers realize the price of premium California avocados will remain stable – not drop – even if an El Niño event occurs this winter (fingers crossed!) and the current drought conditions are diminished. We want our customers, the "premium Californians," to realize we provide hand-grown premium avocados – avocados that are worth the price paid. In every interview we work to ensure the cost of California avocados is not associated with the drought but with their premium quality.

Tom Bellamore, in his "Message from the President" column in this issue, announced that the Commission has just selected a new ad agency and we are now poised to take our marketing effort to the next level. The target customers — these "premium Californians" — may or may not live in California, but they have an emotional connection to California and when given the opportunity they will purchase California avocados. They understand that premium products are worth their price.

One last point. When responding to the media, we make certain to communicate how the avocado industry as a whole uses water efficiently, utilizing the latest available technologies (e.g. micro-sprinklers, soil-tensiometers, etc.). In addition, we discuss the industry's transition to higher density plantings, our ongoing research concerning salinity resistant rootstocks and our exploration of potential new water efficiency technologies. If you're interested in learning more about how you can improve your irrigation systems, see Dr. Tim Spann's article on page 20 entitled "Using Soil Moisture Sensors to Improve Irrigation Efficiency."

Hopefully this multi-faceted issues management example serves to illustrate that all of the Commission's activities, from marketing and production research to industry affairs, are synchronized with one goal in mind: to provide you, the California avocado grower, with the best possible outcome — rain or shine.

# Grower Profile

# Sculptor, Builder, Author, Avocado-Maker

By Tim Linden

A few years into their marriage, when Emily and Bradley Miles started growing avocados on some family land in Santa Barbara County in the 1970s, it represented a bit of a homecoming for both of them.

Emily's grandfather first planted avocados in Carpinteria in the 1920s as one of the pioneers of the avocado industry. And when Bradley was growing up in the 1950s and early 1960s north of Santa Barbara, he had a hands-on relationship with avocado tree grafting.

"We lived in an isolated canyon east of Goleta where there were only three houses and lots of lemons," said Bradley. Lemons were not a particularly hot crop in those years and many growers started converting to avocados. "Nobody knew which variety was going to be a good one so there was a lot of experimenting and grafting. I learned how to graft at a very young age."

Bradley's dad was a physician and not in the avocado business but with many burgeoning groves in the area, grafting provided the younger Miles with the opportunity to earn some cash as a teenager.

Miles graduated from high school in 1962 and had a couple of false starts in college before joining the Army. Always a creative type, after his stint in the military, he returned to college and eventually finished his studies at the Art Institute earning both a Bachelor's Degree and a Master's in Fine Arts with an emphasis in sculpting and ceramics. Armed with the degrees, he thought he would become a college professor but couldn't find suitable work. Instead he started building wooden boats and slowly built a career in the construction business. Today, and for many years, he has kept what he calls "his day job" as a construction consultant.

But back in the late '60s as he was slowly making progress on his educational endeavor, he was also slowly courting Emily Brown. "Her brother was my roommate for a time in college so that's how I knew her. Then she and her brother went to Spain at the same time I was in Europe so I ran into her there as well."

Eventually, back in Santa Barbara the two began dating and the rest, as they say, is history. They got married in 1971 and about a year later they officially began their lifelong affair with the avocado. Emily's family had some acreage that included an 18-foot trailer on the property. The young couple lived in that trailer and took care of the grove. Eventually Bradley built them a proper home from the barn on the ranch.

As he discusses his avocado-producing career, Miles quickly jumps over the next 30 years, clearly excited about when his avocado industry education really began. Along the way, he and his wife were involved in agricultural pursuits with several of her brothers, growing other crops, such as cherimoya and partnering in a packing operation. But by 2006, Bradley and Emily had retired from those partnerships, sold a 43-acre avocado ranch they owned and settled in making their nine-acre avocado grove a laboratory for better growing techniques.

For the past decade, they have been experimenting with several different cultural practices and have successfully built what Bradley believes is a better grove. He said the size of his grove is perfect for conducting experiments. It's large enough to try different ideas, and small enough to do it yourself. He gives a great deal of credit to former California Avocado Commission Research Program Director Jonathan Dixon, quoting him often during a conversation on his cultural efforts. "We still Skype each other often…although I have to call him at 11:30 at night to get a hold of him" as the New Zealand-born Dixon is back in the general vicinity

of his origin.

One of the projects he is obviously most proud of is the effort to lower the height of all his trees so they can be picked from the ground. "I told Emily I don't ever want to see a ladder in my grove again."

Miles said the appearance of a ladder means two things: broken limbs and a picking surcharge. He wants neither.

It was actually a freeze in 2006 that started Miles on his mission to shorten his trees. After stumping affected trees because of the freeze, he noted a robust growth pattern ensued. He reasoned, with Dixon's help, that by constantly pruning the trees and creating an open space in the middle, he could still produce a heavy set with easy picking access. In addition, the much smaller trees would need less water. "We are still in the middle of what could be a seven-year drought – and water is very expensive – we have to think about that."

Miles said the constant pruning has worked. His trees are no larger than eight to nine feet tall and he has cut his water use from 180 gallons per tree to 110 gallons, which is pretty close to a 40 percent reduction. He said the water savings pays for the extra pruning. Like many growers, he had a light crop in 2015 –reflecting the alternate bearing properties of his grove – but the trees are loaded for 2016. "I have more bloom and the trees look very healthy. And I have used less water and less fertilizer."

That brings him to his second big project: constant fertigation. Again working with Dixon, he devised a plan that would constantly give his trees fertilizer in small doses rather than shock them and then starve them, which is what he calls the normal practice. "It's the Chinese meal theory: after you eat a Chinese meal, a few hours later you are hungry again. So are the trees."

Consequently, Miles makes sure his trees get enough nutrients through fertigation and constant mulching. "Jonathan said you should look at an avocado tree in its natural environment, which includes lots of mulch."

As Miles is constantly pruning his trees, he is shredding the branches and allowing them to serve as mulch. When he scrapes below the surface of his trees, he notes a white root system, which tells him the trees are getting plenty of nutrients.

Though Bradley Miles was the only one interviewed for this story, he insists that the Miles operation is a family affair. "I take care of the maintenance on the grove and Emily takes care of the irrigation and the accounting."

He said she keeps meticulous notes each time she irrigates and fertigates and keeps on top of the schedule. It is a clockwork operation.

Miles is confident that California can continue to compete in the world avocado industry. He said growers have to be efficient and mind their costs, especially in the southern part of the state where water costs are going through the roof. But he believes there will always be room for homegrown, California avocados. He said the fruit has "standing" in the marketplace and can get a premium price. "But growers have to pick for quality. We never harvest until we see a woody stem."


Bradley Miles

He said foreign production areas, because of the transportation time, just don't have the ability to leave the fruit on the tree as long as California growers can. They often harvest green fruit, he says, that has not been tree-ripened. "We will always have that local market."

Miles likes to quip that if you grow avocados "you should keep your day job." He has done that and has never lost sight of the many facets of his personality that keep him ticking. "I've always had a creative side…building boats… building our house. And for the past 18 years I have been writing."

He has mostly written short stories and has had a few of them published over the years. Currently, he is working with an editor on a memoir that he wrote about a particularly challenging time in his life. "When I was 36, we were dead broke." A captain of a 1924 schooner offered him the opportunity to spend six months at sea fishing for albacore. Miles kept a journal of this amazing voyage and has committed the story to paper. Each chapter begins with an old fishing superstition ("Don't bring a banana on board." "Don't leave port on a Friday.") and includes stories of the adventure.

"Right now I am working with an editor to make it more readable," he said.

Don't be surprised if *Jigging on the Havana* by Bradley Miles makes it to Amazon.com one day.

# California Avocado Month Tops 100 Million Impressions


*Image courtesy of California Tortilla*

### *Public Relations Activities*

In recognition of June as California Avocado Month, the California Avocado Commission (CAC) coordinated with key California-based chefs and influential bloggers to inspire consumers' use of California avocados during peak season.

On June 4, CAC hosted a media dinner at Curtis Stone's Maude Restaurant in Beverly Hills, which celebrates one ingredient per month on its menu. June was (of course) California avocados, and CAC brought in traditional media and food bloggers to experience the innovative and delicious menu. The 10-course meal featured dishes that utilized California avocados and other seasonal ingredients in creative and innovative ways, including pickled avocados with radicchio, tomato, radish and kohlrabi; avocado powder with rib eye, sweet corn and bone marrow; and for dessert, avocado leaves with chocolate and blackberries.

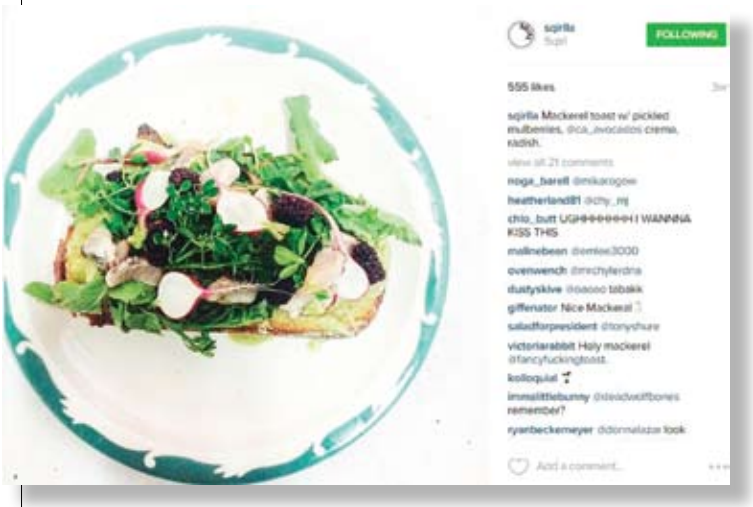
CAC also coordinated with Artisan Chef partners to raise awareness of California Avocado Month. In San Diego, chef Trey Foshee of George's at the Cove created exclusive new California avocado sandwich recipes that were featured in press outreach. These new recipes, including the *Achiote Grilled Fish Sandwich with California Avocado and Roasted Pineapple-Jalapeño Spread* and the *Chipotle, Lettuce, Tomato and California Avocado Sandwich*, were made available to consumers on CAC's website. Foshee also created and promoted California avocado taco specials throughout June in his restaurant.

Throughout June, Jessica Koslow (SQIRL, Los Angeles) highlighted a mackerel toast with pickled mulberries and a California avocado crema (as seen opposite, on page 15); Ivy Stark (Dos Caminos, NYC) developed a California avocado 'light' guacamole that was added to the Dos Caminos Healthy Options menu; Eric Tanaka (Cantina Lena, Seattle) devised a California avocado summer guacamole; and Mike Fagnoni (Hawks Restaurant, Sacramento) made a delicious California avocado summer salad.

*CAC's Jan DeLyser with the staff of Maude Restaurant in Beverly Hills*

The Commission leveraged its wide network of blogger ambassadors, and also worked with an additional group of influencers throughout the month, to inspire posts about California Avocado Month. Each contact received fresh, beautiful California avocados that inspired a wide range of dishes, such as an Avocado BLT (Family Spice), Grilled Bread with California Avocado Bruschetta (Petit Foodie) and spicy Grilled Pineapple and Jalapeño Guacamole (My Man's Belly). This outreach resulted in more than 40 blog and social media posts and 300,000 impressions to date.

CAC's California Avocado Month activities built on prior success and helped to promote the peak of California avocado season while creating excitement and anticipation for California avocados. This year, California Avocado Month activities resulted in more than 100 million impressions.




*California Avocado Mackerel Toast special at SQIRL restaurant in Silver Lake, California*

## *Retail Communications Programs*

CAC's tiered account approach to targeting retail accounts resulted in promotional activity throughout California Avocado Month encouraging consumers to increase their consumption of fresh California avocados.

Customized communications programs were developed and implemented at top tier retailers including Bristol Farms, Gelson's, Mollie Stone's and King Soopers. From social media campaigns to traditional media such as television interview segments, newspaper articles and in-store demos, CAC and this select group of retailers worked together to promote California avocados during June.

Directly engaging with consumers, building brand presence and ultimately selling more California avocados was the goal of a customized program with Bristol Farms. CAC worked with the retailer's social media team to host grower information, nutrition messages, preparation and usage tips, recipes, two featured grower profiles (Del Rey Avocados and Rancho Vasquez Organic Avocados) and photos on a dedicated California avocado page on Bristol Farms' website in support of a two-week in-store promotion.

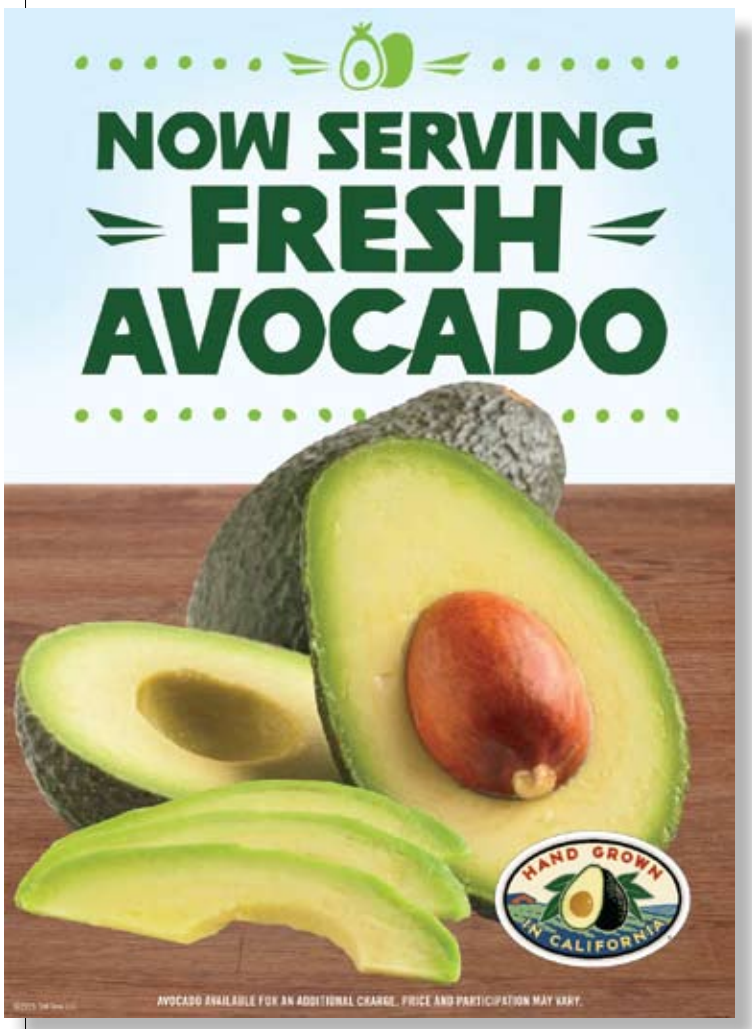
Another social media campaign featured a month of tweets about interesting usage ideas, nutrition tips and recipes on Gelson's Twitter site. The retailer also posted several articles on their website including one about hand-grown California avocados from Rancho Rodoro and featuring a virtual tour of the groves in a video. A third social media campaign was coordinated with Mollie Stone's that included tips and recipes on their Twitter, Facebook and Instagram sites all month long.

Extending to traditional media and in-store activities, Colorado's Channel 2 news featured a segment about California Avocado Month with King Sooper's dietitian who shared tips for using California avocados at breakfast time, in smoothies and salad dressing. She also demonstrated the proper way to cut, nick and peel a California avocado for the morning show's viewers. In all 146 King Soopers' store pharmacies, avocados were the "Dietitian Tip of the Week" and were promoted with easels featuring a CAC-provided photo of grilled avocado from June 12-17. Supermarket dietitians conducted "grilled fruit" cooking classes that featured California avocados. Grilled California avocados also were served at a re-grand opening event where CAC's "Superfood Spotlight: 16 Surprising Ways to Add California Avocados in Your Day" and California avocado cutters were given away to attendees.


Promoting the fruit via customized programs at key top tier retailers during California Avocado Month netted wide exposure. The three customized social media programs reached more than 15,000 Facebook fans and 8,000 Twitter and Instagram followers. An audience of more than 15,400 tuned in to *Colorado's Best* on Channel 2 for the television segment featuring California avocados.

All of the Commission's California Avocado Month activities benefit California avocado growers by creating awareness of California avocado seasonality and building consumer excitement and anticipation for premium California avocados.

# 2015 Foodservice Highlights




*Del Taco (520 units in target states) introduced fresh avocado to their menu this year with bold signage and one offering to "Add Fresh Avocado to Any Item."*


*El Pollo Loco (395 locations in target states) kicked off the California season with a six-week promotion supported by print, online and social media.*


*The direct result of a CAC menu ideation session, The Egg & I (78 units in target states) rolled out this avocado-centric summer promotion.*

*At events like the Global Culinary Innovators Association conference, CAC reaches chain Research & Development chefs to boost awareness and generate demand for California avocados.*


*Current foodservice advertising connects the hand-grown goodness of California avocados with menu promotion successes at restaurants like Denny's.*

*To encourage trial and new menu applications, CAC presents innovative avocado dishes at customized ideation sessions, such as this one at Cheddar's.*

# 2015 Retail Highlights


*Albertsons hosted a "Meet the Grower" event with California avocado grower Chuck Bandy and stores featured their new "California Grown" signage campaign throughout the season.*


*Haggen Southwest promoted California avocados with a 4th of July Sales and Display Contest.*


*Ralphs kicked off the California avocado season with custom "California Grown" avocado bin inserts and signage along with a first-time ever produce item featured on the front cover of their ad circular with California avocado grower Doug O'Hara.*

*Gelson's Markets promoted California avocados with a sales contest in both the produce and service-deli departments. The service deli featured a "California Avocado & Grapefruit Salad."*


*Harmons in Salt Lake City featured California avocados during their 4th of July Sales and Display Contest.*


*In late August, Lunds & Byerlys in Minneapolis held "Meet the Farmer" events in three of their locations, along with supermarket registered dietitian demos in all their stores supported with beautiful displays of California avocados.*

By Tim Spann
Research Program Director

# Using Soil Moisture Sensors to Improve Irrigation Efficiency

As California's historic drought drags on, every grower is feeling the pinch and trying to make the most of every drop of water available. There are many tools available that growers can use to help improve their irrigation practices and ensure the water they are applying is used most efficiently. This article will describe some of these tools and how the information they provide can be used to help survive the drought and improve overall grove management.

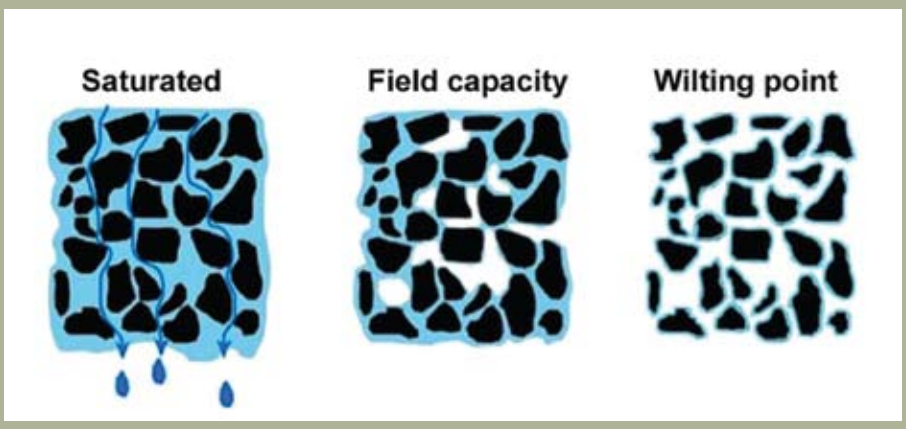



*Figure 1. An illustration of the three phases of soil moisture — saturated, field capacity and the permanent wilting point. At saturation, all of the soil pores are filled with water, but the water is held weakly and the large pores will empty by gravity. At field capacity, the large pores have drained and filled with air, but the smaller pores remain water filled and no more drainage will occur by gravity. At permanent wilting point, the water remaining in the soil is held very tightly to the soil particles by adsorptive forces and the plant roots are unable to overcome these forces to extract more water.*

## Irrigation Distribution Uniformity

Before discussing the various systems available to improve water use efficiency it is important to mention irrigation system distribution uniformity (DU). DU is a measure of how evenly your irrigation system is applying water. If every sprinkler or emitter in your system (or a given irrigation zone) were putting out exactly the same amount of water over a given time, your system would have a DU of 1, or 100 percent.

Common things that negatively affect DU are poor system design, elevation changes, worn or improperly maintained emitters and leaks, among others. Many of the state's Resource Conservation Districts (RCD) offer free or low cost irrigation system DU checks for growers. The RCD will give you a comprehensive report on your system and offer advice on how to improve your system's DU. There are also programs available through the RCDs, water districts and the state to help offset the costs of upgrades you may make to improve your system's DU.

Improving your irrigation system's DU will ensure that you are applying water as uniformly as possible across your grove. But how do you make sure you are applying the right amount of water at the right time?

## Understanding Soil Water

Soils are composed of two basic components — particles and pore space. The particles are the physical components that make up the soil structure — sand, silt, clay, gravel, organic matter, etc. The pore spaces are the voids between the particles that can be filled with water. A soil's water holding capacity is a result of the different ratio of the particles that make it up and their sizes. A soil composed of mostly small (clay) particles will have a high water holding capacity, whereas a soil composed of mostly large particles (sand) will have a low water holding capacity. A good soil has a mixture of large and small particles so that it has good water holding capacity, but also has enough air spaces for good root growth.

When you irrigate, you are filling the pore spaces within the soil with water. Immediately after irrigation the soil can be considered saturated. That is, the majority of the pores within the soil, large and small, are filled with water. The large pore spaces then drain, by gravity, leaving the small pores still filled. Once this

free draining has been completed, the soil is at field capacity — the volume of water the soil is able to hold against gravity. As the soil continues to lose water by plant uptake and evaporation, the soil water content decreases. As the water content decreases, the remaining water is held more and more tightly by the soil particles through adsorptive forces. Eventually, the plant's roots cannot overcome these adsorptive forces and the soil is said to be at the permanent wilting point (PWP). These phases of soil moisture are illustrated in Figure 1 (see page 20). Water available when a soil is near field capacity is "easy" for the plant to take up, and as the soil gets closer to the PWP it becomes increasingly "difficult" for the plant to take up water.

Our goal in managing irrigation is to maintain soil moisture conditions as close to field capacity as possible so that water is easy for the tree to take up. However, if we stray too far the soil can become saturated, creating hypoxic (oxygen deficient) conditions that can lead to increased chloride uptake (see, Decision Support Tools for Avocado Fertilization and Salinity Management: Preview to the Final Project Report on page 25) and exacerbate Phytophthora. On the other hand, if we allow the soil to become too dry, the tree can struggle to take up water, which depending on the time of year can impact bloom, fruit set, fruit growth, flush development and fruit quality. So how do you achieve this apparent balancing act?

## Monitoring Soil Moisture

The easiest way to monitor soil moisture conditions is through the use of soil moisture sensors. For a review of the different types of soil moisture sensors that are available, please see Soil Moisture Technology and Irrigation Management in the Fall 2014 issue of *From the Grove*. There are numerous suppliers of soil moisture sensors and grove monitoring systems on the market, a few of which are listed at the end of this article on page 24. Regardless of which system or type of sensor you use, the information they provide you and how you use that information is similar.

In June 2015, Crop Production Services (CPS) donated a weather station with soil moisture sensors to the Commission for use at Pine Tree Ranch. Since then, Decagon has also donated a soil moisture monitoring system to the ranch. The data shown and discussed in this article is from the CPS system, but again, it is how you use this data that is important, not which system you use.

The systems installed at Pine Tree Ranch both use capacitance

type dielectric sensors placed at four depths — 4 inches, 8 inches, 12 inches and 16 inches — to cover the avocado root zone. These sensors use the capacity of the soil to conduct an electrical charge between two probes. The more moisture in the soil, the greater its capacity to conduct electricity and vice versa. Both systems at Pine Tree Ranch also have soil temperature and electrical conductivity (salinity) sensors built into them. The data from these sensors is reported as volumetric water content (VWC).

VWC is the volume of water in a given volume of soil and is expressed as a percentage. Thus, a VWC reading of 50 percent means that for every given volume of soil half of that volume is water (e.g., a 1 cup soil sample with 50 percent VWC would contain ½ cup of water). The range of VWC readings will vary based on your soil's composition. Typical sandy loam soils have plant available water at values between about 15 percent and 25 percent. The amount of plant available water (i.e., the span between PWP and field capacity) is dictated by your soil's texture. For example, a very sandy soil may only have plant available water between VWC values of 10 percent (field capacity) and 5 percent (PWP), whereas a very loamy soil with high organic matter content may have a range from 35 percent to 15 percent.

## The Data

The VWC content data for July 2015 is shown in Figure 2. The upper graph shows the readings from all four sensors at the four different depths. The lower graph shows the average VWC over the four sensors. The green and red horizontal lines on the lower graph in Figure 2 represent the approximate upper and lower limits, respectively, of plant available water.

Looking at graphs like these tell us several things. First, irrigation (or rain) events are seen as sharp spikes. The very steep, rapid drop in VWC immediately following irrigation is free drainage of the large soil pores as the soil comes to field capacity. When the VWC reading goes above field capacity, leaching is occurring. Leaching is a necessary part of managing avocados for many growers in order to manage salinity levels. However, having data like these can help you to better manage your leaching and minimize excess leaching and water waste. The inverse of this is seen where the VWC dips below the red line. When VWC is below the red line, the trees may be struggling to take up water.

By looking at the graphs of the four different soil depths you can see that there is a lot of fluctuation in VWC at 4 inches. This is largely due to evaporative loss from the soil's surface. Applying a good mulch layer could reduce this fluctuation. You can also see that the soil moisture is depleted the quickest at 8-inch and 12-inch depths, whereas the 16-inch sensor consistently shows the highest VWC between irrigation cycles. This is likely because the trees where the sensors are located were planted in the summer of 2014 and they don't yet have a lot of roots at the 16-inch depth.

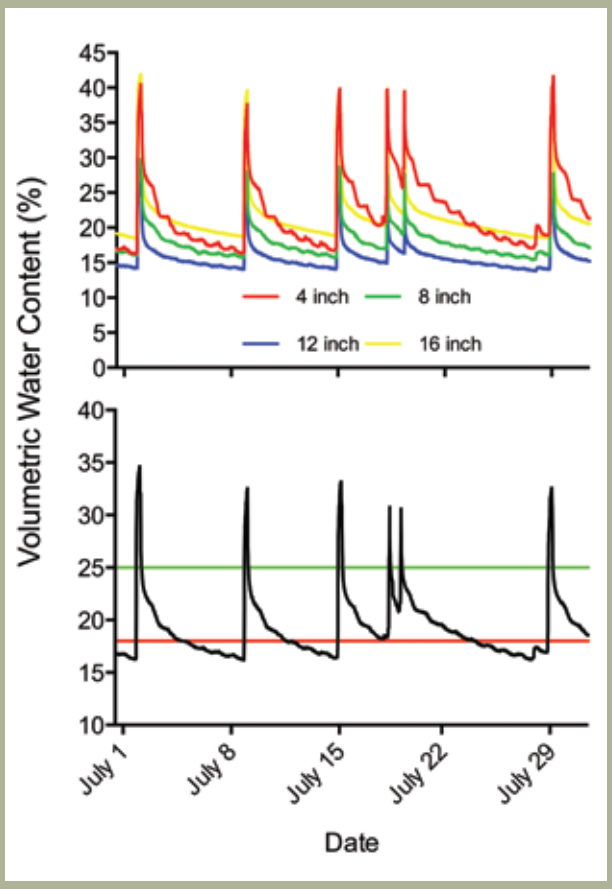



*Figure 2. The soil volumetric water content at Pine Tree Ranch during July 2015. The top graph shows soil moisture readings from four different depths. The lower graph shows average soil volumetric water content and the field capacity (green line) and permanent wilting point (red line) levels.*

## Using the Data to Improve Management Practices

Installing a bunch of sensors in your grove is not going to do anything to improve the health and performance of your trees unless you use the data to change your management practices, but how?

The first, and given the current drought situation, most important thing soil moisture data can help you do is minimize water wastage. For example, the graphs in Figure 2 show that because of the very gravelly nature of the soil at Pine Tree Ranch, the water infiltrates very quickly and fills the soil profile. If we were to zoom in on these data we would see that none of the four sensors ever exceeds a value of about 40 percent VWC, which indicates soil saturation. Once we know this, we can use this information to guide our irrigation by watching our deepest soil moisture sensor — in this case 16 inches.

When our deepest sensor reaches 40 percent, any water we apply will simply push the water in the profile down below the root zone. In the case of Pine Tree Ranch, this typically occurs after two hours of irrigation. The effects of over-irrigation become even more critical if nutrients are being injected. Any nutrients leached below the root zone are literally money down the drain.

The second thing soil moisture data allows us to know is whether we are waiting too long between irrigations. This is indicated by the VWC dropping below the red line on the lower graph of Figure 2. The danger of waiting too long between irrigations is that the trees may actually be experiencing mild drought stress, even if they are not showing any signs of wilt. Drs. Ted Hsiao and Kent Bradford at UC Davis compiled the data from numerous drought stress studies and developed a generalized ranking of plant responses to moderate drought stress. They found that wilting was the fifth response after restriction of canopy development, increase in root growth relative to shoots, osmotic adjustment and stomatal closure. So what does this mean in the real world? It means that the tree is changing its allocation of resources from fruit growth to other processes (e.g., root growth) in order to deal with drought stress. And even though these periods of stress may be transient, their effects accumulate over time and can significantly affect yield.

In the case of Pine Tree Ranch, the data from these soil moisture sensors suggest that shorter duration irrigations more frequently may be better for optimal tree growth and water use.

## Can You Really Grow Trees Successfully Based on Soil Moisture Data?

The short answer is yes. In Florida, Dr. Arnold Schumann conducted a study to test whether he could increase the growth and productivity of citrus trees by intensively managing the trees using soil moisture sensors to dictate when to irrigate. This experiment went as far as to have all of the irrigation valves and well pump controlled electronically to turn on and off automatically based on sensor data.

In this case, only two soil moisture sensors were used, one at 4 inches and one at 18 inches. When the sensor at 4 inches indicated the soil was dry the irrigation would turn on. When the sensor at 18 inches detected the irrigation water the system would shut off. Bearing in mind that Florida's soils are extremely sandy, Figure 3 illustrates what a typical day's irrigation in summer looked like. The irrigation turned on and off multiple times per day for very short periods (about five minutes) in order to maintain the soil moisture level as close to field capacity as possible. (In heavier soils with better water holding capacity such frequent irrigations would not be necessary.) During the night, when the tree's stomates are closed and no water is being used by the tree there is no need to replenish the soil moisture. By keeping the soil as close to field capacity as possible, the tree always has access to "easy" water.

In the case of this Florida citrus study, the trees also were fertigated every day with very dilute fertilizer (about 150 ppm N). The entire system was based on the concept of "open hydroponics" put forth a number of years ago by a Spanish professor named Rafael Martinez. Essentially, by very intensively managing the water and nutrients supplied to the tree, the soil becomes little more than a physical support system for the tree. The goal of growing trees this intensively is that whatever is applied to the tree today is taken up today and incorporated into the structure of the tree.

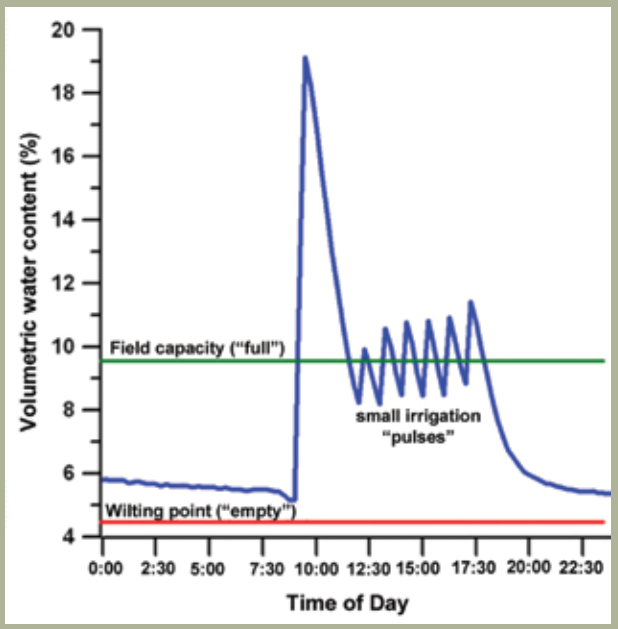



*Figure 3. A typical daily soil volumetric water content graph for a citrus trial in a sandy soil in Florida. The graph illustrates how multiple small pulses of irrigation were used throughout the day to maintain the soil near field capacity and minimize tree stress.*

The trial in Florida compared the intensively managed trees on drip irrigation with fertigation to conventional grower practices (microsprinklers and dry fertilizer application) and a hybrid system using microsprinklers with fertigation. The entire trial was 15 acres with replicated plots of ½ acre each.

The results of this trial after 2.5 years are shown in Table 1 on page 24. In absolute terms, the intensively managed trees did not save a lot of water. However, because the trees experienced virtually no drought stress, they grew much more quickly and have a 50 percent larger canopy after

## Table 1.

| Cumulative water and nitrogen fertilizer applied, and citrus tree canopy growth over 2.5 years. | | | |
|---|---|---|---|
| | Grower Standard | Microsprinkler | Drip |
| Irrigation water (gal/acre) | 133,718 | 143,242 | 103,422 |
| Fertilizer N (lb/acre) | 253 | 64.3 | 47.5 |
| Canopy volume ($ft^3$/acre) | 27,523 | 36,705 | 41,464 |
| Water efficiency ($ft^3$ of canopy/1000 gal water) | 205.8 (1x) | 256.2 (1.24x) | 400.9 (1.95x) |
| N efficiency ($ft^3$ of canopy/lb N) | 108.8 (1x) | 570.8 (5.2x) | 872.9 (8.0x) |

2.5 years. This resulted in a water use efficiency ($ft^3$ of canopy per gallon of water) of almost twice the grower's standard practices. In addition, by "spoon" feeding the fertilizer to the trees every day and ensuring that a minimum of leaching occurred, the nitrogen use efficiency was eight times higher in the intensively managed trees. The hybrid system using microsprinklers with daily fertilizer injection improved water use efficiency by 25 percent and nitrogen use efficiency by 5 times.

Not every grower is going to be able to afford a myriad of sensors, electronic valves and computer control systems to manage their irrigation. However, the data from soil moisture sensors can be used to modify your irrigation practices to achieve modest water savings by minimizing excess irrigation (except as needed to manage salinity), and improve tree growth by minimizing the drought stress the trees experience between irrigations. When these changes are coupled with improved fertilization practices tree growth, yield and health can be improved immensely.

The following is a short list of some of the companies who manufacture soil moisture sensors and environmental monitoring systems. Some companies offer basic systems and others offer very complex systems that can monitor many different environmental conditions. All of them offer data loggers that connect to their sensors and can send data to your computer by Wi-Fi network, cellular connection or manual download. All of these companies can provide systems that will provide you with the basic soil moisture data described in this article. Which, if any, system you choose will depend on your budget, the size of your grove and what you are trying to accomplish. Each of these companies has a very competent technical support department that can help you design a system to best suit your needs..

### Spectrum Technologies, Inc.
Aurora, IL
800-248-8873
http://www.specmeters.com/

### Onset Hobo Data Loggers
Bourne, MA
800-564-4377
http://www.onsetcomp.com/

### Decagon Devices
Pullman, WA
800-755-2751
http://www.decagon.com/

### CPS Crop Connect
Madera, CA
559-479-2138
http://cropconnect.com/weather/

### Anything Weather Communications
Palm Desert, CA
800-845-0383
http://www.anythingweather.com

*By David Crowley, Salvatore Campisi, Julie Escalera, Carol Lovatt, Philippe Rolshausen and Mary Lu Arpaia*

# Decision Support Tools for Avocado Fertilization & Salinity Management: Preview to the Final Project Report

Over the past five years, the California Avocado Commission (CAC) has funded a project to develop Decision Support Tools (DST) that can be used by avocado growers to better manage avocado fertilization and the effects of soil salinity on avocado yields and fruit quality. In order to research fertilization best practices, we utilized data from hundreds of trees over several years and across a transect of the major avocado production areas in Southern California.

Using advanced statistical methods and artificial neural network models, we utilized the data to decipher the patterns in leaf nutrient analysis data and determine how different elements affect crop yields. The project also examined variations in the salinity tolerance of different rootstocks and the extent to which damage caused by chloride accumulation in the foliage can be offset by managing tree nutrition.

This project is now in the final phase of data analysis, and a number of interesting and important findings are emerging from the data set. In this article we report a preview of our findings and the type of information that will be provided in the Decisions Support Tools. When successfully deployed, growers will be able to evaluate the cost-benefit of various management practices and determine how to optimize their economic return.

## Deciphering Interaction of Variables Affecting Fertilization

Current recommendations for avocado tree fertilization are based on guidelines that were originally developed for citrus and have since been modified by various plant testing laboratories. While California avocado growers have utilized these guidelines with some success, it has been difficult to obtain specific avocado fertilization recommendations based on actual data linked to yield.

This is due to the high cost of leaf analysis and sampling at the block level as opposed to sampling and yield measurements for individual trees. There is also high variability in avocado yields from one year to the next due to alternate bearing, as well as high variability in the leaf nutrient status of trees within the same orchard and along the row due to microsite conditions affecting root growth, soil conditions and fertilizer distribution. Variables such as irrigation water salinity, chloride toxicity, use of different rootstocks — and the interactions between these variables — obscure the relationship between yields and leaf nutrients. Sorting out this natural variability is a huge challenge and is compounded by the fact that in many cases leaf and soil analysis reports are archived but seldom used.

Fortunately, it is now possible to solve this problem by taking advantage of powerful new statistical methods and machine learning methods to establish linkages between independent and dependent variables. These new methods allow researchers to examine the relationships between plant nutritional status and fruit yields, salinity effects on fruit quality, or irrigation water quality and soil water status on chloride toxicity.

The traditional approach to crop modeling over past decades has been to set up trials in which all vari-

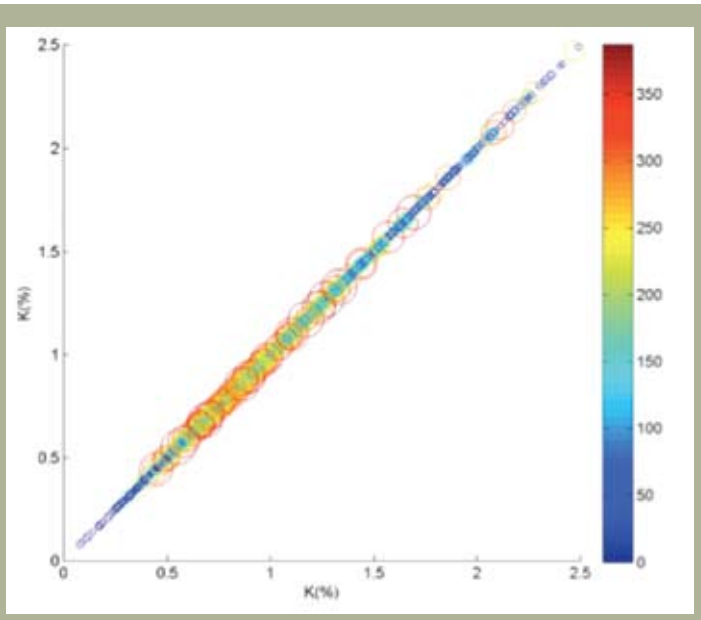



*Figure 1a*

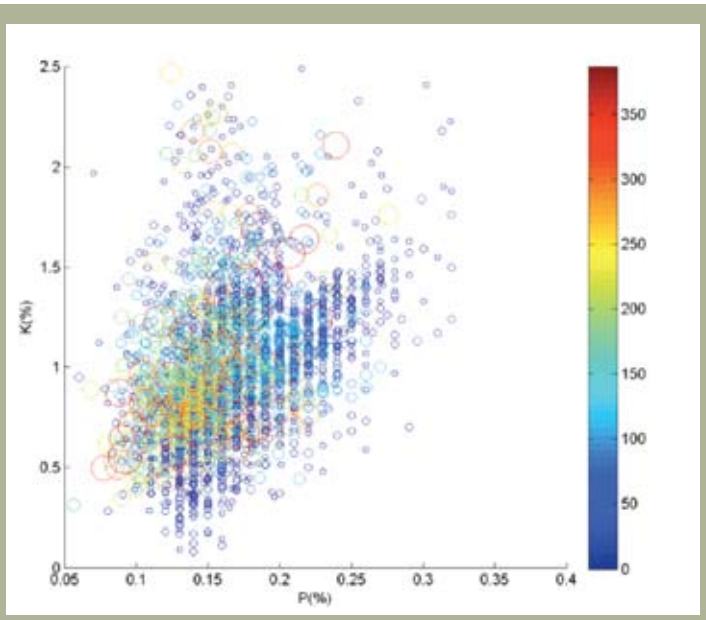



*Figure 1b*

*Yields of avocado as affected by leaf potassium content (left, Figure 1a), or by the interaction of leaf potassium and leaf phosphorus contents (right, Figure 1b). Yields are denoted by color and size of the circles representing individual trees. Approximately 3,000 data points are included in the plots, which clearly illustrate an optimum range of 0.5 to 1.3 percent for potassium, but which centers at 0.8 percent potassium when phosphorus is at 0.15 percent.*

ables are controlled except for one variable of interest, e.g. same rootstock and soil but different nitrogen fertilization amounts. In comparison, our approach has been to acquire a data set that reflects the full range of variation that occurs within the avocado industry. The DST project collected data on 15 trees per available rootstock in 12 orchards located on a transect from San Diego to San Luis Obispo. In the nutrient analysis research that is highlighted below, we included several additional unpublished data sets from Carol Lovatt that include leaf analysis and yield data for individual trees and over multiple years.

## Determining Target Ranges for Nutrients

Preliminary workup of the data shows that all the data sets have similar distributions and variances, which allows us to conduct a meta analysis of the combined data. We began by identifying the nutrient yield relationships and studying the interactions between individual combinations of nutrient elements.

Figures 1a and 1b plot fruit yields as colored circles of increasing size corresponding to increasing yield and identify leaf nutrient levels that are associated with the best tree yields. Small blue circles represent low yielding trees with approximately 50 kg of fruit per tree. Large red circles represent high yielding trees with 300 kg of fruit per tree or more. Figure 1a reveals the range where a single element is optimal — in this case potassium. In Figure 1a, we see that the yellow and red circles representing high yielding trees span from 0.5 to 1.2 percent potassium, but note that the central target is ~0.8 percent for most trees.

Figure 1b plots potassium versus phosphorus in a scatter diagram. In this figure, the clustering of yellow and red colored circles show that both potassium and phosphorus should increase together to maintain high yields, with potassium at a near optimum level for most trees at 0.8 percent and phosphorus at 0.15 percent. As phosphorus increases above 0.2 percent, there are no high yielding trees, illustrating the potential for overfertilization or nutrient imbalance that causes a yield loss.

Another method of data analysis — referred to as "frontier" or "envelope" analysis — plots the frequency of trees with a specific nutrient content along with a corresponding box plot of fruit yields. This method allows us to compare the current industry yield average versus the yields that could be obtained by bringing the trees to their optimal nutrient levels for individual nutrients or nutrient ratios.

Figure 2 illustrates the relationships between leaf sulfur content and tree yields. The results clearly show that increasing sulfur to 0.55 percent is associated with a 40 lb/tree yield increase as compared to the majority of trees in the data set, which had an average of 0.33 percent leaf sulfur. While yield responses to deliberate sulfur fertilization have not been tested for avocado, these results are especially intriguing given the results many growers are observing by using sulfur burners to control soil and irrigation water pH.

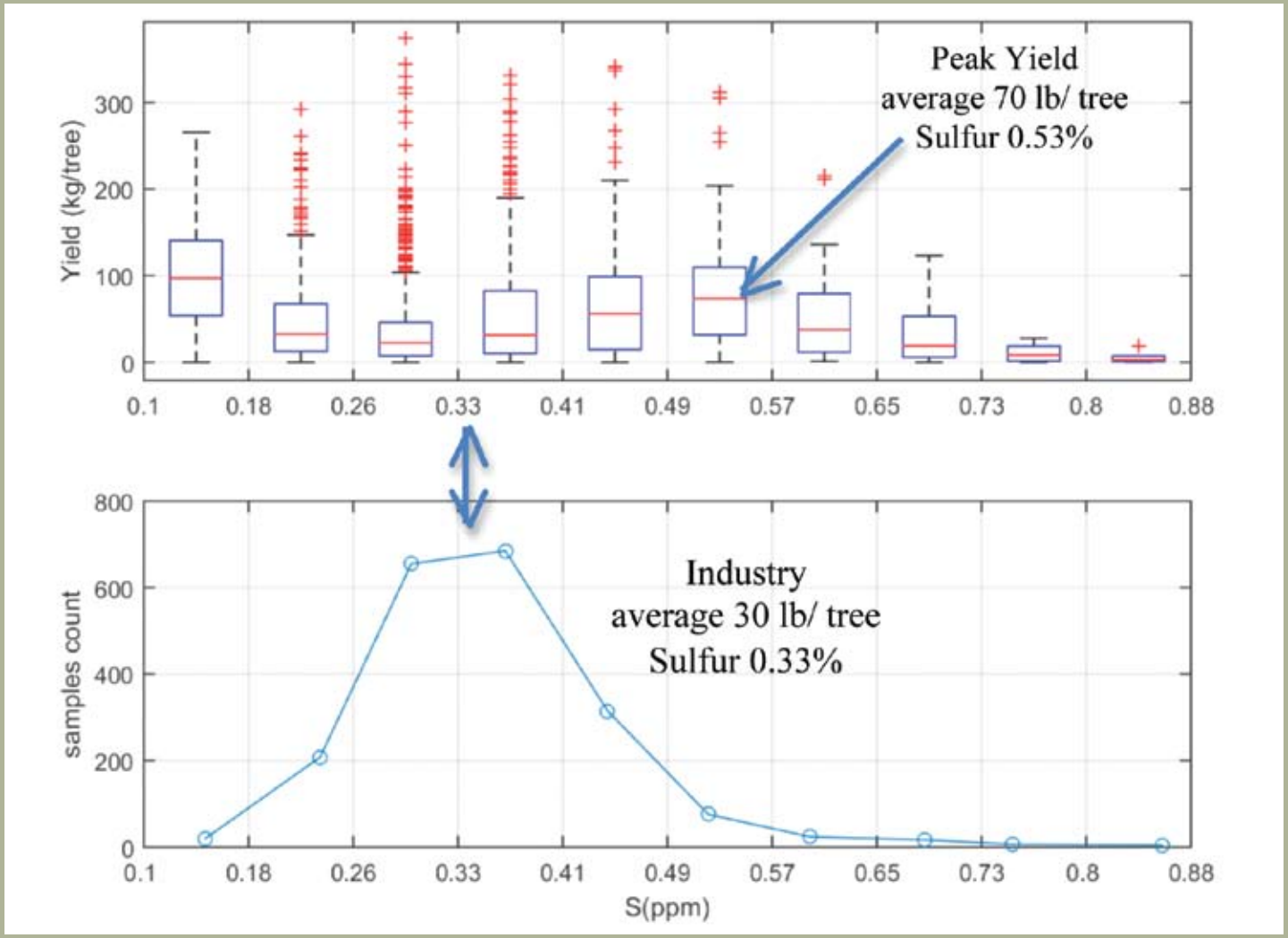



***Figure 2***

*Frontier analysis showing box plots of yield for trees having different levels of leaf sulfur. The average yield is indicated as a red line centered in each box. The bottom plot shows frequency of trees in each sulfur level category. The majority of trees in the study had ~0.33 percent leaf sulfur, versus trees with peak yield occurring less frequently and having 0.53 percent leaf sulfur. Data suggest sulfur is limiting for most trees in this study and probably also for the avocado industry in general.*

Based on analyses to date, we can now confidently provide new target ranges for leaf analyses that can be used to guide avocado fertilization programs. As shown in Table 1, the values for several elements vary substantially from earlier recommendations and current industry conditions. In general, most trees were in the optimum range for nitrogen, phosphorus, and potassium, but were deficient in calcium, zinc, manganese, boron and sulfur. We also can predict yield losses as nutrient levels exceed the optimum values.

While powerful statistical tools allow us to mine the data set for optimal ranges, the results of our analyses have revealed that there are multiple interactions between different nutrient elements. In other words, as certain nutrients go up yields can be further increased by reoptimizing other nutrients to obtain the optimum nutrient ratios. Using clever plotting methods (see Figure 1), we can visually evaluate how different combinations of two nutrients affect yields. However, the problem becomes much more complex when optimizing all of the elements at the same time. In this case, a multidimensional nonlinear pattern analysis is required in which a model is trained to fit real world data, and then validated with new data that it has not seen before to determine how well the model works. Once validated, the model then becomes a working tool that can be used to predict yields based on the equation that weights the importance of each input variable to predict the output variable — in this case, yields. The ability to apply these tools for avocado modeling is very new and has been made possible by the availability of machine learning software that is used for applications such as market analysis, handwriting and voice recognition.

The DST project is the first to

use artificial neural network (ANN) models for crop modeling. Preliminary results from our first ANN models have been described in reports available on the CAC website. The major focus has been establishing leaf nutrient relationships with yield and the effects of chloride on avocado yields. However, the ANN modeling approach has many applications. For example, last year while examining the effects of salinity on fruit quality we determined that high chloride content in the fruit is associated with a greatly decreased ripening time after the fruit is removed from controlled atmosphere storage. This suggests that fruit from salinized orchards will have a much shorter shelf life. Correspondingly, we observed that increasing tree calcium levels (measured as leaf Ca content) is associated with increased ripening time and a greater shelf life. These results are now being confirmed in a repeat test of fruit from trees that have been subjected to different levels of chloride and different nutrient management regimes.

## Salinity Management

Avocado is the most sensitive of all horticultural crops to salinity and a major challenge for the industry is developing recommendations for irrigation management that will save water while making use of increasingly saline groundwater supplies. In the DST project we have focused much of our data collection and analysis on the effects of chloride toxicity, which is the major hazard associated with use of saline water. To model this relationship, we installed soil probes that continuously monitor soil aeration, water availability and electrical conductivity (salinity) of the pore water solution for trees located in different soils in the DST project sites.

Our research shows that high yields can be maintained at leaf nutrient analysis values as high as 0.5 percent for leaf chloride, but this becomes increasingly difficult to achieve as irrigation water chloride levels go above 80 parts per million. We also have established that there are many nutrient interactions that affect fruit yields as chloride levels increase in the trees. One of the surprise discoveries has been that root hypoxia caused by waterlogging appears to have a major impact on the amount of chloride uptake by avocado. This has been observed in many crops, but never quantified for avocado, and illustrates the interactive effects of irrigation management and fertilizer management. These effects are still being examined in detail by Ph.D. student Julie Escalera, who is modeling soil aeration status in relation to leaf chloride content for her dissertation research.

As we complete our analyses during the final year of the project, we will continue to report additional details and findings from our modeling work and statistical analyses. It has been especially useful to bring to bear complementary statistical approaches to confirm the main results from the predictive, but much more complicated, ANN models. ANN models are especially powerful for multifactor optimization, but can also be regarded as black boxes and require careful dissection to confirm predicted relationships. Advanced statistical methods such as frontier plots allow us to see how particular interactions play out when examined closely.

The tools developed by the DST project should be of high value to avocado growers and provide an innovative new toolbox for crop modeling in general. When the DST equations are deployed, a web-based user interface will provide user-friendly toolset where yield predictions can be generated based on model software programs.

| Nutrient | Optimum Range | Highest Frequency |
|---|---|---|
| N (%) | 2.25-2.9 | 2.25-2.7 |
| P(%) | 0.1-0.15 | 0.15 |
| K (%) | 0.7-0.9 | 0.9 |
| Ca (%) | 1.8-2 | 1.4 |
| Mg (%) | 0.6-0.9 | 0.5-0.6 |
| Zn (ppm) | 50-80 | 34 |
| Mn (ppm) | 110-145 | 75 |
| Fe (ppm) | 55-80 | 55 |
| Cu (ppm) | 4-7 | 9 |
| B (ppm) | 38-60 | 25 |
| S (ppm) | 0.45-0.53 | 0.3-0.37 |
| | In excess | |
| | Good | |
| | Deficient | |

**Table 1**

*Table 1. Optimum ranges of leaf nutrient levels for avocado versus the range of elements found in most trees in a meta analysis of several avocado data sets where yield and nutrient data were available for individual trees.*

*By Tim Linden*

# Water to Play Big Role in 2016 Crop

The fruit is on the trees but will it size and survive the rigors of the fall and winter? These are the million dollar questions that will be answered in the coming months.

"I've heard everything from 350 million pounds to 500 million pounds," said Mission Produce Inc. Sales Category Manager Dave Fausset, talking of the 2016 California avocado crop.

Fausset, who sits on the Hass Avocado Board, has been exposed to many different predictions, but he said water will tell the tale. "Whether it's 375 million, 425 million or more will depend on the rain we get. We need to get rain and not all at one time. If we get some good rain spread out over time, the crop will size and next year we will be rockin' and rollin'."

He believes the low end number – 350 million pounds – will only be accurate if there is no rain or if other weather factors adversely influence the crop, such as heat in September or wind in October or beyond.

Others interviewed had similar viewpoints.

Rob Wedin of Calavo said estimators seem to be predicting a significant crop increase, with the final figure falling in the 350-400 million pound range. He said many factors will go into that final number, including when and how much rain comes. "We are going to have to deal with that but I think it's unwise to complain about rain," he said, clearly taking into account California's four-year drought.

Bob Lucy of Del Rey Avocado Co. said an initial estimate of 385 million pounds would mean a crop of about 100 million pounds more than this year. He said growers in the northern growing districts seem to have a very heavy set, while it is closer to average in the southern districts. Del Rey is intimately involved in marketing the fruit from the Morro Bay region and Lucy said it appears those growers will have a very nice crop in 2016. Those tend to be the latest California avocados on the market. As he spoke in early September, with the rest of California completing its harvest, Morro Bay still had at least three more weeks left of its season.

## The 2015 Crop

Lucy characterized 2015 as a good year for most growers. Though the crop was smaller, he said the industry "did a heck of a job marketing it, especially early on."

The Del Rey executive serves as chair of the California Avocado Commission Marketing Committee and he said Jan DeLyser and her CAC team did a great job of target marketing the fruit to willing retailers. He said this group included most California retailers, who capitalize on the locally grown aspect, but Del Rey has many other retail customers across the country that also see value in the California brand. "Our philosophy is to give the buyer a choice. Let them choose what they want. Just like when they buy wine, there are a lot of different options."

All in all, Fausset of Mission said 2015 proved to be a pretty good year, especially for the growers that harvested their fruit early. He said there was very good movement on the California crop during the heavy promotional time period from Cinco de Mayo to 4th of July. "We had a little trouble in late July and August as Mexico had a very big flora loca crop, which caused the price to fall."

Fausset noted that the overall volume of avocados moved in July – more than 200 million pounds – made it the largest-ever single month for avocado consumption in the United States.

While California moved a lot of its avocados in the first six months of the year, Fausset is not ready to call that the "new normal." He said that in a short year, which does describe


2015, the best window for California fruit is in the spring to early summer period. "But remember Mexico's flora loca crop was the biggest ever; it's not always going to be that way."

Kellen Newhouse, director of global sourcing & international business development for West Pak Avocado Inc., called the 2015 California crop year "a great success." He noted that going into the year, many were apprehensive about the size of the Peruvian crop and how the timing of those imports would shift pricing and the picking window for California fruit. "Even though a lot of fruit was picked early and the season ended historically early, California growers enjoyed great prices throughout the season," he said. "The window for California fruit is changing depending on its crop size and the crop size of Mexico and Peru. For California growers it will be important to continue to be dynamic and understand the global picture for the best returns."

Wedin was like-minded, noting that the early, aggressive movement in 2015 worked very, very well. But he cautioned that every year is different, and what works for one year's set of circumstances may not be the same the next year.

Looking strictly at the numbers, he said for Calavo, California volume was up 12 percent, while the average price per pound fell only 9 percent. From an economic model standpoint that means more dollars in the grower's pocket, which means a fairly solid year. Wedin did credit the early movement in March, April and May with creating a fairly good year throughout. That early, heavy movement allowed many growers to avoid the lower prices that came in July and August.

For 2016, if the large California crop does materialize, Fausset expects that it will hit the market earlier with some January sales.

Wedin believes California growers will be aggressive early next year, especially if El Niño delivers a lot of early rain, but he said how that plays out will also be a function of the imports. Mexico also has a big crop on its trees, and it is expected that more acreage will be certified for U.S. export, including some in the state of Jalisco.

## California's Premium Fruit

The California avocado label program, initiated by the California Avocado Commission, has proven to be successful and it does differentiate California's crop leading to premium positioning.

Fausset said Mission missed its window a bit on securing the labels for 2015, so in 2016 it will be a focus of the firm. "Absolutely there are plenty of customers who prefer California fruit."

He said the high-end supermarkets that have no trouble paying the premium price are prime targets for the program, but so are retailers across the board. "Even Costco and Walmart want to embrace the locally grown concept," he said.

Lucy said for many retailers, a premium California avocado makes a lot of sense for their customers. "The California name has a lot going for it. It has a positive stigma of being a trend-setter. And the California avocado is also fresher and has the local angle."

Again, he noted giving the consumer a choice is a great marketing strategy.

Wedin said California has an excellent piece of fruit that is worthy of a premium strategy effort. He wondered however, if there is the money available – from the industry – to make that case to the consumer. He said the trade loves California fruit during the California season and remains very loyal to the brand. But he is not sure they or the consumer are willing to pay extra for the fruit.

In addition, there are other countries in the market who are able to sell their fruit at significantly lower prices, in the midst of the California season, causing the California industry to deal with this downward pressure on their price.

With regard to the effort of giving California fruit a premium spot in the marketplace, Newhouse of West Pak applauded CAC for "doing an outstanding job of positioning the California avocado for the future. This year was an example of a smaller crop that had strong pricing throughout the season despite what the import market was doing. There will be small crops and we will still see bigger volume crops out of Cali-

fornia but I do believe that CAC will position itself year to year to deal with the size of the crop and position the marketing with key retailers in the best way for the growers."

## Total 2016 Crop

For the first time ever, U.S. consumption of avocados is forecast to top the two billion pound mark when the final chapter is closed on 2015. But even after reaching that lofty number, further growth is expected. Fausset said that for budgeting purposes, the Hass Avocado Board has estimated a U.S. sales number of 2.25 billion pounds for 2016. "I think it will be more than that but for budgeting purposes we don't want to over shoot it."

He said the two billion pound mark will be hit this year even though Peru actually decreased its shipments due to a strong European market. With U.S. production expected to be up significantly next year, and new Mexican states joining the party, a forecasted 10 percent increase in consumption is very conservative.

In fact, Fausset believes that the only thing that will hold back U.S. consumption to 2.25 billion pounds is a very strong world market that drives up the price and puts a bigger demand on supplies moving elsewhere.

Wedin believes the U.S. market can absorb a 15 percent volume increase on an annual basis with little disruption. However, he said 2016 volume could jump higher than that if California's production is greater than expected, because Mexico is also looking at a big crop. But Wedin believes retail can move 2.5 billion pounds with promotional pricing. With 10-15 percent annual growth in volume that hasn't been necessary, but if the stars align and more product needs to be sold, he believes the retail price will drop to levels necessary to move the increased volume. He reasoned that retailers operate in a competitive environment and will do what's necessary as avocados have become a very important staple in the produce department.

West Pak is taking a more conservative guess as to the size of next year's crop. "The 2016 California avocado crop looks bigger than this year's crop," said Newhouse. "Trees are set heavy but we have a long time between now and the start of the season. With good rains and a mild winter we could see a strong crop for 2016 that is north of 350 million pounds. With a larger crop I see the California window expanding back to its more natural range of spring until fall."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# PSHB Research Update

By Tim Spann
*Research Program Director*

Although we haven't seen the rapid expansion of the polyphagous shot hole borer (PSHB) infestation in San Diego County that was feared, it doesn't mean that our researchers have been any less active in trying to find solutions. Significant, positive advancements have been made in the search for chemical control solutions for PSHB and Fusarium Dieback, as well as in the refinement of the trap and lure being used to monitor for the beetle.

### *Section 18 Emergency Exemption Application*

Since PSHB emerged as a threat three years ago, one of the Commission's primary goals has been to develop management tools for avocado growers. This includes both chemical (pesticides, fungicides) and non-chemical (chipping, solarization) approaches. As every grower knows, getting new pesticides registered —even in emergency situations —is a long and tedious process. After carefully considering the pesticides currently registered on avocado, evaluating information from Israeli scientists about their experience with PSHB, and discussing redbay ambrosia beetle strategies used in Florida, the decision was made to pursue two section 18 applications — one for a pesticide and the other for a fungicide.

The pesticide chosen for a section 18 is Hero®, which contains the active ingredients bifenthrin and zeta-cypermethrin. This product was selected for several reasons. First, zeta-cypermethrin is already registered for use on California avocados in the form of Mustang® so we didn't need to seek permission for use of one of the active ingredients. Second, Hero® is likely a couple of years away from full EPA registration – it is currently in the IR-4 process for full registration and all of the residue analyses have been completed. Lastly, and of critical importance, the section 18 request has strong support from Hero's® registrant, FMC.

Over the past year, a small team led by Drs. Joe Morse and Frank Byrne at UC Riverside has been working diligently to acquire the necessary efficacy data to submit with the section 18 application. To say this has been a challenging process is an understatement. These beetles are difficult to work with and many of the trials had high control mortality, often masking the pesticide effects. However, the team persevered and got the job done. We are happy to report that the completed Hero® section 18 packet arrived at DPR's office in Sacramento on September 3 and is under review. Without any unforeseen pitfalls, the process should take about three months, so we are cautiously optimistic that we will have a positive outcome by year's end.

Our focus will now shift toward developing the section 18 packet for Tilt® fungicide. Tilt® has been selected because it, too, is already in the IR-4 program and has strong support from Syngenta. Dr. Akif Eskalen is heading the efficacy trials on Tilt® and other fungicides, and as soon as he has assembled the necessary efficacy data the Commission will proceed with the section 18 application.

### *New Names for Fungi and San Diego Beetle*

The Commission held two shot hole borer update meetings in Escondido and Santa Paula on September 1 and 2, respectively. Dr. Stouthamer, who has been working on determining the origins of the shot hole borer populations in California and their correct identification, proposed a new common name for the San Diego population of the beetle. According to DNA analysis, the San Diego beetle is probably a distinct, but closely related, species from the L.A. population. Dr. Stouthamer has named the San Diego beetle the Kuroshio Shot Hole Borer (KSHB). The name comes from the Kuroshio Current that flows between the beetle's native islands of Taiwan and Okinawa.

Dr. Eskalen also reported that the *Graphium* and *Acremonium* species of fungi associated with PSHB have been formally named. The two fungi are now known as *Graphium euwallaceae* and *Acremonium pembeum*. Not to be outdone by Dr. Stouthamer's creativity, Dr. Eskalen chose to name the *Acremonium* species for its pink color using his native Turkish language — pembe.

While these official names are of relatively minor importance to growers, officially naming new species is important scientifically. A new species name cannot be proposed until a detailed description of the species and its biology has been completed. Thus, the official naming of these species means the researchers have a fairly detailed understanding of the beetle and fungi and have collected a lot of data integral to understanding how to control them.

### *Trap and Lure Improvements*

At the early September meetings, Dr. Stouthamer presented new information concerning the traps and lures we have

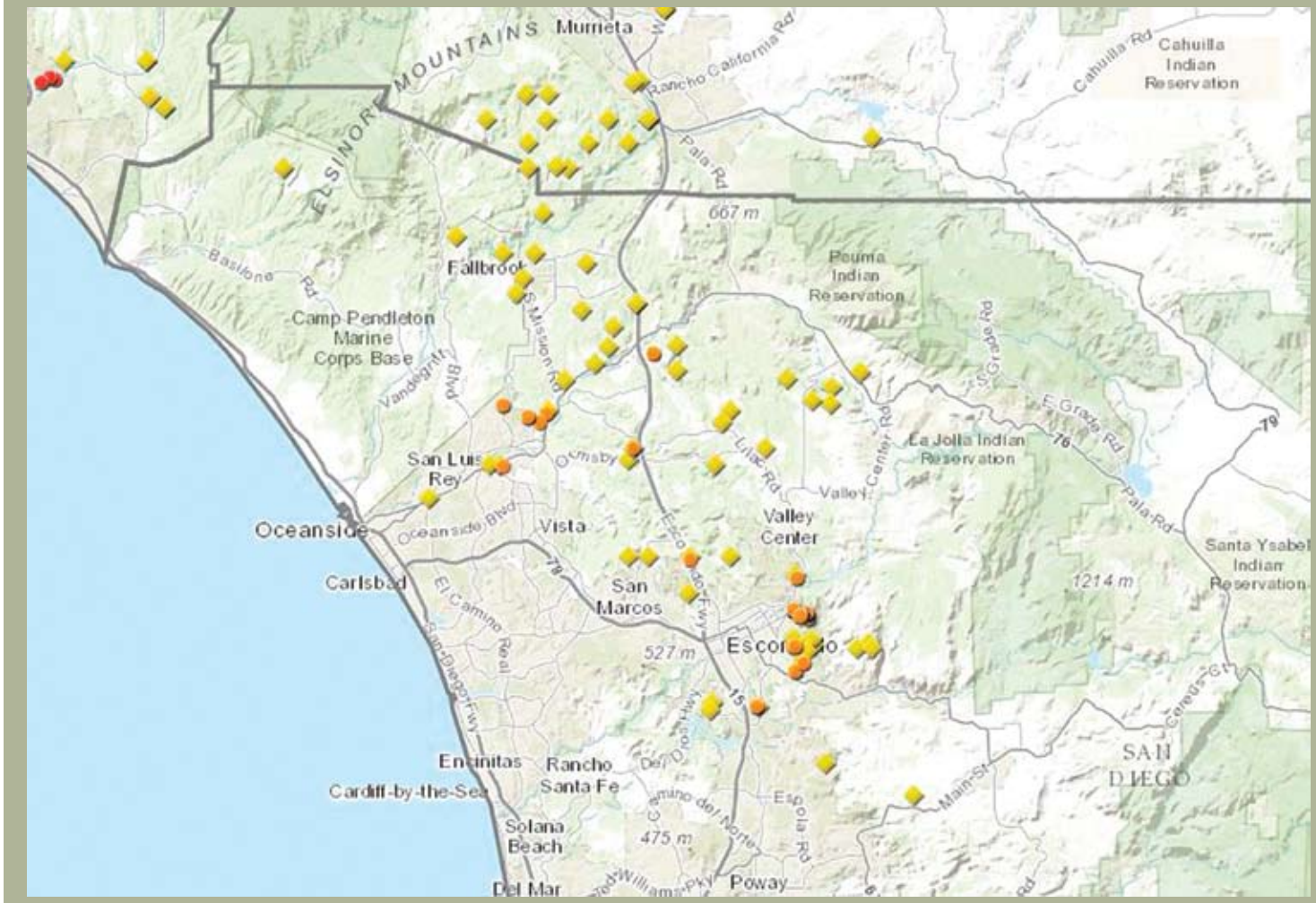



*Figure 1. The distribution of the Kuroshio shot hole borer (San Diego population) remains relatively confined to the Escondido and Bonsall areas of northern San Diego County.*

been using to detect PSHB. The Commission has been funding Dr. Stouthamer to test various trap designs and lures and he has made some important discoveries, especially if you have invested in a trap and are checking it yourself.

Quercivorol, a chemical that is produced by the beetle's fungal symbionts and serves as an attractant, is used as the lure. Currently, one lure is used per trap, but Dr. Stouthamer ran tests to determine whether multiple lures would be even more attractive. He discovered that trap capture actually declined when two or three lures were placed on a trap compared with one lure. He is now working with the lure manufacturer to produce a half strength lure to see if it will be more effective than the current full strength lure.

Because many bark beetles are attracted to ethanol, Dr. Stouthamer also examined whether adding ethanol to the traps in combination with the lure would increase their effectiveness. He found that ethanol actually reduces the efficacy of the traps, acting to detract the beetles rather attract them. In addition, he discovered that some formulations of antifreeze (particularly those used for RV winterization), which is used in the bottom of the traps to preserve the captured beetles, contain ethanol. To maximize trap efficacy, it is very important to make sure that the antifreeze being used in traps does not contain ethanol.

Lastly, the lure currently being used is produced by a company from Canada. However, a Costa Rican company has contacted Dr. Stouthamer to ask him to test their version of a quercivorol lure. In his initial trials, the Costa Rican lure appears to be as effective as the Canadian lure currently used. The hope is that having some competition in the market will bring down the cost of the lures.

## *Current Beetle Distribution*

One of the points of discussion at the recent PSHB meetings was the distribution of the beetle and the apparent lack of spread that was widely expected to happen this summer. The KSHB (San Diego beetle) remains relatively confined to the Escondido area with a second, smaller area of infestation near Bonsall.

A couple of explanations are possible for the lack of


*Figure 2. The polyphagous shot hole borer (L.A. population) has continued to move steadily northwest, and is now within 1.5 miles of the Ventura County border.*

spread. There may be some native beneficials feeding on the beetle or fungi and slowing their spread. It may also be that the beetle is spreading within groves, but is not moving out of those groves since there are plenty of host trees within the groves.

There is a third possibility that is even more alarming – that growers are not reporting possible infestations. If this is true, it would be extremely detrimental to the industry as a whole. Growers are strongly encouraged to communicate with the Commission or Drs. Eskalen and Stouthamer if they suspect the beetle is in their grove. The Commission has been working extremely hard to garner support from the state and federal governments — both financially and from a pesticide registration standpoint — to combat this pest. However, we cannot make a strong argument if we don't know the full extent of the problem.

On the northern front, the PSHB (L.A. beetle) has continued its slow, steady movement toward Ventura County. The closest known infestation is just north of the 101 freeway between Calabasas and Woodland Hills, and puts the beetle within about 1.5 miles of the Ventura County line. The Commission, in cooperation with the Ventura County Agricultural Commissioner's office, has increased the number of traps along the Ventura County border with the hope of detecting the pest as early as possible.

That said, growers are reminded that the traps and lures being used are not 100 percent effective and have a limited range of attraction. It is of the utmost importance that growers remain vigilant and actively survey their own groves for any sign of this pest. Dr. Eskalen's website (http://eskalenlab.ucr.edu/avocado.html) includes numerous resources to help you identify this pest and provides information on how to submit a sample from a suspect find.

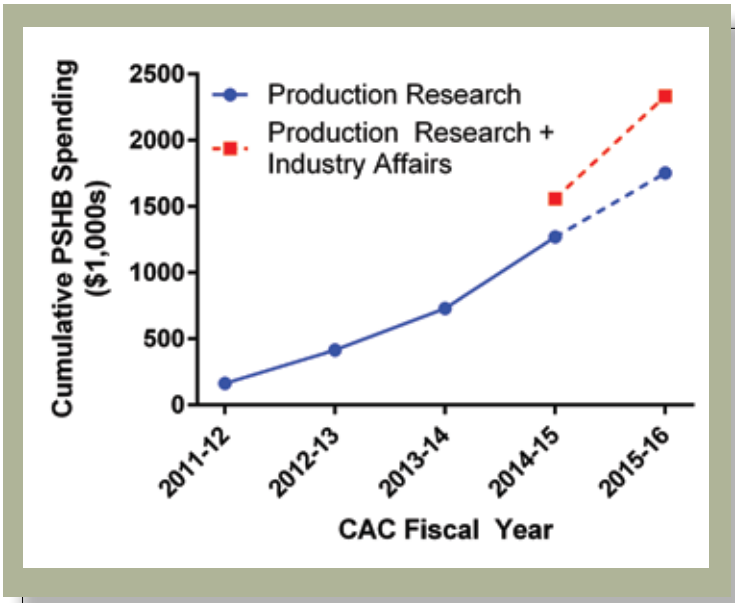
# Commission Relentless in Hunt for PSHB Management Options

By Ken Melban
*Vice President of Industry Affairs*

It has been about a year since the polyphagous shot hole borer (PSHB) was first detected in commercial avocado groves in Escondido, and the Commission remains aggressive in our search for possible control options.

Currently there are 19 groves confirmed to have San Diego beetles — 18 in San Diego County and one in Orange County. The Los Angeles beetle is knocking on the door of Ventura County with multiple finds in ornamental trees near the border, the closest within 1.5 miles. While there has certainly been beetle movement and additional groves are infested, it appears, for now, that the spread hasn't occurred as rapidly as was first feared. But there is a tremendous amount of uncertainty about the behavior of this insect, and it remains a legitimate threat to California avocados. We could wake up tomorrow to widespread infestations throughout the entire avocado industry.

Since 2012 the Commission has funded $1.6 million in research specific to PSHB and Fusarium Dieback (FD), with another $700,000 in project requests for the upcoming 2015-16 fiscal year. Past and current funding for research includes identification of PSHB and FD disease; monitoring for PSHB and FD; assessment of fungicides and biocontrol agents to control FD transmitted by PSHB; evaluation of pesticide and biocontrol agents for PSHB; trapping optimization and possible PSHB attract-and-kill strategies; and the epidemiology of PSHB. In addition, last year, once the beetle was discovered in commercial avocado groves, the Commission immediately launched an early detection program to provide the industry with real time information on the location and movement of the beetle populations.




With this year's smaller-than-expected crop and reduction in projected assessment revenue, the Commission made cuts mid-year to all programs. In addition, over the last few years, the board has worked to methodically spend down the unexpected high reserve that had accrued. At the August Commission meeting, President Tom Bellamore provided the board with preliminary program planning for 2015-16 and possible budget and assessment scenarios. During that discussion, the board began to wrestle with the current level of PSHB/FD spending compared with current budget constraints. Although the board remains committed to pursuing every possible option to manage this pest, they are prudently considering what is sustainable over the next few years. It was the general consensus of the board to stay the current course on the level of research spending, with the understanding that if it became necessary to increase the research funding those monies would need to come from another program.

On September 1 and 2, grower meetings were held in Escondido and Santa Paula. UC Riverside researchers Drs. Richard Stouthamer, Frank Byrne and Akif Eskalen reported on the progress of their research activities. Specific information presented at these meetings can be found in Dr. Tim Spann's "PSHB Update" article. This was the third series of grower update meetings the Commission conducted in the past year, along with multiple email updates. The Commission will continue to provide updates to the industry as more information becomes available.

*Dr. Eskalen educates growers on PSHB/FD identification at a grower meeting on September 2 in Santa Paula.*

By Tim Linden

# Florida Remains a Steady Supplier

With California dominating the avocado market for decades, and Mexico's emergence over the past two decades, Florida's avocado production has often been lost in the shuffle.

In fact, when called to discuss the state's avocado crop, Mary Ostlund, director of marketing for Brooks Tropicals LLC, the largest avocado shipper in the state, joked, "Why are you calling us? California usually doesn't bother with Florida."

Alan Flinn, manager of the Florida Avocado Administrative Committee, said there are about 7,000 acres of avocados in Florida, with virtually all of them green-skinned varieties. "We have 65 named varieties in the state," he said, with virtually none of them the Hass variety.

Ostlund said Hass just doesn't grow in Florida's hot and humid climate, which is much better suited to the thin green skin, than the thick black skin. "If you plant a Hass tree here, it ends up looking like a green-skinned variety," she quipped. "I am unaware of any Hass acreage."

Flinn said that during a typical year, Florida will produce between 800,000 and one million bushels (a bushel being approximately 50 pounds) of fresh avocados, which equates to a crop of 40-50 million pounds. Historical numbers reveal crops as large as 60-70 million pounds. He said the 2015 crop is a bit on the light side.

Florida avocados are shipped 12 months of the year, but most shippers begin sometime in April with peak shipments during the heart of the summer and then tapering off toward the end of the calendar year.

Following citrus, avocados are the second largest tree fruit crop in Florida, representing about 60 percent of the tonnage that falls in the tropical fruit category. Prior to Hurricane Andrew, which hit in 1992, Florida had about twice the avocado acreage it has today. That storm wiped out a lot of acreage, but Flinn said average yield per acre is about twice as much as it was around that time so current tonnage isn't much different than when the state had twice as much acreage.

Although avocado varieties produced in South Florida look similar due to their "green skin" and are easily distinguishable from the Hass varieties grown in California and around the globe, they are not all the same. Florida avocados fall into one of three main types: West Indian, Guatemalan and Mexican. These three avocado types collectively comprise some 60 major and minor commercial varieties that mature at different times during the season in various weights and sizes. As a consequence, yields per acre vary among producers, depending on the production techniques and varieties grown.

Ostlund said most of Florida's avocado acreage is in Dade County, which is also the state's most populous county. She noted expanding urbanization makes expanding the avocado acreage basically impossible.

But the Brooks executive said Florida avocados are experiencing the same increasing popularity that the Hass avocado has enjoyed over this past decade. She said Florida is the biggest market for the homegrown fruit, but there is also some strong pockets in other regions of the eastern half of the United States, most notably the northeast. "Very few Florida avocados travel west of the Mississippi," she said.

Ostlund noted that Florida consumers, as well as many from the nearby-Caribbean Islands, were raised on green-skinned avocados and that is what they prefer. She added that weight and health conscience consumers also prefer Florida avocados over the Hass, as Ostlund claims they "contain less fat and fewer calories." In fact, Brooks markets its Florida avocados under the "SlimCado" moniker as the firm tries to exploit that advantage.

But Ostlund said that the Florida avocado crop does not really compete against the Hass avocado. It has a market of its own based on its own supply and demand curve. "We don't compete against the Hass. There is no competition; you won," she said, noting the huge volume disparity between commercial green-skin production and the production of the Hass.

Florida avocados are typically much larger than your average Hass avocado as they can be 3 to 13 inches long and weigh as much as two pounds.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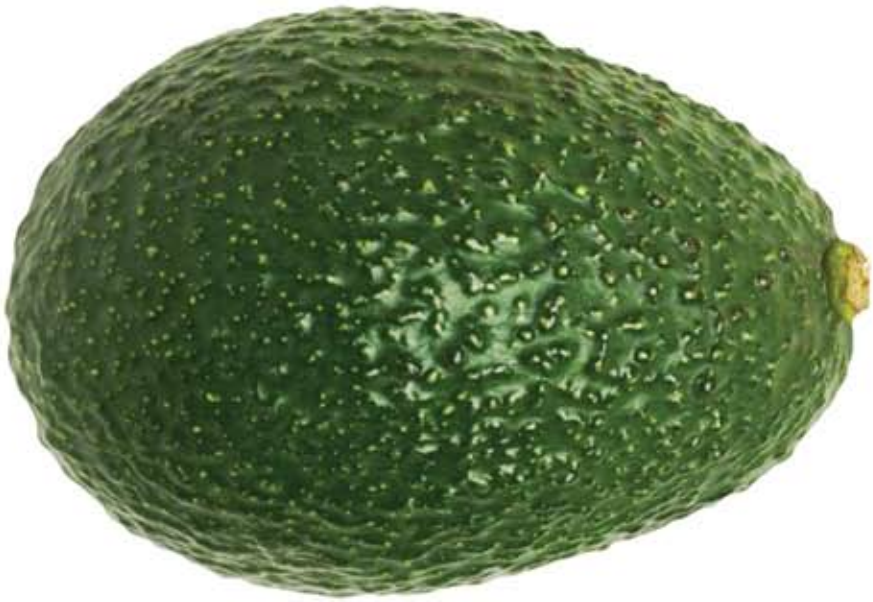

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