WEST COAST NUT

APRIL 2020 ISSUE

SPOTLIGHT:

PROACTIVE DEFENSE AGAINST SPOTTED LANTERN FLY

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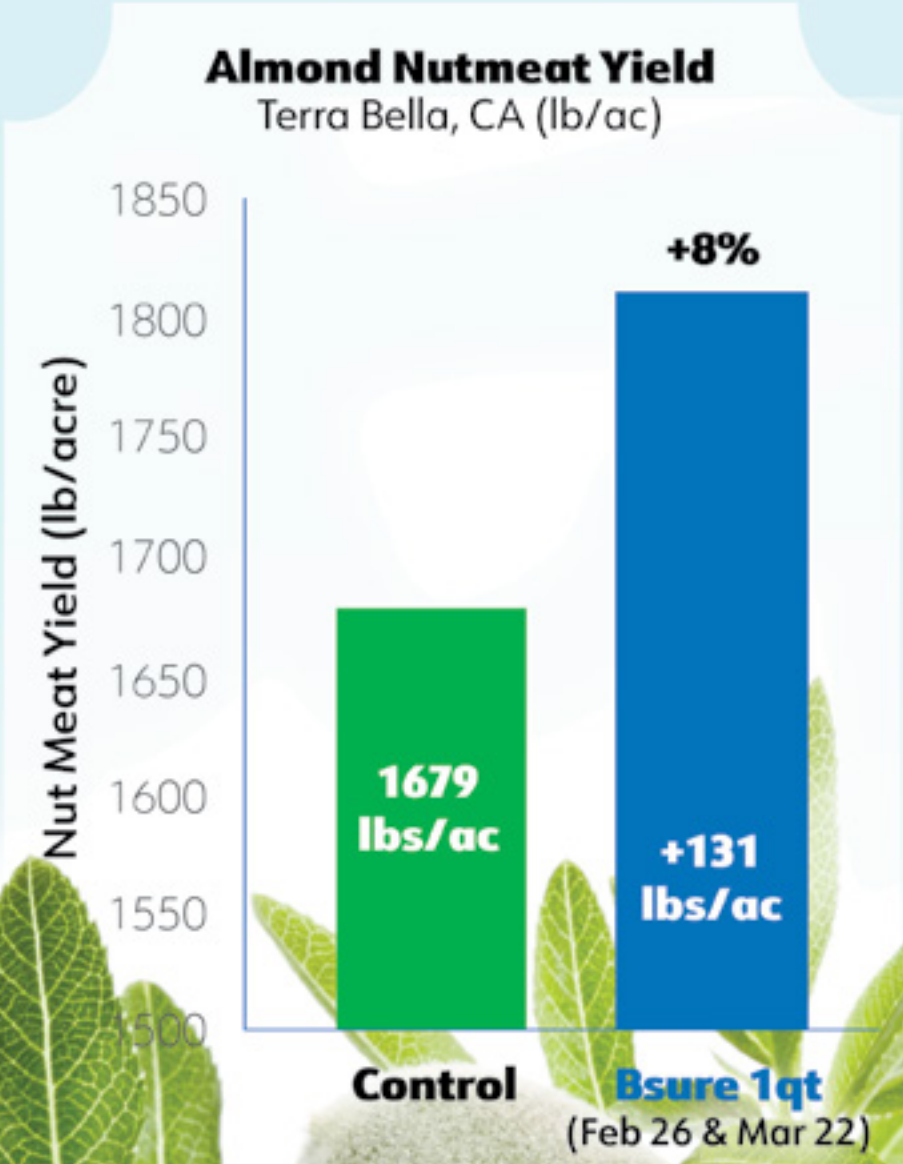

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Integrated NOW Approach

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See full article on page 6

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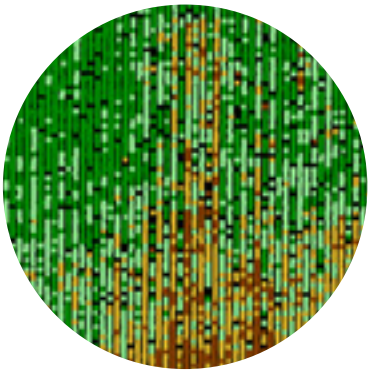

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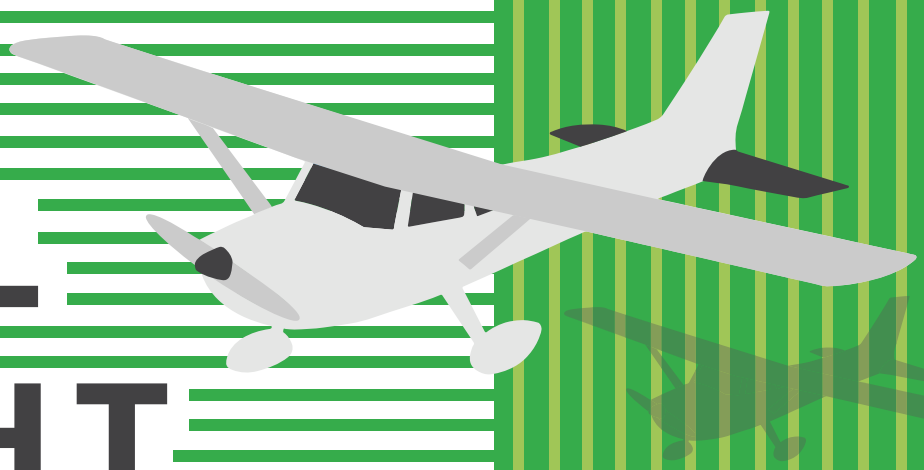

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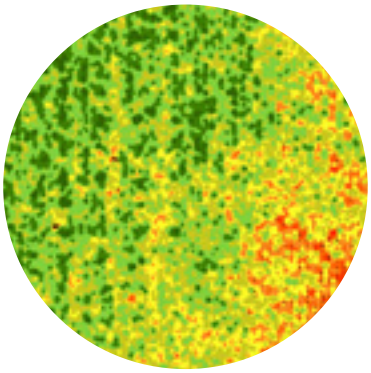

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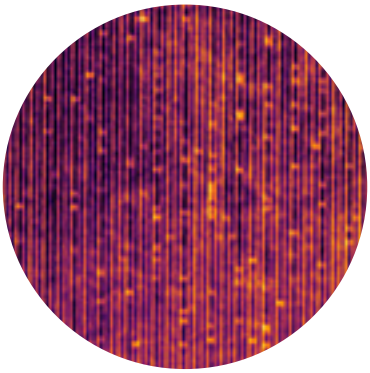

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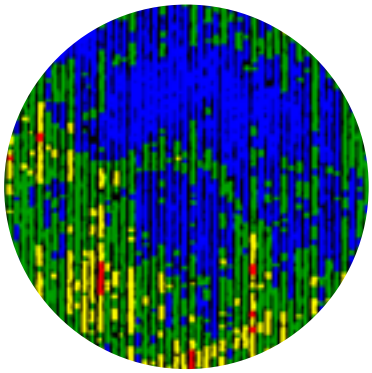

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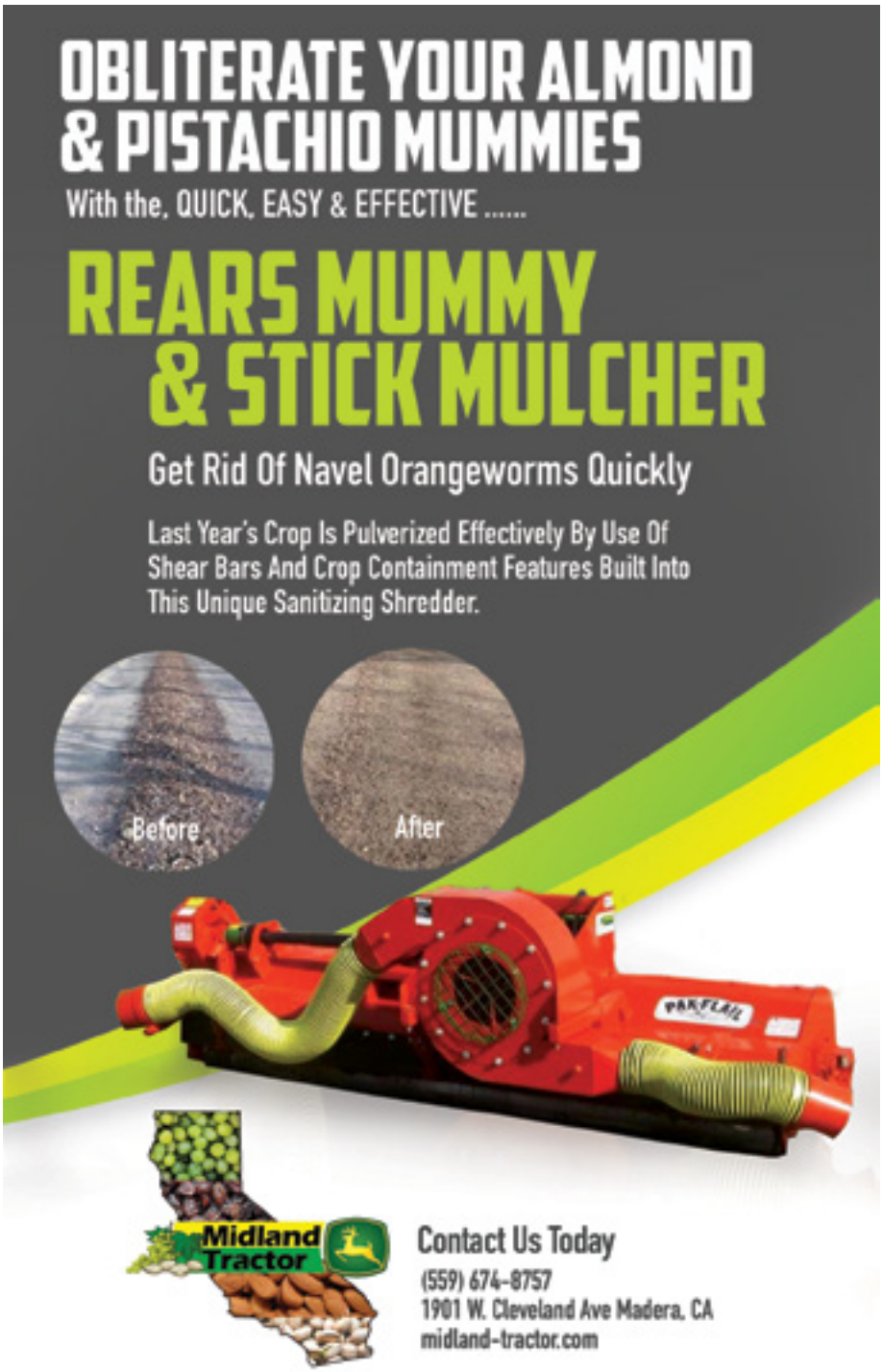
Integrated NOW Approach:

DON'T LET LAST YEAR'S LOW NOW NUMBERS LEAD TO COMPLACENCY

By **CECILIA PARSONS** | *Associate Editor*



IT'S NO SECRET THAT MANY ALMOND AND pistachio nut growers in California found much lower navel orangeworm (NOW) damage in their crops in 2019, but no one is guaranteeing that 2020 will bring a repeat of that good fortune.

Navel orangeworm populations in California's pistachio and almond orchards can "turn on a dime" according to Joel Siegel, USDA-ARS research entomologist, without continuous attention to good control programs. Navel orangeworm damage in previous 'bad' years contributed not only to lower marketable yields, but also affected export opportunities.

A primary pest in almond and pistachio orchards, navel orangeworm is also prolific, producing three to four generations in one growing season. The larvae overwinter in mummy nuts left in the orchard after harvest. First instar larvae take advantage of hull vulnerability and early splits to bore into the kernels and feed. Larval feeding can also introduce fungal infections leading to aflatoxin contamination. In almonds some cultivars are more susceptible to damage, especially later-maturing softshell almonds with a lengthy hull split period or a poor shell seal. Early splits and pea splits in pistachios invite NOW infestations. Poor hull integrity also makes pistachio nuts vulnerable to NOW.

Though aflatoxin is a natural occurence in almond orchards, some variability in test results is expected. Managing this issue carefully is an important priority for the Almond Board of California, Julie Adams, the Almond Board's Vice President of Global

Continued on Page 8

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Continued from Page 6

Technical and Regulatory Affairs, said at The Almond Conference 2018 in Sacramento.

Lower NOW damage in pistachio during the last two years was due to good hull integrity, Bob Klein, manager of California Pistachio Research Board said. Damage levels during the past two years are unprecedented in the industry and Klein warned growers not to expect a third year in 2020.

Good orchard sanitation is the cornerstone of NOW control, University of California farm advisors, and industry representatives strongly agree. Mating disruption is an effective tool as are timed insecticide sprays and early harvest. However, Klein noted at the recent Pistachio Day event, that less than one in eight pistachio growers use all the tools available to them for NOW control.

"If 50 percent of growers are doing overwintering sanitation I would be surprised," Klein said.

Almond and pistachio growers who cut back on NOW control efforts also put neighboring orchards at a higher risk of NOW infestation.

"At minimum look at your sanitation practices. They are the cornerstone of control – even if your damage is low," Siegel said.

Siegel noted that in almonds, damage was not uniformly low up and down the Central Valley. North of Merced, NOW damage levels were higher, and aflatoxin was more of an issue. South of Merced, NOW levels never amplified in pistachio orchards over the season, he said, possibly because growers have taken orchard sanitation more seriously due to higher levels of NOW infestation in the past.

Besides orchard sanitation as a control, Siegel said growers would need a timely insecticide spray program. Mating disruption is not a stand-alone control, it needs insecticide support, Siegel said. Growers can decide if they want to eliminate one spray per season, but they need to understand that using all the NOW control tools available will help them achieve desired results.

Urged by their industries and buyers, more almond growers have performed orchard sanitation to reduce overwintering NOW populations and adopted mating disruption to protect developing nuts. Spray timing and techniques have also contributed to control efforts and cleaner nut crops.

A singular approach to NOW control is not effective, said UC IPM Extension advisor Emily Symmes. Without good orchard sanitation, numbers can't be significantly reduced with mating disruption. If timing is not right or spray applications can't be done within a short amount of time, populations will remain and build over the growing season, putting much more pressure on the crop at harvest.

Keeping an eye on the neighbors and their NOW control- or lack of is also important, Siegel said. Navel orangeworm moths can fly in when one of their numerous host crops dries up or is harvested.

When infested trees of alternate hosts are harvested, navel orangeworm moths may migrate into almond orchards. Treating border rows (at least 10 rows) may be adequate to prevent the moths from infesting the almond crop when navel orangeworm numbers are low to moderate in a given area.

Constant vigilance in controlling NOW in almond orchards will keep reject levels down said Mel Machado, director of grower relations for Blue Diamond Growers.

The reason damage levels in almonds are down, Machado said is because more growers invested in sanitation. They should also be taking a serious look at mating disruption. Machado said use of this tool for NOW control would make hull split treatments more effective.

He said he is hearing from almond growers who have a good NOW control program that they have been able to cut one spray application but not eliminate sprays altogether.

Zack Raven, ranch manager and grower services for Keenan Farms said securing export markets is vital for the pistachio industry. Lower prices for exported pistachio nuts or outright rejection of shipments due to aflatoxin contamination could be the outcome if pistachio growers are not vigilant every year in controlling NOW.

Considering the larger harvests that are on the horizon for the pistachio industry, Raven said taking orchard sanitation seriously is a must for all growers. If damage levels rise, customers are going to demand lower prices or not take the product at all.

When neighbors are on board with a control program, mating disruption is a NOW control tool that has proven to work. The plume of mating disruption pheromone expands and moves back and forth, he said, and has proven to be effective when coupled with orchard sanitation. Success with those two controls may allow a grower to skip a spray application after a year or two, he said.

Raven said depending on processor there is a potential to lose up to 20 cents per pound in quality bonuses due to insect damage, along with the damaged nuts in the load- which are not included in the grower's total and not paid for.

Mating disruption cost ranges from $100-130 per acre. With an average size pistachio crop, it would only take about three cents per pound to cover the cost.

Raven said Keenan Farms is using one less spray due to our neighbors jumping on board with mating disruption and will continue to be vigilant with sanitation.

"Mating disruption has saved us $50 an acre and more importantly, helps secure our export markets for future years to come," Raven said.

> **"At minimum look at your sanitation practices. They are the cornerstone of control – even if your damage is low."**
>
> Joel Siegel, USDA-ARS Research Entomologist

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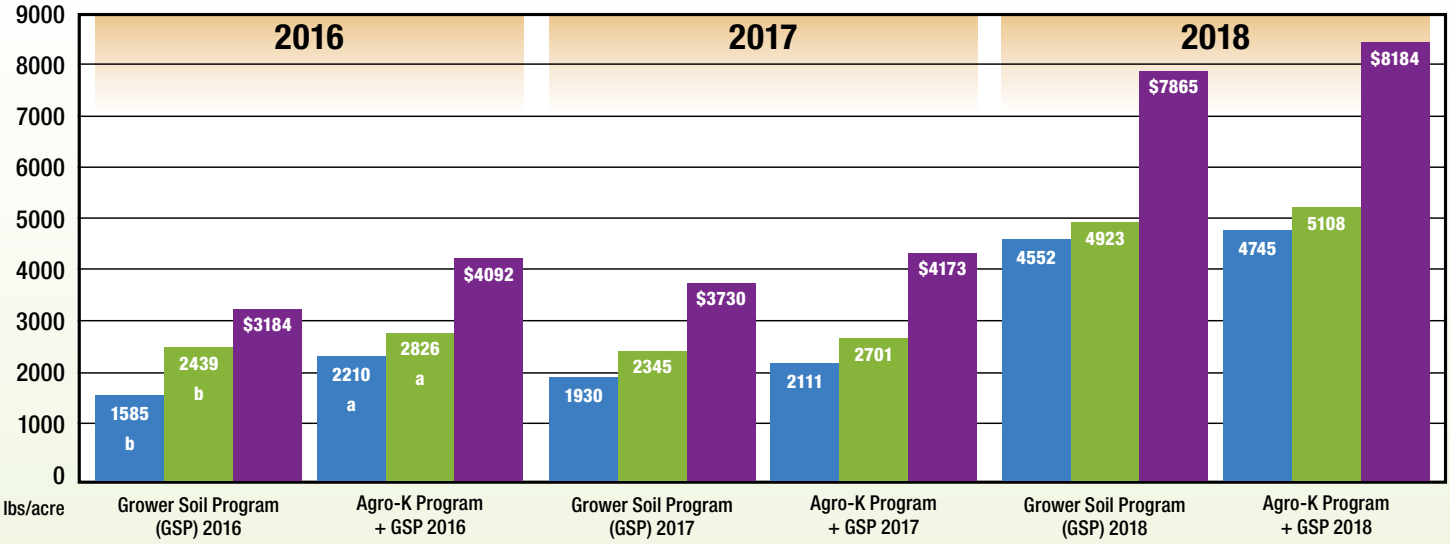

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PISTACHIO GROWERS FINDING A LOT TO LIKE IN GOLDEN HILLS CULTIVAR

By **MITCH LIES** | *Contributing Writer*

IT ISN'T SO MUCH THE GOOD YIELDS, THE high quality and good pack out that is drawing California pistachio growers to the cultivar Golden Hills. According to Zack Raven, farm manager of Keenan Farms in Kettleman City, Calif., the big draw for Golden Hills is its early harvest.

"The number one reason why it is such a great variety is because it comes off significantly earlier than Kerman," Raven said.

The earlier harvest, typically 10 days before the industry standard Kerman, leads to reduced susceptibility to navel orangeworm and spreads out the harvest season, Raven said. "It works for both the processor and the grower," he said.

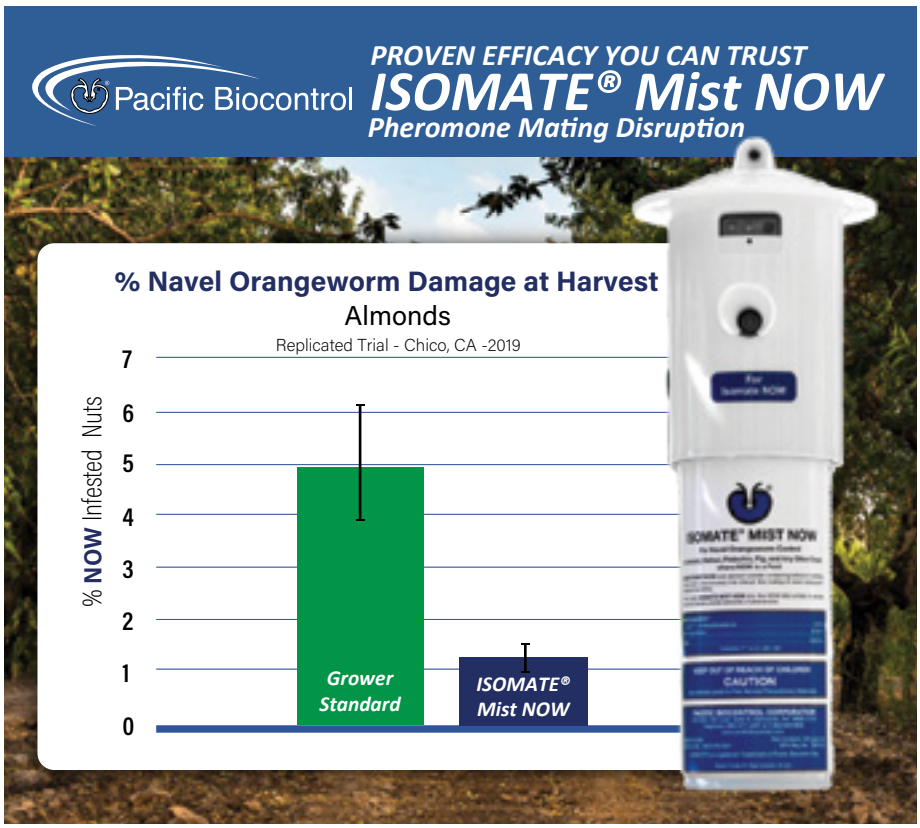
Released from the University of California breeding program in 2005, Golden Hills production has increased from about 3,000 acres in 2012 to approximately 65,000 acres today, making it by far the most successful variety to come along since Kerman was released in 1957.

"From what we can tell, it looks like pretty much all the new planting, with the exception of some acres going into Lost Hills, are Golden Hills," said Dan Edward Parfitt, a retired UC Extension pomologist, who developed the variety with former UC Kern County Farm Advisor Joe Maranto.

To date, the variety appears to more than hold its own when it comes to yield. According to Raven, Golden Hills yields have topped 6,000 pounds an acre in some of his orchards, up about 500 pounds over a good-yielding Kerman orchard. And its split nut percentage is considerably higher than Kerman, he said.

"On the Golden Hills, it seems like we're getting maybe 2 to 3 percent closed shells," Raven said. "It is very minimal, and it is less variable than with Kerman."

Also, Raven has seen virtually no damage in Golden Hills to the navel orangeworm, and at times has been able



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> **“From what we can tell, it looks like pretty much all the new planting, with the exception of some acres going into Lost Hills, are Golden Hills.”**
>
> Dan Parfitt, UC Davis

This 8-year-old Golden Hills orchard in Coalinga was among the first planted in California. Today the variety accounts for the lion’s share of new pistachio plantings (all photos by M. Katz.)

to reduce treatment costs by cutting out the final spray, given that Golden Hills is being harvested about the time of the pest’s final flight.

Nut size is a little smaller than Kerman, Raven said, but it is adequate. And Bob Klein, manager of the Administrative Committee for Pistachios, said he has heard processors say Golden Hills’ pack out rate is higher than Kerman’s, which can reduce transportation costs.

Growers also are finding benefits from the variety’s more upright growth trait and short branches: They are able to increase planting density, going from an average of 130 trees per acre with Kerman to 140 to 155 trees per acre with Golden Hills, and increase harvest efficiency.

“Its canopy doesn’t go beyond the curtains of the harvesters, so everything drops straight down,” Raven said. “It makes everything a lot easier.”

The trees shorter branches also contribute to improved shaker efficiency, Parfitt said, as the energy from shakers more easily reaches branch extremities than in varieties with long branches, where a significant percentage of the shaker’s energy has expired by the time it reaches branch extremities.

Another plus for the variety is it has outperformed Kerman in low-chill years. “They don’t need as much chill as Kerman, which helps out a lot,” Raven said. “It seems like it has been low chill of late. Things are getting warmer. And this variety can help put a bandage on that issue.”

Part of the superior performance in low-chill years, Parfitt said, can be attributed to the performance of the Golden Hills’ pollinizer, Randy, which flowers much earlier than the Kerman pollinizer Peters. Some orchardists, in fact, have taken to interspersing Randy in Kerman orchards to help offset the effects of low chill on Kerman, Parfitt said.

About the only downside Raven has encountered thus far into his experiences with Golden Hills is a lack of flexibility in harvest timing.

“When it is time to harvest, you need to get in there and shake them ASAP,” Raven said. “You can’t wait another seven to ten days like you can on a Kerman. You need to get going and shake it when they are ready. If you wait on this variety, it tends to turn on you a little quicker. The nuts don’t hold

Continued on Page 12

Zack Raven of Keenan Farms said early harvest is the biggest advantage of the Golden Hills variety

Breeder Gets What He Was Looking for in Golden Hills

In the late 1980s, when then UC Davis pomologist Dr. Dan Edward Parfitt set out with then UC farm advisor Joe Maranto to find new pistachio varieties, he was looking for several of the traits exhibited by Golden Hills, a variety that today is catching on in a big way with California pistachio producers.

"I was looking at different maturity dates," said Parfitt, who retired last year but is still doing some pistachio research. "I was looking at nut size, because large nuts are always great. I was looking for low non-splits and few blanks, because those traits contribute to high grower-paid yield."

Parfitt didn't get the nut size he was hoping to achieve – Golden Hills nuts are slightly smaller than Kerman, the industry standard – but he was able to achieve the other traits, and there were some bonuses thrown in. For one, Golden Hills trees have a more upright growth pattern and smaller branches, which has improved harvest efficiency and increased planting density. And the variety has performed admirably in low-chill years.

Today, roughly 20 percent of the California pistachio acreage is planted to Golden Hills and more are going in all the time. Ironically, however, as Parfitt describes it, there wasn't a big push to develop new varieties when he and Maranto started on the research.

"A lot of people in the industry really didn't understand why we were (pursuing new cultivars)," Parfitt said, "and people in our department didn't understand why we were doing it. Particularly our leadership was not very supportive, until it proved out. Now that it has proved out, everybody is pretty happy with what we've accomplished."

Golden Hills and Lost Hills, another variety gaining in popularity among California pistachio producers, emerged as the top varieties from multiple crosses that Parfitt and Maranto analyzed in variety trials that they planted in three locations in 1988, '89 and '90.

"From that, down in the southern San Joaquin Valley, we selected nine items for testing against Kerman, and we set up a couple of advanced selection plots around 2000. From there, we ended up picking Golden Hills and Lost Hills and the male Randy. Randy was picked because we needed an early male."

Five years later, in 2005, Golden Hills was released, and by 2012, after nurseries had built up supplies and growers were seeing promise in the variety, growers were planting the cultivar in earnest.

Rate of acceptance further accelerated after the variety significantly outperformed Kerman in the back-to-back low chill winters of 2014 and 2015.

As for split percentage and other traits he and Maranto pursued in their search for new cultivars, Golden Hills has excelled.

"Golden Hills generally have pretty high split and relatively few blanks," Parfitt said.

> "The number one reason why [Golden Hills] is such a great variety is because it comes off significantly earlier than Kerman."
>
> Zack Raven, Keenan Farms

Continued from Page 11

onto the tree very well like a Kerman."

In an article published in West Coast Nut magazine last August, Craig E. Kallsen, UC Cooperative Extension citrus and pistachio farm advisor for Kern County, noted that research trials have demonstrated that trees just coming into bearing will harvest later than mature bearing trees. And, because many of the older Golden Hills trees in the San Joaquin Valley are just coming into bearing or have only been bearing for a few years, they tend to harvest closer in time to older Kerman trees. "However," Kallsen wrote, "this will not continue. A finished harvest for a mature Golden Hills orchard is completed 10 days to two weeks before a mature Kerman orchard, if growing in the same valley location."

As for harvest timing, Kallsen wrote that Golden Hills is ready to harvest once a majority of the hulls have split.

The variety can require more post-harvest irrigation than Kerman, Kallsen wrote. "For optimal yields and if green leaves are present, continue to meet water requirements of the mature trees after harvest (which may be an additional month or six weeks)," he wrote. "Attempting to institute post-harvest regulated deficit irrigation on Golden Hills, which usually is harvested by the end of August or early September in the southern SJV, may produce yield and nut quality results quite different from the fully irrigated post-harvest trees in our small experimental trials."

Lost Hills, which also has been generating interest among Central Valley pistachio producers, is similar to Golden Hills in many respects, according to Parfitt, including in its early maturity. Unlike Golden Hills, however, it has a larger nut size than Kerman, and its canopy and growth pattern are more similar to Kerman than Golden Hills.

"From what I've seen, it looks pretty good," Raven said of his experiences with Lost Hills. "The nut is much larger. I wouldn't say you are getting better poundage, but from what I've heard, you will eventually get more pounds per acre from the variety."

Raven said the nut quality and split nut percentage of Lost Hills is similar to Golden Hills. And, as with Golden Hills, growers need to closely monitor the nut at harvest.

Raven said Golden Hills has outperformed Kerman in low-chill years.

"You have really got to pay attention," Raven said. "Even though the hull looks a little green and doesn't look ready to shake, if you go out there and pull them off, they are absolutely ready to go. You've got to pay a little more attention come harvest. Like Golden Hills, the variety won't hold on very well; not like the Kerman."

Gumdrop, another pistachio variety generating interest, harvests even earlier than Golden Hills and Lost Hills. "It is an interesting variety," Parfitt said. "It is a big tree and has a good yield, and it is a little larger nut than Golden Hills."

One issue with the variety, according to Klein, is it harvests so early that processors are reluctant to work with it because of the significant gap between its harvest and that of the Golden Hills and Lost Hills.

"They don't seem to have a great deal of interest in it," Klein said, "but I know there are some being planted out there."

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Winter Chill Wrap Up **2020**

By **KATHERINE JARVIS-SHEAN** | *UCCE Orchard Systems Advisor, Sacramento, Solano and Yolo Counties*

A FEW WARM SPELLS AND A RE-cord-breaking dry February with little-to-no fog have a lot of people in the tree crop industry wondering about chill accumulation this past winter, and if it would impact bloom in the spring. As I write this article in late February, almonds and a few early stone fruit are the only trees to have bloomed. But, despite some warm conditions, the chill accumulation numbers indicate that we should have enough chill for a decent bloom in our later blooming crops. You can be the judge, reading this in April, as to whether those accumulation numbers match what the trees felt and needed when it comes to winter chill accumulation. The story of this winter varies depending on how you count winter chill, so in addition to reviewing how chill accumulation went this past winter, now is a good opportunity to discuss tools to help you count chill in the future.

Why Do We Care About Winter Chill?

Deciduous trees have evolved a mechanism to essentially count the passing of winter, to know when cold conditions are in the rearview mirror, warm conditions are stable, and the outside world will be a safe place for tender flower blossoms and young leaves and shoots. Crops and cultivars vary in how much winter cold they need to meet this cold accumulation threshold. Some spring warmth can compensate for trees not getting all the chill they want, but there is a minimum chill requirement that needs to be met for buds to open in the spring. As the warm winters of 2013-14 and 2014-15 reminded us, when deciduous trees don't experience adequate winter chill, they will have straggled, prolonged bloom, which can lead to problems protecting flowers from spring diseases and a variety of sizes and harvest readiness timings at the end of the season. Even worse, inadequate chill can result in delayed bloom, which can mean pollinizers don't overlap with the target variety, leading to poor fruit or nut set.

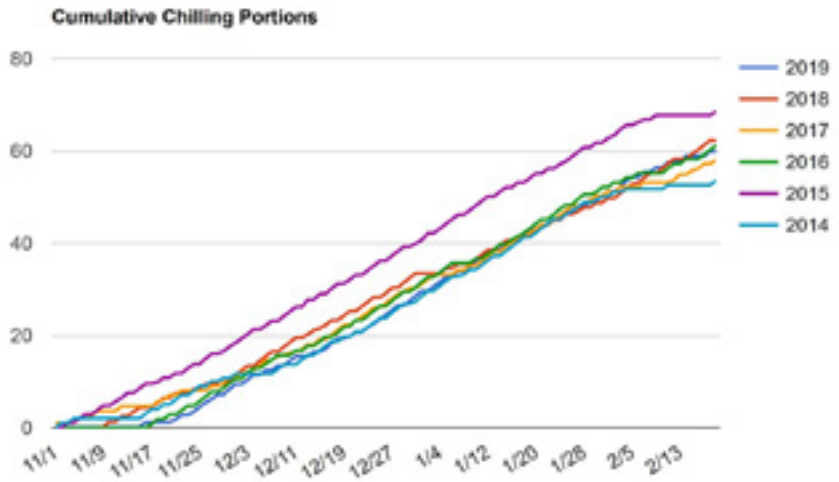

Figure 1. Chill accumulation counted as **chill portions** at the Firebaugh CIMIS station, November 1-February 19.

So, How Did Chill Accumulation Stack up This Year?

When I ran the numbers on Febru-

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	Chill Portions				Chill Hours			
Region	2019	2014-2018	2014	2013	2019	2014-2018	2014	2013
Northern Sac Valley[a]	60	63	56	54	924	792	657	1034
Southern Sacramento Valley[b]	58	63	57	54	788	741	566	1002
Northern San Joaquin Valley[c]	61	63	59	55	994	902	825	1088
Southern San Joaquin Valley[d]	59	57	52	54	917	804	641	1015
Central Valley Average	59	61	55	54	914	817	681	1034

Table 1: Note: Some stations were excluded because of data quality concerns.

a. Biggs, Durham, Williams, Gerber (except 2013, for which Biggs and Williams were not available)
b. Twitchell Island, Winters, Verona, Woodland, Davis
c. Kesterson, Los Banos, Merced, Manteca, Denair, Modesto, Oakdale
d. Coalinga, Firebaugh, Five Points USDA, Fresno State, Parlier, Westlands, Arvin-Edison, Belridge, Blackwells Corner, Shafter, Stratford, Delano

Continued from Page 14

ary 19th for chill accumulation at all the CIMIS stations in the Central Valley (Nov 1-Feb 19), the average for the whole valley is 2 percent below the average of the last five years when counted in Chill Portions. As you can see in **Table 1(see above)**, regional averages ranged from 8 percent below average in the southern Sacramento Valley (5 chill portions) to 2 percent above average in the southern San Joaquin Valley (2 chill portions). Note that the year listed is the year in which the winter started. For example, this winter is shown below as 2019. Chill hours, on the other hand, indicates we are 11 percent above the average of the last five years for the whole Central Valley.

How Does This Year Compare?

Another way to look at this winter is to compare it with the winters of 2013 and 2014, the last couple of low chill winters that resulted in unusual (in some cases, yield-decreasing) spring bloom timing. Compared with the winter of 2014, across the whole Central Valley, chill is 7 percent higher this winter when counted using chill portions. This ranges from just 2 percent higher (1 chill portion) in the southern Sacramento Valley to 13 percent higher (7 chill portions) in the southern San Joaquin Valley. Winter chill accumulation this year is fairly equal across regions. The relative difference is due to 2014 being a much warmer winter for the southern San Joaquin. Compared to the winter of 2013, we've accumulated 8 to 11 percent more chill (5 to 7 chill portions) this year. On the other hand, Central Valley-wide, this winter was 34 percent higher when counting using chill hours.

Looking both relative to average recent conditions and relative to warm recent years, while it was not a boom winter for chill accumulation, it does not look like a bust winter either. When counted using the chill portions method, this winter's chill accumulation has squeaked through above the yield-decreasing winters of 2013 and 2014. I would not expect the flash bloom we saw in almond this year to play out in other crops. But the chill portions numbers indicate we have (narrowly?) avoided yield-decreasing bloom and leaf-out problems this season.

I've largely emphasized chill portions above. This is a winter to highlight the differences among the two models, because depending on which tool you use to count chill, this winter was either warm but not disastrously warm (chill portions) or cooler than

I'VE LARGELY EMPHASIZED CHILL PORTIONS ABOVE. THIS IS A WINTER TO HIGHLIGHT THE DIFFERENCES AMONG THE TWO MODELS, BECAUSE DEPENDING ON WHICH TOOL YOU USE TO COUNT CHILL, THIS WINTER WAS EITHER WARM BUT NOT DISASTROUSLY WARM (CHILL PORTIONS) OR COOLER THAN AVERAGE (CHILL HOURS).

average (chill hours). We'll see if bloom and leaf-out timing this spring gives hints to which is true. Research in orchard crops indicates that the chill hours model is not the best option. Research over the last 30 years in every Mediterranean climate (California, Europe, Israel, Australia, South Africa and South America), has found the chill portions model to count winter chill accumulation as well or better than the chill hours model, in terms of the stability of the output and whether accumulation numbers match up with what trees show on the ground and in the field.

Chill Hours Model v. Chill Portions Model

There are three basic differences between the chill hours model and the chill portions model.

1. *Chill hours count any hour between 32° to 45° F as the same. Chill portions give different chill values to different temperatures.* Temperatures between 43° to 47° F have the most chill value. The chill value on either side of that range are lower, dropping to no value at 32° F and 54° F.

2. *Chill hours only count up to 45° F. Chill portions count up to 54° F.* This makes chill portions better able to approximate how trees in Central Valley agriculture, most of which evolved in fairly mild climates, count chill.

3. *Chill hours do not subtract for warm hours. Chill portions can.* The math is tricky, but the concept is simple: Chill portion accumulation is a two-step process. First, a 'chill intermediate' is accumulated, but can be subtracted from if cold hours are followed by warm hours. Second, once the chill intermediate accumulates to the certain threshold, it is converted into a 'chill portion' and the chill intermediate count starts over from zero. The chill portion cannot be undone by later warm temperatures.

Continued on Page 18

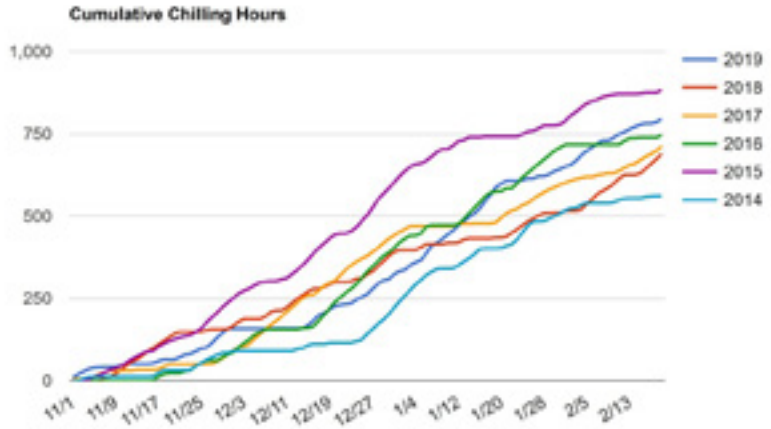

Figure 2. Chill accumulation counted as chill hours at the Firebaugh CIMIS station, November 1-February 19.

Continued from Page 17

It's hokey, but simpler to think of chill portion accumulation as filling 'chill buckets' which then fill a 'chill tank.' Cool hours add to what's in the bucket until it's full. Warm hours along the way can spill out some of what's in the bucket. But once the bucket is full and dumped into the tank, that chill can't be spilled or lost. The warm January of 2014 (winter 2013 in the table above) showed the need for this component. Warm January day temperatures subtracted from the cool temperatures of the night before in the chill portions counting (though did not subtract from cool temperatures in November and December). However, chill hours kept ticking upward. This led to a surprising spring in 2014 for those who were watching the high chill hours accumulation. Bloom was much longer than normal for many cherry and prune orchards, reportedly up to three weeks, as opposed to the usual 3 to 6 days. Pollinizer varieties in pistachio did not bloom in time with the main variety in many orchards. These abnormal spring conditions resulted in significant yield reductions for many growers.

How Can You Check on Chill Accumulation in Your Area?

Whether you want to start getting more comfortable with counting in chill portions, or want to check up on chill accumulation using the chill hours model, UC has tools to help you. Click on over to http://fruitsandnuts.ucdavis.edu/Weather_Services/chilling_accumulation_models/. The UC Fruit & Nut Research and Information Center has teamed up with the CIMIS weather station network to automatically calculate winter chill accumulation using multiple chill models, including chill portions and chill hours. Select a model first, then your nearest CIMIS station from the list, then set your dates (I start counting Nov. 1 for all models). The great thing about this tool is it will give you a graph of accumulation over the season for the last five years (as well as a numerical table of chill accumulation every day of the winter period). This allows you to look back and visually see, for example, how much a warm spell impacted chill accumulation this winter. The graph will also show chill accumulation for the last five years, so you can see how the current year compares with winters past.

When using these tools to look at the Firebaugh station, for example, you can see the trends discussed above playing out at one station. Chill portions accumulation this year (2019, dark blue) matches with many recent years, and is not as low as 2014 (light blue) **(Figure 1, see page 14).** The chill hours graphic shows this winter to have been above all other years except 2015 (purple) in chill accumulation (**Figure 2 see page, 17**). Time and the trees may tell which version of counting is more accurate.

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The Ins and Outs of Tissue Testing

Be Ready to Take Action on Early Sampling Protocol Results

By **RICH KREPS** | *CCA, Contributing Writer*

AS THIS YEAR'S SPECTACULAR BLOOM is now replaced with delicate green leaves, it's time to start the foliar testing process. Of course, the UC has created and implemented the Early Sampling Protocol (UCD-ESP) to better assess our nitrogen needs long before we notice a real problem.

Last year we witnessed a crazy March filled with turbulent storms charged with an abundance of lightning strikes. The atmospheric nitrogen that was transformed through those charges may have been a great contributor to higher than normal nitrogen numbers many of my growers experienced. The good news is, much of it went into the trees and not through the soil for potential leaching. (As I am writing this article before you'll see it in April, I'm still praying for the same type of weather events!) In turn, on many blocks we noticed elevated levels of magnesium as well with those higher N numbers. Which brings up the next point: What about the other nutrients? What should we be looking for? Better yet, how do we fix it.

First of all, be prepared to make changes if you are spending the money to take tissue tests. What good are the numbers if you aren't going to address the issues? If you notice manganese is low, but you are continuing to hammer zinc and boron, because that's what you've always done, don't waste the effort on the test.

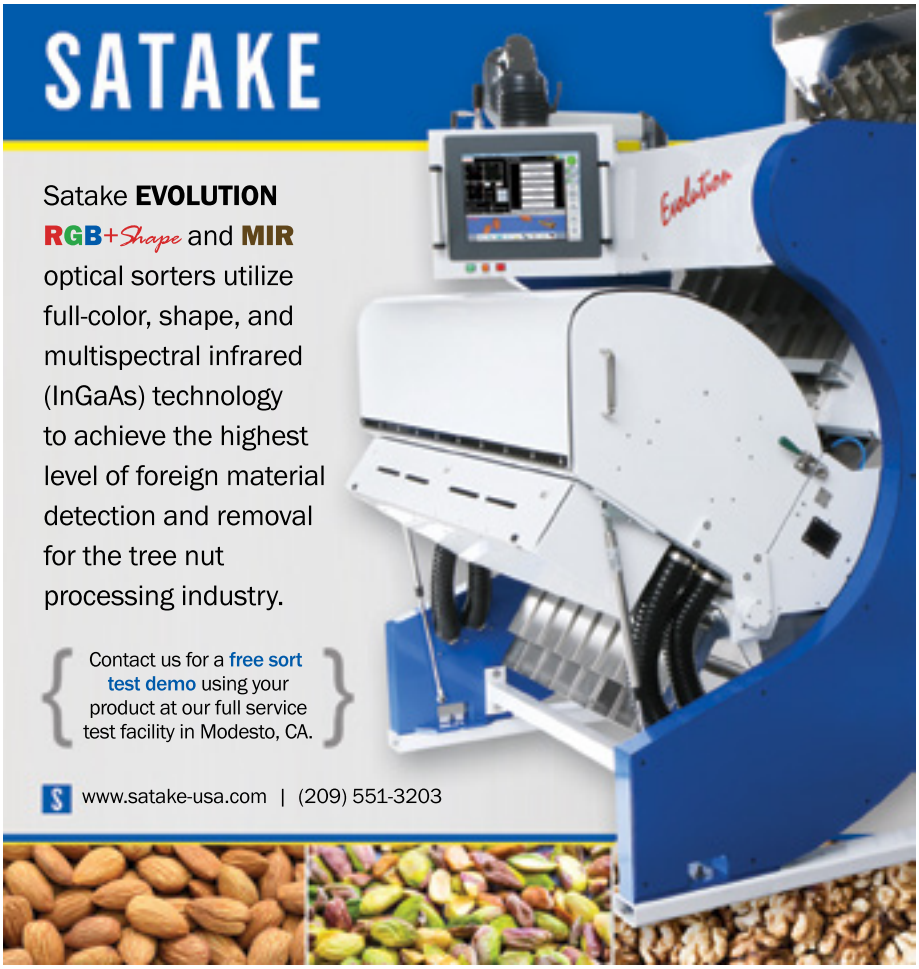
Look over last year's July numbers. If you were in the 3.0 ranges or higher, and still added a good slug of nitrogen in your post-harvest routine, you may be able to reduce your early N shots this Spring. Analyze your early N numbers and make those adjustments. Rank growth opens a whole new Pandora's Box of issues that we can discuss in a later issue. Smaller, more frequent shots will ensure a better, more constant saturation in the root zone to match tree demand. Of course, that requires more attention to the logistical details, but many companies are now offering wonderful fertigation systems to make that process easier.

Know Your Demand

A good way to develop your skills is to study your nutrient demand curves and match the application with the potential uptake. For almonds, here is a good website location to get started: https://ucanr.edu/sites/scri/Crop_Nutrient_Status_and_Demand__Patrick_Brown/Variability_Assessment/

You'll notice the graphs of the leaf concentrations. This gives us a baseline of how levels fluctuate throughout the season. N, P, Zn and Cu start high and taper off throughout the season. Ca and Mg continue to rise throughout the season, yet we rarely continue with our applications of those nutrients well into July. K will rise slowly from April to May, normally takes a dip and then it's a steady rise from June to July when things really heat up. Can we say evapotranspiration? As photosynthesis

Continued on Page 22



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Once nut set is complete and petal fall and rapid leaf expansion is occurring growers need to focus on two key components affecting yield – 1) maximizing leaf size and chlorophyll development during rapid leaf-out and 2) continuing to push nut cell division and calcium into nut cell walls before the division window closes. These two steps are critical to achieving top yields at harvest.

Demands for zinc, magnesium, and other micronutrients reach peak demand timing during rapid leaf and root development. Soils are often cold and wet during this time which limits nutrient availability and uptake hindering root and leaf growth and chlorophyll development. Satisfying peak nutrient demands are critical to maximizing yield potential. Zinc is the cornerstone for leaf, root and vascular system development. Manganese and molybdenum play a key roles in nitrogen metabolism. Iron, magnesium, copper and manganese are backbones of chlorophyll development and structure. Shortages of one or more of these nutrients will limit yield potential. Applying Micro SeaMix and Sysstem Leaf Max with fungicide or insecticide sprays at rapid leaf-out is an ideal way to meet early season almond nutrient needs while simultaneously reducing plant stress. Maximizing leaf surface area ensures the photosynthetic factory is capable of supporting and sizing a large nut crop.

At petal fall, nut cell division is not yet finished and it is important to support the final stages of this process with foliar phosphorus and calcium. Foliar applications are important as cold and/or wet soils combined with limited root activity at this time limit uptake of these important nutrients. Vigor SeaCal supports uptake of phosphate for increased cell division leading to increased nut size. Tank mixing 100% ortho-phosphate based AgroBest 9-24-3 and Vigor SeaCal with fungicide sprays delivers the nutrients needed, in the right form and at the right time to maximize nut cell division and ultimately increase nut size. Nut size and weight directly impact yield. Proper nutrient management at rapid leaf-out also reduces May/June nut drop another major factor to increased yields.

This spring make the most of your fungicide and insecticide sprays. Talk to an authorized Agro-K dealer today about how Micro SeaMix, Sysstem Leaf Max, Vigor SeaCal and AgroBest 9-24-3 can help maximize your profitability.

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Almonds - Nutritional Fact per 100 g

Nutrients	mg	Percentage
Folates	50 µg	12.5%
Niacin	3.385 mg	21%
Pantothemic Acid	0.47 mg	9%
Pyridoxine	0.143 mg	11%
Riboflavin	1.014 mg	78%
Thiamin	0.211 mg	16%
Vitamin A	1 IU	0%
Vitamin C	0 mg	0%
Vitamin E	26 mg	173%
Sodium	1 mg	0%
Potassium	705 mg	15%
Calcium	264 mg	26%
Copper	0.996 mg	110%
Iron	3.72 mg	46.5%
Magnesium	268 mg	67%
Manganese	2.285 mg	99%
Phosphorus	484 mg	69%
Selenium	2.5 µg	4.5%
Zinc	3.08 mg	28%

Continued from Page 20

is supercharged, Iron goes ballistic in the tissues June through July, or at least it should…

Now take all that data and store it in the back of your mind. The real test will be comparing previous years soil test, to tissue tests and yields. That's where the rubber meets the road. Did previous applications give you superior results? When did you do those applications? What nutrients did you combine?

Let's look at a typical almond nutritional profile in a handful of nuts we eat.

You'll notice potassium (K) is at listed at 705 mg. We know they take up a lot of K. But did you know that almonds are a great source of magnesium for us at 268 mg? That's more than a third of K's amounts. And who knew almonds provided 484 mg of phosphorus! Almost 70 percent of our daily intake requirement can be met in a handful of almonds. How many of you as farmers address enough P throughout the course of the season? And how many make sure it's delivered or at least quickly weathered in the right form as orthophosphate?

Feed Them What They Can Use

Remember, a plant can't drink polyphosphate. If your tissue tests are low in early P, you better address that issue quickly. And in cold and wet soils, it has to be ortho. Poly P takes too long to break down in the spring. Almonds are also a good source of Calcium, 264 mg in a serving to be exact. Now think back to your agronomy and realize calcium is not mobile in a plant. When it gets assimilated into a cell, it does not come back out if new growth needs it. Plants need a constant supply of calcium throughout the season. With that much going into the nut, and tissue calcium levels rising throughout the season, do we apply enough all year long? Probably not. If our water is laden with bicarbonates, or we've over applied a non-plant ready P source, we have even less available calcium in season as demand increases.

Manganese levels remain fairly constant in the tissues throughout the season. But what do we do with the ability to deliver manganese if we use one of its greatest disruptors, glyphosate, in summer weed control? You're going to kill your weeds. Why not apply some of your Mn upstairs in summer mite sprays? Be diligent and think of the action/reaction response we always talk about. You may have been using the right products all along in the wrong places at the wrong time.

You as a farmer have so much to deal with on a daily basis, keeping track of how your nutrition is assimilated often gets overlooked. Many of our fertilizer manufactures create blends for us hedging our bets with a blanket approach to micronutrients. Since micronutrients are used in much smaller levels than the big boys, they can be addressed in much smaller amounts. But when they become a limiting factor, you have to be prepared to make changes to ensure they get applied correctly, with the 4 R's, in a timely fashion. Take a test and use them as a tool to make changes to your program. Being proactive with your crop advisors will give you much better chances of improving yields. Matching nutrient delivery to nutrient uptake will not only improve those chances, it'll keep you from applying unnecessary nutrition that could block the uptake of something else. Take those tissue tests, read them, assess them, compare them to previous seasons yields and then most importantly, make adjustments. We all know, doing the same thing over and over again expecting different results is futile. Your crop is too valuable to not sweat the small stuff. Tissue tests can keep the small stuff from becoming big problems.

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ALMOND BLOOM INTENSITY

May be Affected by Prior Year's Irrigation Practices and Diseases

By **E. FICHTNER** | *UCCE Farm Advisor Tulare and Kings Counties,*
and **M. CULUMBER** | *UCCE Farm Advisor Fresno and Kings Counties,*
and **B. LAMPINEN** | *CE Specialist, UC Davis*

FACTORS INFLUENCING A CURRENT year's almond bloom intensity may have been initiated 9 months prior to bloom. In almond, bud development generally occurs in late spring (**Figure 1**). During the initial phase of bud development, vegetative and flower buds are all morphologically similar. In late summer, however, a portion of the buds will differentiate to form flower buds. Consequently, the physiological and pathological stresses exerted on almond trees the prior year may influence bloom and subsequent yield in the current year.

Orchards that are overwatered the prior year may exhibit low bloom intensity in the current year. A review of the prior year's stem water potential records is the first step in assessing the potential influence of over-watering in suppression of subsequent bloom. Based on researcher observations, trees maintained either at or above (i.e. wetter than) the baseline tended to have lower bloom intensity the following year. The baseline value is the expected stem water potential of a fully watered orchard. Baseline values vary depending on environmental conditions (temperature and relative humidity) and are specific for each crop. If stem water potential records are not available, observations of bloom distribution both within orchards and trees may elucidate the cause of current bloom irregularities.

Figure 1. Buds (circled in red) are visible in the leaf axils on June 23, 2018. At this time, vegetative and flower buds can not be distinguished based on morphology. Photo: E. Fichtner

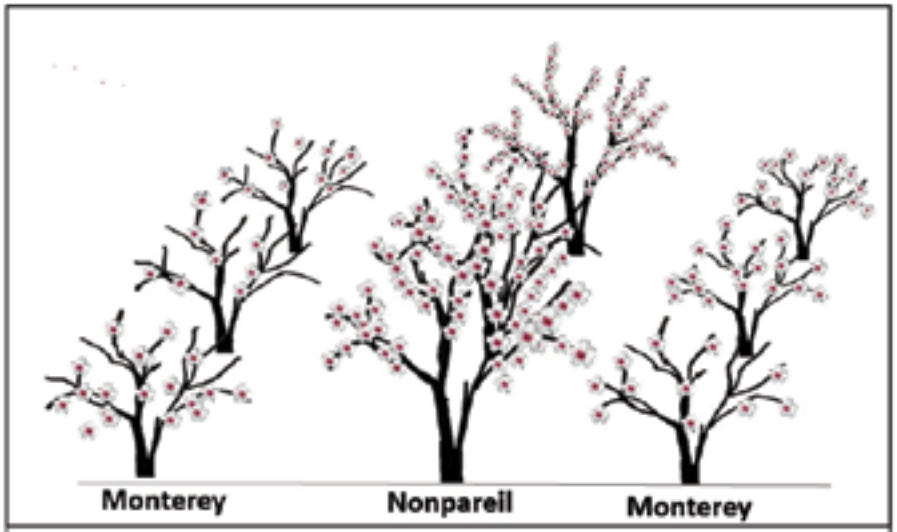

Figure 2. Look for patterns of bloom intensity within orchards. If larger varieties exhibit greater bloom intensity than smaller varieties, the smaller varieties may have been overwatered the prior year in comparison to the larger varieties.

Orchard-Level Observations

If bloom density at full bloom varies between rows of different varieties (forming a repeated pattern across the

Continued on Page 26

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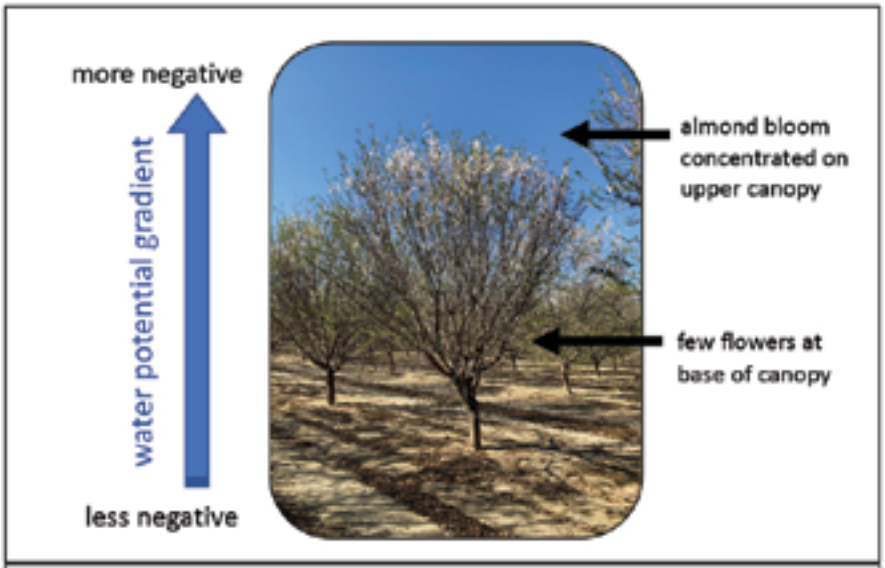
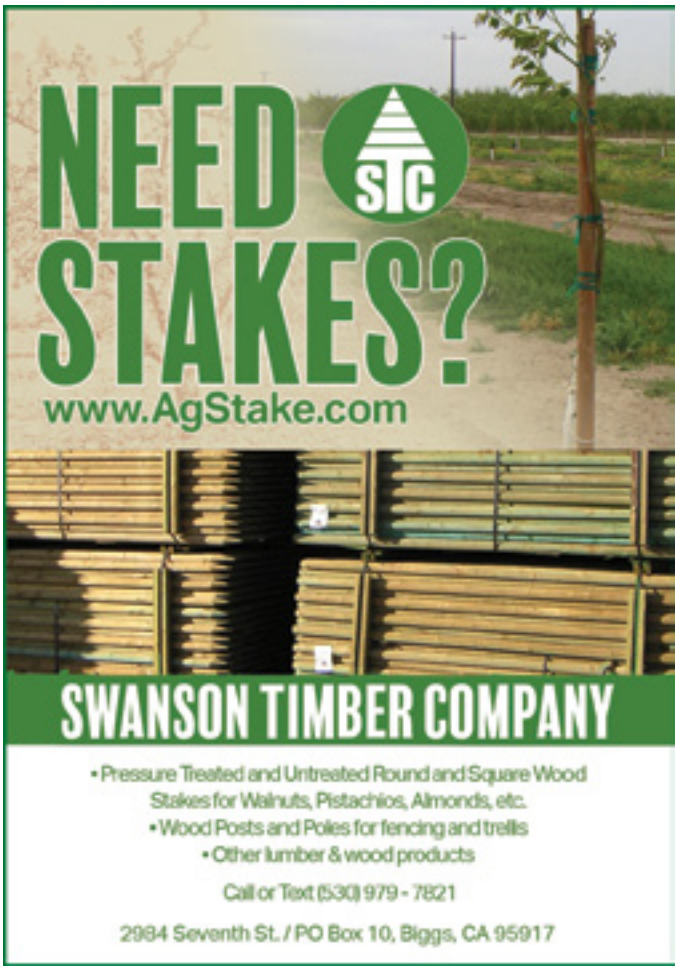


Figure 3. The higher bloom intensity in the upper canopy may be related to lower (more negative) stem water potential in this region of the canopy during bud development. In this orchard, lower positions only had vegetative buds with very few reproductive buds. Photo: B. Lampinen

Continued from Page 24

orchard) the prior year's water status may have influenced flower bud development.

If an orchard is comprised of multiple varieties, the bloom intensity should be evaluated for each variety at full bloom, which will likely occur on different days. If a variety characterized by smaller trees exhibits lower bloom intensity than a variety with larger trees, it is likely that the smaller trees were over-irrigated the prior season. For example, an orchard planted with Monterey and Nonpareil may have lower bloom intensity in the Monterey rows than in the Nonpareil rows (**Figure 2, see page 24**). The Monterey trees often tend to be smaller than the neighboring Nonpareil, and therefore receive more water per unit tree canopy than the Nonpareil. As a result, Monterey may be maintained at or above the baseline in an orchard where irrigation management is based on the water status and tree water requirements of Nonpareil.



Within-Tree Observations

If the bloom is concentrated at the top of the canopy (**Figure 3**), and flowering is sparse in the lower canopy, the orchard may have been overwatered the prior season. The water potential varies throughout the tree, with the increasingly negative gradient progressing sequentially from the soil, through the roots, stems, lower canopy, and upper canopy (Figure 3). The water potential in the upper tree canopy may have been conducive to floral bud production while the water potential in the lower canopy may have been too high (i.e. too wet) to promote flower bud development.

Combination of Orchard-Level and Tree-Level Observations

If bloom intensity appears to vary between rows in a pattern indicating differences between cultivars, with low bloom intensity occurring predominantly in the lower interior canopy, hull rot the prior year may be a contributing factor. Although the symptoms of hull rot are often noticed at harvest, the lasting effects of hull rot may go un-

Figure 4. Black streaking caused by *Rhizopus stolonifer*, a fungal pathogen responsible for hull rot. The pathogen kills spur and twig tissue by producing a toxin called fumaric acid. Photo: Brent Holtz

noticed until bloom and bud break the subsequent year. *Rhizopus stolonifera* is particularly responsible for producing a toxin (fumaric acid) that kills spurs and twigs (**Figure 4, see page 26**) associated with infected nuts. Unlike slight over-irrigation the prior year, hull rot infections may result in acute spur mortality, resulting in destruction of both vegetative and floral buds. Susceptibility to the disease varies between cultivars, resulting in differential symptom development between rows. Nonpareil, Sonora, and Winters are all susceptible. Additionally, because hull rot is promoted by orchard moisture and humidity during hull split, the symptoms are more pronounced in the lower canopy (due to humidity) and the disease may have a synergistic effect with overwatering in reducing the following year's bloom.

Another factor contributing to a preponderance of flower buds in the outer canopy of mature trees across orchards is shading related dieback (**Figure 5**). The probability of a spur setting a flower is related to previous year leaf area. For example, non-bearing spurs with a leaf area of greater than 50 cm^2 have more than an 80-percent probability of supporting flowers the following year. If light infiltration to the lower canopy is not sufficient to provide adequate carbohydrate storage in spurs, flowering potential in the lower canopy will be diminished. Over 80 percent of the nuts produced by a given tree are borne on spurs; consequently, any factor limiting photosynthesis in spurs will affect flowering potential.

Figure 5. Shade-out is another factor that may limit floral intensity and consequent nut production to the upper canopy. Poor light interception to the lower canopy will limit photosynthesis and carbohydrate storage in spurs. As a result, spurs in the lower canopy may not support flower buds and have a higher probability of mortality than those in the upper canopy.

The Converse Scenario

A heavy bloom in the current year may be related to a propensity of non-nut bearing spurs the prior year. Several factors may have contributed to low nut set the prior year, including a) diseases at bloom (i.e. blast or brown rot); b) weak beehives; c) weather non-conducive to bee flight; and d) frost during bloom. When nut set is low, spurs retain carbohydrate stores resulting in increased leaf area and an increased probability of flowering and setting a crop the following year.

Key Takeaways

If almond bloom at a given ranch appears irregular, assess potential causes by making detailed observations of the bloom patterns both within orchards and within individual trees. Also consider differences in bloom density between cultivars, being sure to make comparisons at the same time stage of bloom progression. Irrigation related records from the prior year may also provide clues for determining the potential for orchard water status to have influenced the bloom in the current year.

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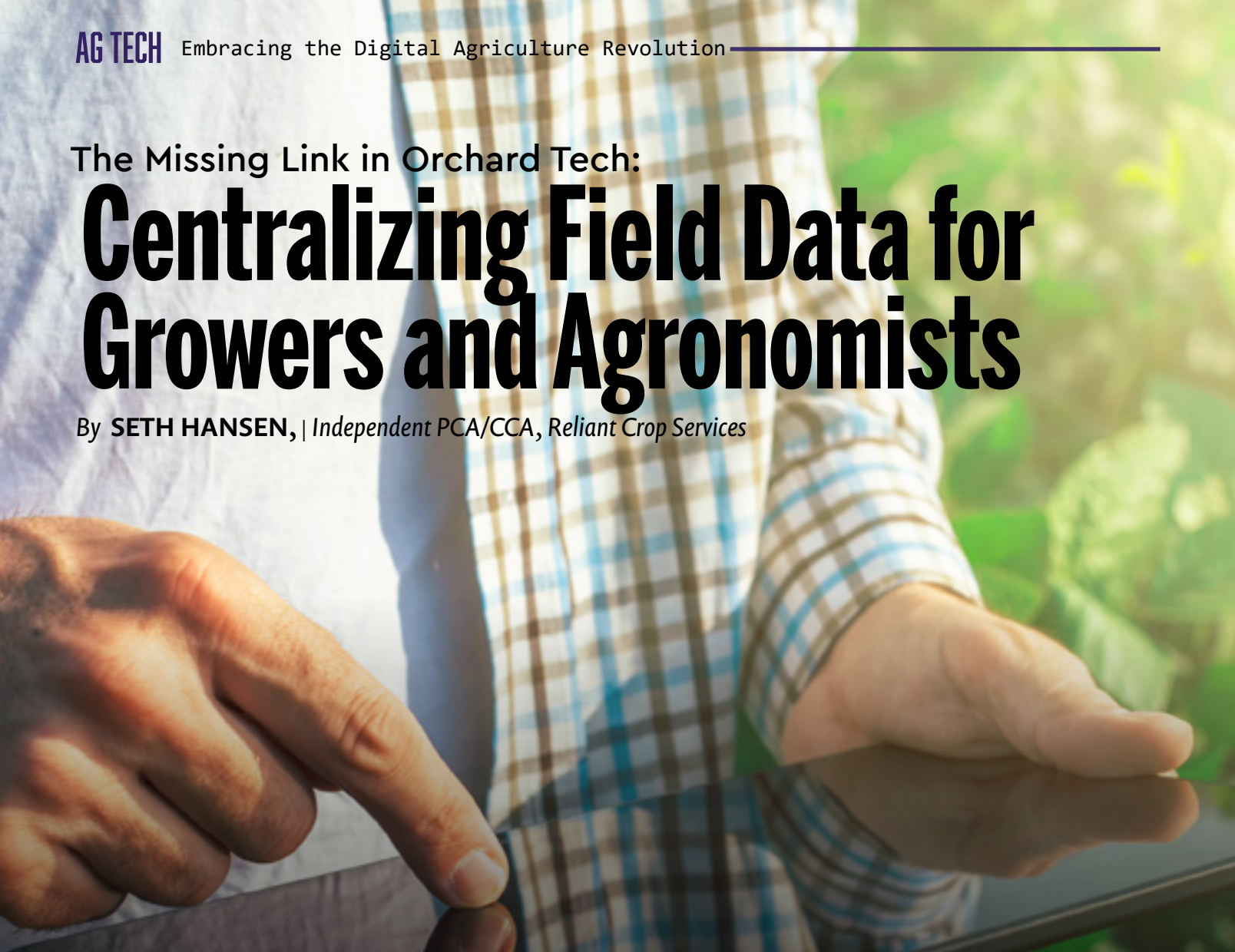

The Missing Link in Orchard Tech:

Centralizing Field Data for Growers and Agronomists

By **SETH HANSEN,** | *Independent PCA/CCA, Reliant Crop Services*

HAVE YOU VENTURED INTO THE world of ag tech for your orchard, hoping to gain efficiency in your operations, and found that you only lost valuable time and money in the process? Have you decided not to renew a farm software license because it simply did not fit how you work? If so, please know that you are not alone. The digital ag revolution is here, but difficulties in managing the data can make it feel like a losing battle.

"Digital agriculture" is a broad term used to describe an approach to farming that leverages digital tools to improve the efficiency and sustainability of crop production. It encompasses basic practices like digital field mapping and record-keeping, to advanced tools like high resolution imagery, robotics and machine learning. It is often described as the fourth "revolution" in agriculture, and hailed as one of the most promising opportunities for the industry to meet the challenge of feeding a growing global population.

For millions of acres of commodity crops like wheat, corn and soybeans in the Midwest, some of these tools have been used by farmers for decades. Precision ag tools enable growers to track their crop growth through satellite imagery, make variable rate fertilizer applications, collect yield data at harvest, and establish management zones based on the data for the next season. Data analytics are employed to select the hybrid seed and planting rates, tailored to the climate, soils and pests of specific fields.

However, in our world of orchards and vineyards, these same tools have

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"SOFTWARE COMPANIES ARE RESPONDING TO THIS NEED. SOME ARE WORKING BUILDING OUT COMPREHENSIVE FIELD DATA PLATFORMS, WHILE OTHERS ARE FOCUSING ON INTEGRATING WITH MULTIPLE TECHNOLOGY PROVIDERS FOR EASIER SHARING OF FIELD DATA"

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"DIGITAL AGRICULTURE IS A BROAD TERM USED TO DESCRIBE AN APPROACH TO FARMING THAT LEVERAGES DIGITAL TOOLS TO IMPROVE THE EFFICIENCY AND SUSTAINABILITY OF CROP PRODUCTION"

Continued from Page 28

not garnered the same level of adoption. Our crops, production cycles, field sizes, irrigation systems, spraying and harvesting equipment, pests and inputs have made adapting some of these digital tools difficult. It makes sense that software, imagery, and equipment companies have focused on regions and crops with significantly greater acreage and lesser complexity. Our digital tools in the orchard have historically focused on weather, regulatory compliance (pesticide recommendations), and irrigation management.

Fortunately, many digital tools tailored to orchard crops have recently been developed. From sprayer tracking to fully automated sprayers, remote irrigation controls, multi-depth soil moisture probes for deep-rooted crops, and satellite/aerial imagery designed specifically for tree canopies, there are many new tools commercially available.

It is becoming more common to see sensors and controls deployed in the field, and the data is flowing. In fact, there is now so much data available from the field, that growers, ranch managers and agronomists are starting to experience "data fatigue." The problem is not only that the volume of data is so large; it is that the grower may not have the means to make use of the data efficiently. Unlike our colleagues in the Midwest, who have accumulated years of remote sensing, application and yield data for fine-tuning their digital tools, we are still in our digital infancy. This data fatigue, which you may be encountering now on your farm, often results from the following problems:

- Limited integrations - users may view imagery and scout fields in one app, write pesticide recommendations in another, monitor soil moisture and control irrigation systems in yet another, and still track costs and generate reports elsewhere.

- Redundant data management - because each tool is not integrated with others, the user may be required to set up their farms, fields,

sensors and activities in multiple platforms, increasing time spent on manual data entry.

- Rigid licensing - not every farming entity is structured the same, and the ability to share data and coordinate activities between the grower, employees, commercial applicators, or outside agronomists does not conform to the available licensing options.

- Inflexible user interfaces - the inability of users to control what data they want to enter, view or send to others, and how they want to do it. One grower may want to view each soil moisture probe reading, while another would like to view a prioritized list of readings at a particular moisture threshold.

- Reduced mobile capabilities - users may find that mobile tools have limited functionality, and they still have to go back to the office to complete set up or reporting tasks in the desktop portal.

- Roadmaps to nowhere - when the tool does not function as needed, the customer may find their requests for added features or improvements at the end of a long list, with little hope for a resolution.

While equipment costs and performance in the field can have a limiting effect on adoption by growers, many of the greatest barriers to technology adoption are related to the actual software necessary to manage the technology. If a grower wanted to digitally track a pest control activity in a field, from scouting to recommendation, sprayer tracking to use reporting with weather conditions, and finally to accounting with all activity costs for the application, they might use six different software platforms to accomplish it. Consider the costs associated with each software platform and the time required to complete this common workflow. Is it any surprise that few growers have this digital capability? And, if one or more of the steps in this workflow must be completed manually - perhaps on paper - how much less valuable are the remaining digital tools? A complete digital workflow is greater than the sum of its parts.

Growers manage very diverse and demanding operations. They must be able to manage equipment and employees, respond to pests and weather at a moment's notice, comply with a host of regulatory agencies, and nurture their crop to harvest with little guarantee that the market will return prices to cover their costs invested. For many growers, this is accomplished with limited support staff. If the digital ag revolution is to take root in orchard production systems, growers will need software that connects all the field data in one place, and provides the tools to leverage that data how they see fit.

The good news is that software companies are responding to this need. Some are working building out comprehensive field data platforms, while others are focusing on integrating with multiple technology providers for easier sharing of field data. A few technology providers may need to adjust their business model, which often includes software licensing fees to access the data, in addition to the hardware sales. Growers that desire to access their data through another system may be unwilling to pay full price for the data license. However, increased hardware sales may be realized when their technology is compatible with other software platforms.

Growers will need to make adjustments in their operations also, such as building their technology capabilities. This may include investing in mobile devices, and training staff to use the software. The grower transition to greater technology adoption can be facilitated by the technology provider or agronomists who already provide field services to the grower and have experience with these tools. At minimum, growers should be identifying 1) their greatest pain points around field data, and 2) a software provider that can meet these specific needs, and is focused on future improvements for orchard growers.

Digital agriculture is certainly an industry buzzword right now, but it is also more than that. It is a movement to develop and deploy amazing tools in orchard production systems, and hopefully overcome some of the greatest challenges facing our industry. It is time to unlock the potential of these digital tools by equipping the growers and agronomists who use them to access their data and leverage it in their own unique operations.

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Food Safety Modernization Act

FDA's Intentional Adulteration (IA) Rule is Here

By **ROGER A. ISOM** | *Western Agricultural Processors Association*

WHILE MUCH OF THE ATTENTION OF late has been focused on the Produce Safety Rule for farms and hullers, and the Preventive Controls Rule for Human Food for processors, there is another rule that tree nut processors must be gearing up for and implementing. Why? Because inspections were slated to start happening in March 2020. The FDA Food Safety Modernization Act (FSMA) final rule for Intentional Adulteration (IA) is aimed at preventing intentional adulteration from acts intended to cause wide-scale harm to public health, including acts of terrorism targeting the food supply. Such acts, while not likely to occur, could cause illness, death, and/or economic disruption of the food supply absent mitigation strategies. Rather than targeting specific foods or hazards, this rule requires mitigation (risk-reducing) strategies for processes in certain registered food facilities.

While acts of intentional adulteration may take many forms, including acts of disgruntled employees or economically motivated adulteration, the goal of this rule is to prevent acts intended to cause wide-scale harm. It is designed to primarily cover large companies whose products reach many people, exempting smaller companies. It does not cover farms.

For the IA rule, FDA has taken an approach similar to Hazard Analysis Critical Control Point (HACCP) system, an approach adopted by industry for the identification, evaluation and control of food safety hazards. Each covered facility is required to prepare and implement a food defense plan. This written plan must identify vulnerabilities and actionable process steps, mitigation strategies, and procedures for food defense monitoring, corrective actions and verification. A "reanalysis" is required every three years or when certain criteria are met, including miti-

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Compliance Dates for IA Rule Based on Size of Business	
Size of Business	Compliance Date
Very small	July 26, 2021
Small	July 27, 2020
Other businesses that do not qualify for exemptions	July 26, 2019

Continued from Page 32

gation strategies that are determined to be improperly implemented.

Each facility subject to the rule must conduct a vulnerability assessment. This is the identification of vulnerabilities and actionable process steps for each type of food manufactured, processed, packed or held at the food facility. For each point, step, or procedure in the facility's process, the following elements must be evaluated:

- The severity and scale of the potential impact on public health. This would include such considerations as the volume of product, the number of servings, the number of exposures, how fast the food moves through the distribution system, potential agents of concern and the infectious/lethal dose of each; and the possible number of illnesses and deaths.
- The degree of physical access to the product. Things to be considered would include the presence of such physical barriers as gates, railings, doors, lids, seals and shields.
- The ability to successfully contaminate the product.

Mitigation strategies: These should be identified and implemented at each actionable process step to provide assurances that vulnerabilities will be minimized or prevented. The mitigation strategies must be tailored to the facility and its procedures. To help facilities with this effort, the FDA has created the "Food Defense Mitigation Strategies Database (FDMSD)." The FDMSD is a tool designed to help owners and operators of a food facility identify mitigation strategies to protect against intentional adulteration. It contains a collection of potential mitigation strategies that could be implemented to significantly minimize or prevent vulnerabilities at actionable process steps, and is intended as a starting point for facilities to consider when identifying potential mitigation strategies. Facilities can customize and tailor strategies listed in the FDMSD to apply to their specific circumstances. The FDMSD is not an exhaustive list of potential mitigation strategies, and facilities can create their own.

Mitigation Strategy Management Components

Steps must be taken to ensure the proper implementation of each mitigation strategy. In each of these areas of food defense, the facilities are given flexibility to establish the actions most appropriate to their operation and product.

Monitoring: Establishing and implementing procedures, including the frequency with which they are to be performed, for monitoring the mitigation strategies.

Corrective actions: You must establish and implement written food defense corrective actions procedures that must be taken if mitigation strategies are not properly implemented. The procedures must describe the corrective actions steps you would take to ensure that appropriate action is taken to identify and correct a problem that has occurred with implementation of a mitigation strategy and, when necessary, to reduce the likelihood that the problem will recur. Corrective actions must be appropriate to the nature of the actionable process step and the nature of the mitigation strategy. It must also be documented.

Verification: Verification activities would ensure that monitoring is being conducted and appropriate decisions about corrective actions are being made. Verification is the application of methods, procedures, and other evalua-

tions to determine whether a mitigation strategy or combination of mitigation strategies is or has been operating as intended according to the food defense plan. Food defense verification activities must be documented: Verification that food defense monitoring is being conducted; Verification that appropriate decisions about food defense corrective actions are being made; Verification that mitigation strategies are properly implemented and are significantly minimizing or preventing the significant vulnerabilities. To do so, you must conduct activities that include all of the following:

- Review of the food defense monitoring and food defense corrective actions records to ensure that the records are complete, the activities reflected in the records occurred in accordance with the FDP, the mitigation strategies are properly implemented, and appropriate decisions were made about food defense corrective actions.
- Other activities appropriate for verification of proper implementation of mitigation strategies.
- Verification of reanalysis.

Training and recordkeeping: Facilities must ensure that personnel assigned to the vulnerable areas receive appropriate training; facilities must maintain records for food defense monitoring, corrective actions, and verification activities.

You are required to make and keep records related to the following:

- Food defense plan, including vulnerability assessment, mitigation strategies, monitoring procedures, corrective actions procedures, and verification procedures
- Documentation of food defense monitoring of mitigation strategies
- Documentation of food defense corrective actions taken
- Documentation of food defense verification activities
- Documentation of food defense plan reanalysis
- Records documenting required training

If you haven't started putting together your food defense plan, and addressing the potential for intentional adulteration, now is the time. One useful tool is FDA's Food Defense Plan Builder, which can be found online at https://www.fda.gov/food/food-defense-tools-educational-materials/food-defense-plan-builder. They just released Version 2.0, and it is pretty handy. The time has come for tree nut facilities to have their food defense plans in place and operational. An IA rule inspection could be just around the corner.

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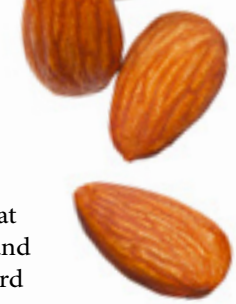
Study Shows Sharp Jump in Input Costs for Almonds

By **MARNI KATZ** | *Editor*



A REVIEW OF almond cost studies over the last two decades reveals that costs to establish and maintain an orchard have increased significantly in the last three years. While costs had remained steady between 1998 and 2016, the overall costs for establishing and producing an acre of almonds in California went up significantly between 2016 and 2019.

UC Davis Economist Brittney Goodrich also noted significant shifts in operating costs for almond growers in recent years in six major categories: irrigation, pollination, pesticides, labor, fertilizer and harvest.

Goodrich analyzed annual cost studies by the UC's Agriculture Issues Center for the Northern San Joaquin Valley between 1998 and 2019 to get a sense of how and where almond growers are spending their money when establishing and maintaining an almond orchard. These numbers are based on assumptions and may not represent exactly what's happening for a specific grower or orchard, but they display the general trend in almond costs.

"One of the key takeaways is that costs from 1998 through 2016, adjusted for inflation, are fairly steady until you get into the transition from 2016 to 2019 where costs have increased quite a bit," Goodrich said. "Just looking at operating costs, they were around $2,400 per acre in 2016 and in 2019 they were at $2,700 per acre, so between 2016 and 2019 there has been a $300 per acre increase in operating costs."

Total costs, including land and establishment costs hovered at around $4,500 per acre between 1998 and 2016, and then experienced a sharp incline to more than $5,700 in the last three years. At the same time, average base prices for inshell almonds have leveled off as global demand has softened for California almonds, and this dynamic is likely eating into growers' net returns.

"Some of the increased cost is due to land values increasing and some is due to increased costs for bees, water and fertilizer."

The costs of pollination, irrigation and fertilizer all figure more heavily as a percentage of overall costs in a micro-irrigated bearing almond orchard, while pesticides, labor and harvest costs have comprised a smaller percentage in the last seven years. In 2002, pesticides, labor and harvest made up more than 60 percent of total operating costs, while irrigation, pollination and fertilizer each made up less than 10 percent of total production costs. By 2019, pesticides, labor and harvest had dropped to 43 percent of overall operating costs, while irrigation, pollination and fertilizer jumped to as much as 45 percent of operating costs. Pollination for traditional, cross pollinating varieties has gone up, for instance, as per-hive costs have soared from $40 per hive in 2000 to about $200 per hive or more.

Continued on Page 38

Increased pollination costs have contributed to the overall increase in input cost (photo by M. Katz.)

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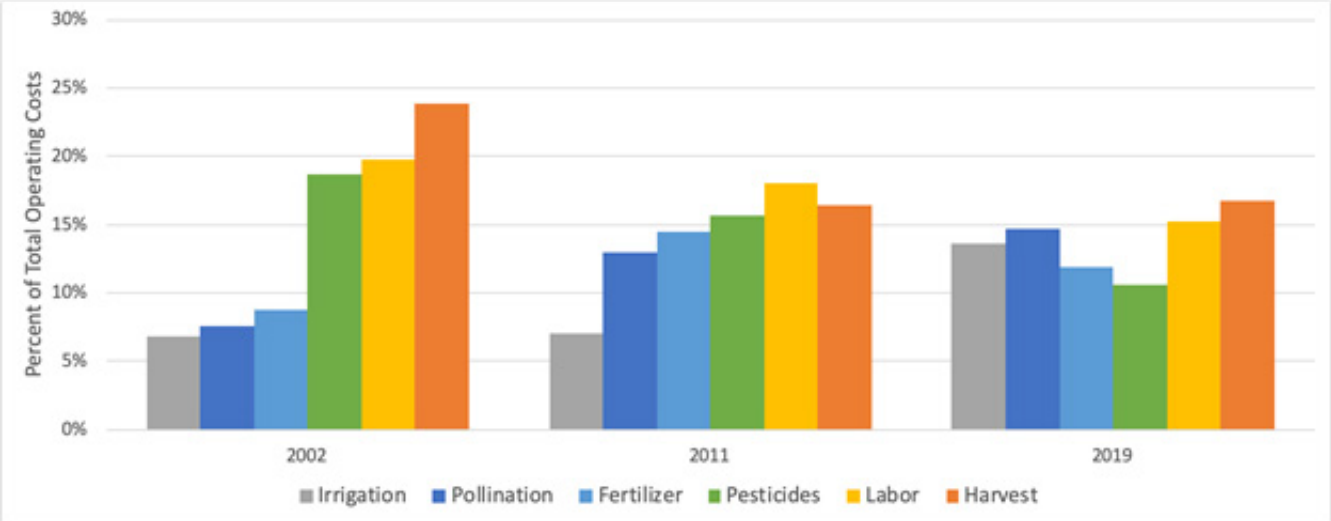

Cost Categories as a Percentage of Total Operating Costs for Almond Production in the Northern San Joaquin Valley Using Micro-Sprinkler Irrigation, 2002, 2011 and 2019 (courtesy B. Goodrich.)

Continued from Page 36

While this will come as no surprise to growers, more surprising, perhaps, is the effect that rising land prices and interest rates have had on overall costs over the last three years. Between 2016 and 2019, Goodrich reported, the assumed interest rates jumped from 3.25 percent to 6 percent and average irrigated land values increased an average of 8 percent. She noted that growers should consider the opportunity costs of farming the land, versus leasing it or selling to reinvest, as part of the cost analysis of doing business.

Higher establishment costs, including ripping out old orchards, chipping and shredding, planting and purchasing new trees, have also increased. Shifts in production practices were part of this dynamic: chipping and shredding orchards, for instance, is a more expensive alternative to burning.

"With the cost of production increasing over the last decade or so and the relatively low almond prices right now, net returns from almond production have likely narrowed for many almond producers," Goodrich said.

Still, she noted, new almond orchards continue to be planted, suggesting that almonds remain a profitable crop of choice compared to other options in California's Central Valley.

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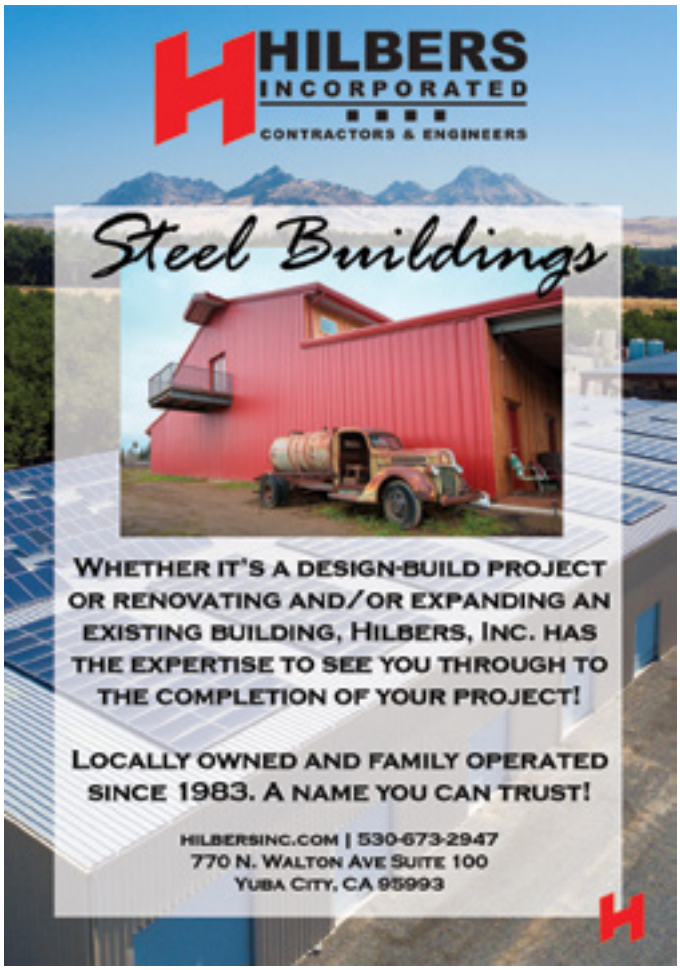
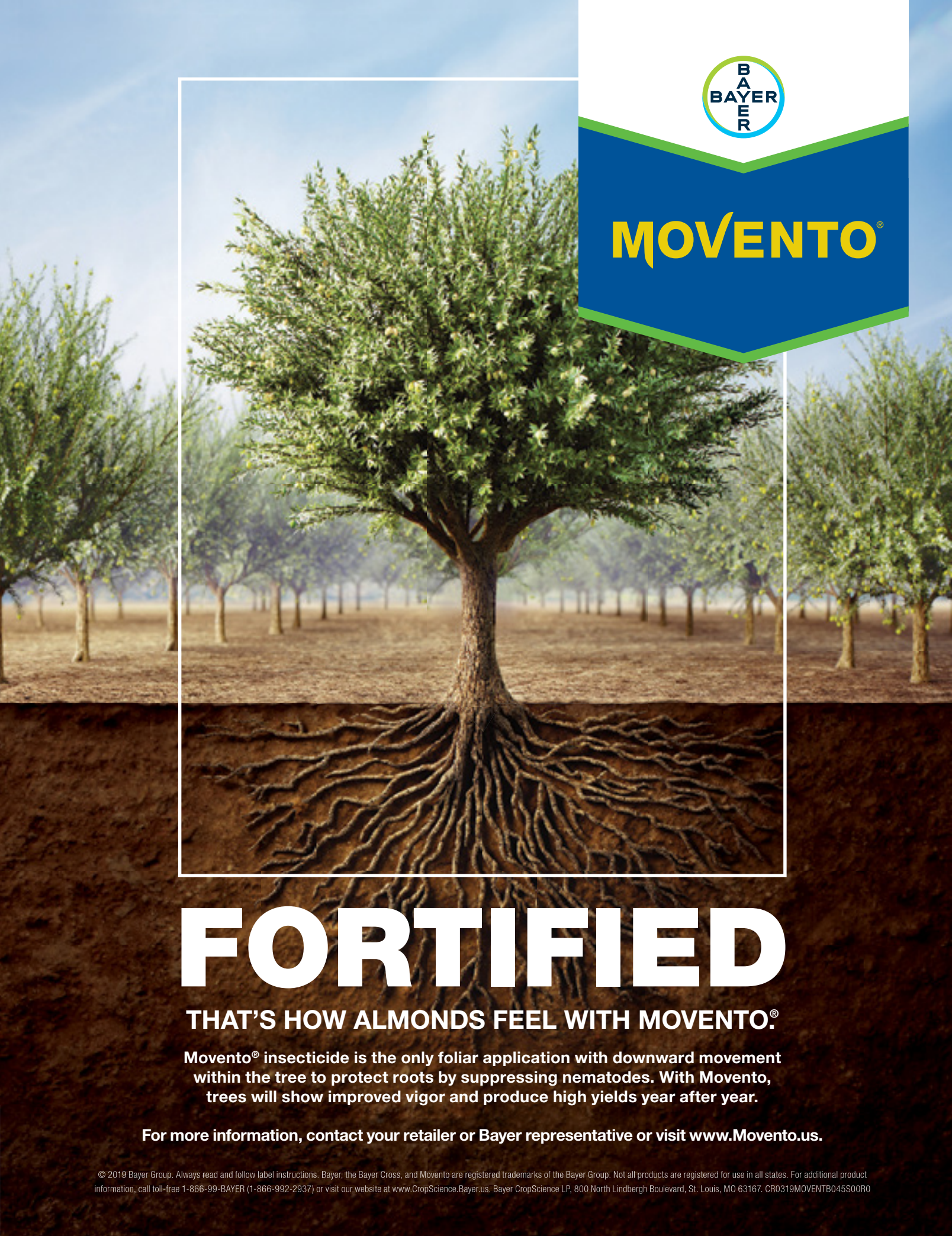


A recent analysis reveals higher establishment costs have contributed to higher overall costs for new almond orchards. (photo by M. Katz.)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Training Young Walnut Trees

Research Shows Yield and Quality Advantages to Unpruned/Unheaded Method Compared to Traditional Minimal Pruning

By **JULIE R. JOHNSON** | *Contributing Writer*

Research has shown the unpruned/unheaded method of training young walnut trees produces quality nuts and good yields (photos by Julie R. Johnson.)

YOUNG WALNUT TREES, LIKE YOUNG children, need to be trained, and if not trained correctly, the outcome could be much less than desirable.

One of the goals of walnut tree training, according to Janine Hasey, UCCE farm advisor emeritus, is to create a final tree structure that is capable of bearing heavy yields and maintaining productive fruitwood. In addition, early cropping, reduced breakage, allowing ease of moving equipment through orchards and filling the space allotted to the grower are among the desired outcomes.

In a presentation on walnut tree training using the no pruning/no heading approach, Hasey said growers have several training options to choose from, however, with each option comes more decision making. And the options are multiplying as more and more information is provided through studies and research on training and pruning practices.

Hasey said training young walnut trees occurs in years 1 to 6 in the life of an orchard.

"The traditional method of training has involved using a modified central leader with minimum pruning method. This method has been used for decades," she added. "That is with the traditional headed trunk and headed scaffolds in the training stage. I had recommended this method for the past 28 years."

In an article Hasey wrote on the subject, she stated, "We believed for decades that if lateral bearing walnuts (most of our varieties) were not pruned, their growth would stall out from early cropping."

However, research conducted over more than a decade by Hasey, UC Davis Extension Specialist Bruce Lampinen, and Katherine Jarvis Shean, UCCE orchard advisor, Sacramento/Solano/Yolo counties, has given growers the no pruning/no heading method to consider as a training option, along with variations of the unpruned method.

"Results from trials on several walnut varieties, including Howard, Chandler, Tulare, Forde, Solano and Livermore, have shown young walnuts do not need to be pruned in order to keep them growing or to produce adequate yields," Hasey said.

In addition, the no pruning/no heading method saves on labor costs and reduces opportunity for disease and pests.

No Pruning/No Heading

Hasey explained that when she talks about "no pruning," it means no heading and limited thinning.

"Obviously you are going to have to thin some branches on the lower tree. You have to take off the lower branches for shaker operations and branches that are a safety hazard for ease of maintenance," she said. "Also, a single trunk at first dormant must be selected."

Training starts at first dormant pruning, assuming trunk development only during first leaf, which is what takes place in 99 percent of walnut orchards.

Training 101

At first leaf training works to develop the trunk, Hasey said. "In the first dormant, at year one, that is when you either head the trunk, or you don't head. If you choose to not head, leave the leader unheaded. Ten to 12 feet of growth is desirable."

It is in the second leaf that the primary scaffolds are developed on the tree. The second dormant is when the grower either heads the primary in minimum pruning, or opts for not heading the primary in the unpruned/unheaded system. Remove branches below 4 to 5 feet (3 to 4 feet for hedgerows).

"In the third leaf, the secondary scaffolds are developing. In the no-head systems, the tree is developing short shoots or spurs during that time and you may see some extension growth," Hasey added.

At the tree's third dormant, in minimum pruning, the secondary is headed, or in the no-heading method the secondary is left alone, and the only pruning is for orchard access and disease management.

"Unpruned trees tend to grow as a central leader with the primary branches naturally well-spaced along the trunk and at wide angles," Hasey explains.

For fourth leaf, the tertiary scaffolds are developing and with no prune orchards, she said that is when growers see a lot of extension growth. At fourth dormant, again the option for minimum pruning is to head the tertiary or in the no-pruning method, don't head the tertiary.

Pruning Trial Results on Varieties

The research on the Howard started at first dormant and went through year eight for Howard and seven for Chandler. This trial was by Lampinen and took place at the Nickels Soil Lab in Arbuckle. It started in the second growing season comparing pruned to no pruning methods.

"With the Howard, after seven years of pruning treatments we saw no benefits to pruning compared to unpruned," Hasey said. "The comparable yield was exactly the same."

The Chandler orchard was planted in hedgerow in 2008, class 2-3 soil. The trial's first pruning treatments in March 2009 were: Heavily pruned

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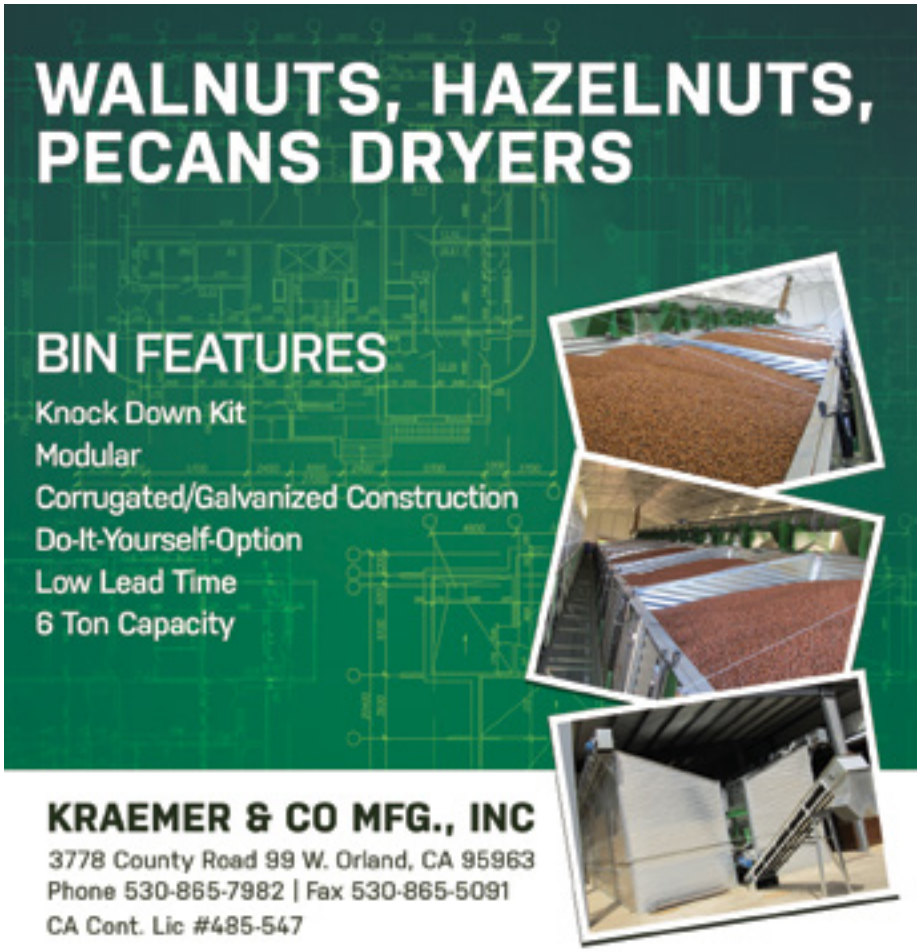
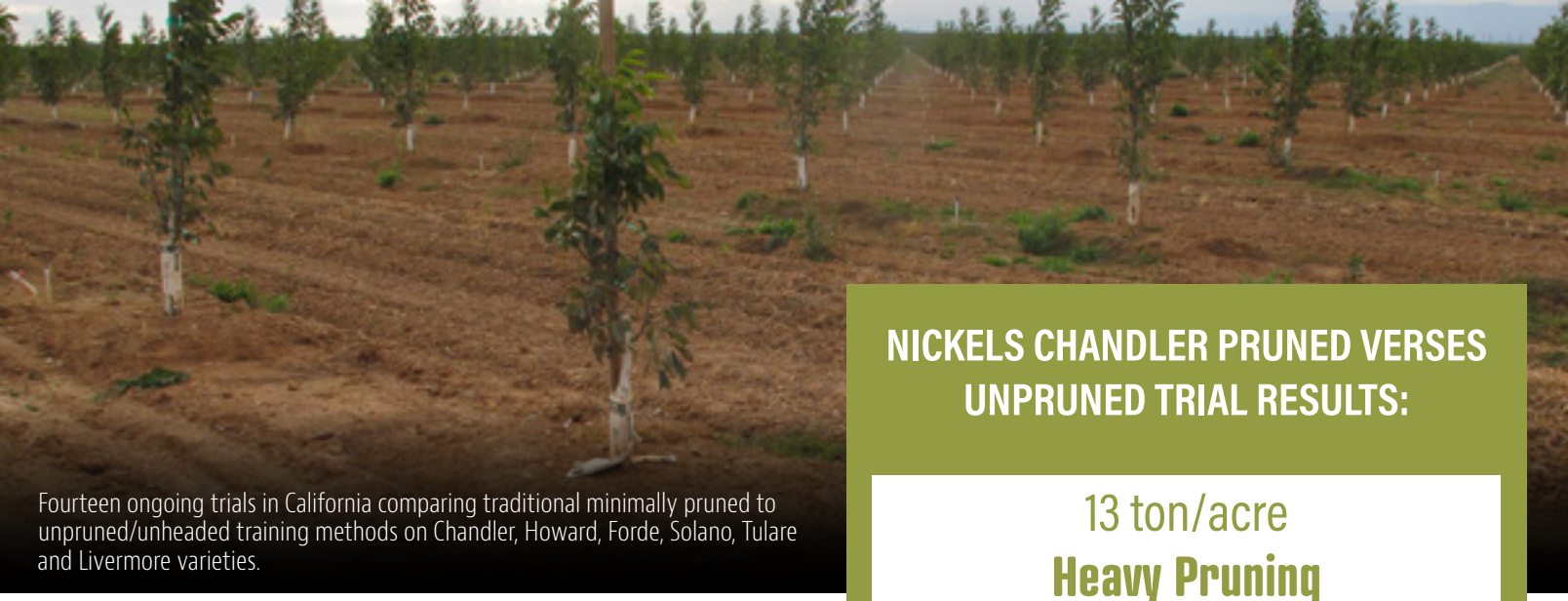
"Results from trials on several walnut varieties, including Howard, Chandler, Tulare, Forde, Solano and Livermore, have shown young walnuts do not need to be pruned in order to keep them growing or to produce adequate yields."

--Janine Hasey, UCCE





Fourteen ongoing trials in California comparing traditional minimally pruned to unpruned/unheaded training methods on Chandler, Howard, Forde, Solano, Tulare and Livermore varieties.

NICKELS CHANDLER PRUNED VERSES UNPRUNED TRIAL RESULTS:

13 ton/acre
Heavy Pruning

14.3 ton/acre
Minimal Pruning

15.3 ton/acre
Acre Unpruned

Continued from Page 41

(Hasey does not recommend this method), minimally pruned (what has for decades has been the traditional method), and unpruned/unheaded. In all methods the lower limbs below 3 feet were removed.

"I recommend removing necked buds. Primary buds more than 5 feet from the ground that are necked and have a viable secondary bud below it should be rubbed off to the side so as not to damage the secondary bud," Hasey said.

She also recommends the use of tall stakes or extension for unpruned/unheaded trees.

"Use tall stakes at planting or apply extensions by first dormant before second leaf. Stakes are not always needed; it depends on wind conditions where the orchard is located and on trunk growth. Always tie trees to the stakes loosely," Hasey said.

During the trial, researchers learned in the third year that minimally pruned trees needed 10 inches more water than the unpruned trees, and from the second to fourth leaf on all pruning methods, the yield on the unpruned trees was greater than the other methods with the trend continuing through the seventh leaf. The difference was especially significant between the heavily pruned trees compared to the unpruned trees.

Regarding walnut quality of the different pruning methods, in 2013 there was significantly more shrivel in the minimum pruned orchard crop compared to the unpruned trees. In years 2014 and 2015, there were no significant differences in quality, Hasey said.

In summarizing the Chandler pruning trial, Hasey said the heavy pruning method resulted in smaller trees and lower yield in years two and three. After seven years, the cumulative yields were not significantly different for any pruning treatment, but the unpruned/unheaded trees did trend higher. In addition, water use efficiency was higher in the unpruned/unheaded orchard.

"We saw no benefits to either minimum or heavy pruning in this trial," she added.

Statewide Walnut Training Trials

There is a total of 14 ongoing trials in California comparing pruned to unpruned/unheaded training methods on Chandler, Howard, Forde, Solano, Tulare and Livermore varieties from Butte to Tulare and Kings counties, Lake and Contra Costa counties.

The trials are researching variations of the unpruned/unheaded method, Hasey said.

What researchers have learned so far is that during the orchard development phase, advantages to unpruned/unheaded training include early increased yield, crop distributed over more primary scaffolds, less limb breakage in years five-seven, and trends toward better nut quality.

"We found some of the disadvantages to pruning are the costs of labor to prune and dispose of prunings, more scaffold breakage in years after pruning stops, lower canopy shades more rapidly which leads to quality problems, and pruning wounds exposed the tree to *botryosphaeria* infection," Hasey added.

She says that the statewide pruned versus unpruned/unheaded trails, along with grower trials and experiences, just don't support the common idea of pruning and heading lateral bearing walnuts is needed for growth and productivity.

"This is a major paradigm shift in walnut training. Growers now have more viable options available to them than just minimal pruning," Hasey said.

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Farming is the Family Tradition at Heinrich Farms

By **JENNY HOLTERMANN** | *Contributing Writer*

Eric Heinrich walks through a young almond orchard (Photos by J. Holtermann.)

AGRICULTURE RUNS DEEP IN the Heinrich family. You could even say it is in their blood. Gordon Heinrich, the patriarch, is a fifth-generation farmer and farming with three of his sons, Eric, Phil and Jerad. All nine of the Heinrich offspring have ties back to agriculture, whether it be an equipment engineer, irrigation specialist, pest control advisor, or nutritionist. Farming is the family tradition.

In the mid-60s, Gordon's father started farming almonds after selling his dairy. He grew up understanding hard work and had a desire to build his own farming legacy. Gordon is grateful for the opportunities that presented themselves over the years.

"Farming is a tough thing to get into, and I was blessed my father helped me get started. With some hard work, things started to fall into place. The good Lord blessed us. I always wanted to farm, and I enjoyed working alongside my dad when I was young," Gordon said.

He knew he wanted to provide the same for his children. Over the years, Gordon was able to establish his own farm and build the foundation the family knows today. He eventually grew his farm to now specializing in almond and walnut farming, commercial spraying, management, and harvesting, as well as operating a walnut huller and dryer based in Modesto, Calif.

The three sons had a desire to farm as well but worked elsewhere before returning to the family farm. Eric, the oldest son, had opportunities to start his own custom farming business. Once Heinrich Farms grew larger, he was able to incorporate his spraying business into the family farm. With the onset of increasing regulations, Eric was able to provide benefit by tackling the regulatory aspect of the family farm and provide his expertise.

Jerad claims he never left, but he admits he briefly worked for a bus company and is still a full-time firefighter for Modesto Fire Department. He always

Continued on Page 46

Heinrich Farms is a fifth-generation farming operation run by the Heinrich family, from left, Phil, Jerad, Eric and father Gordon.

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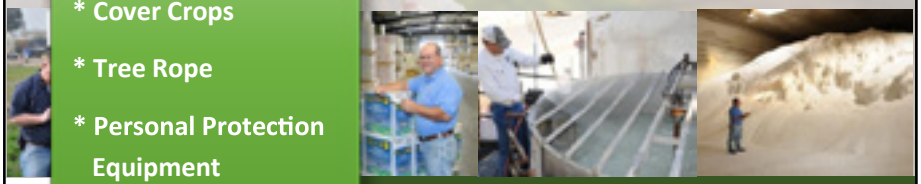

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worked for the farm during harvest, but it wasn't until after he graduated with his AA degree that he became more involved in 2003. Jerad enjoys working with his hands and specializes in mechanics, running harvest activities and new orchard development.

Six years ago, Phil missed his love for farming. He worked in construction and was even a security company owner but had a longing to get back to his roots. Phil said, "My dad said he had a little work for me, not sure how much at the beginning. It turned out he was able to keep me busy." Now Phil manages the walnut huller and dryer as well as the day to day farming.

Gordon was pleased to bring his sons back into the family business. He said in the end, "the feeling was we were stronger together than apart."

"Each one of the boys has special talents, their jobs evolved around their talents. It kind of keeps us out of each other's hair. But if needed, we all get out there and irrigate at midnight, or jump on the tractor in the middle of the day or whatever it takes to get the job done. We are all willing to be there," he said.

Gordon Heinrich, right, is proud to share the farming tradition with his sons Eric, left, and Jerad.

They may have their expertise and their tasks throughout the day, but everyone helps out where needed and can fill in when the other gets caught up on something else.

Gordon beams with pride as he discusses the ability of any of his children to aid in keeping their farm successful.

"Even my daughter, who is a schoolteacher, assisted with harvest last year.

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All my children have been hands-on and worked on the farm at some part."

A key to their success is the longevity of their employees.

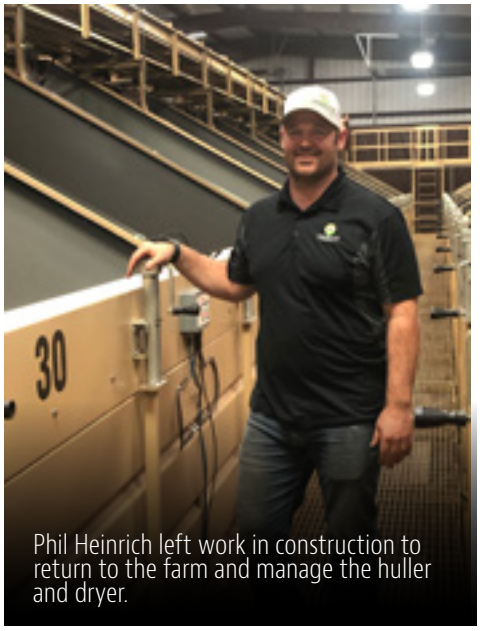
"We are fortunate to have guys work for us for 20 to 30 years," Phil said. "It means something to them to do a good job. They pride themselves in their work."

At Heinrich farms they know that the people who work for them have families to feed too. They want to make their farm a desirable place to work. By setting an example of hard work and perseverance, the Heinrich family shows firsthand how to work together as a team.

They can make it work by genuinely operating as a family unit. The three sons all returned to the farm at different points in their lives and personal development. Each bringing something to offer and compliment the other, so they all prosper.

"We evolved, adapted and grew into our positions as needed. As the team needs us, we rise to assist. There is something kind of special to be able to work with your family. You understand each other," Eric said.

When discussing key challenges to their farm, Gordon states, "one of the biggest challenges to our business is regulations; anything from water, pesticides, dust, labor. Everything is consistently changing. What might have been legal a few years back, now you might not be able to offer that anymore. Staying compliant and up-to-date is challenging."


Phil Heinrich left work in construction to return to the farm and manage the huller and dryer.

As Eric tackles the regulatory side of the business, he agreed.

"We want to comply and by being engaged with solutions, we can get our voice out there," Eric said.

Eric credits his involvement with California Farm Bureau Federation and political advocacy for his ability to stay on top of regulations. He also points to social media as a tool to better help him advocate.

"It is an interesting point in history where we can be on our ranch, on our tractor and be able to share your story with agriculture. To be able to be active in telling the real story is an important part of shaping public opinion."

He sees telling the farming story as a vital part of the business and the success of being able to combat challenges.

"I love the challenge, always doing something different and constantly learning new things, being the best stewards of the land, and hoping to pass it down to the next generation," he said.

As to Phil's favorite part of farming, he loves being able to watch the growth as the seasons change. "I enjoy watching things grow and your hard work pay off. As soon as we see the buds swell and the leaves start to push, I love it."

Watching their hard work grow and keeping the farm alive for the next generation is evident in all their responses. Jerad adds, "having relationships in the community, and being a part of a farming community is extremely rewarding."

The overall love and passion for agriculture runs deep in the Heinrich blood. Gordon is proud to be able to share this life with his sons.

"I have to pinch myself when I get up in the morning. I enjoy working with my sons. That they have the same interest as me, love for farming, love for growing crops," Gordon said.

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Adult spider mite populations can build rapidly as temperatures rise in the spring. (All photos courtesy UC Statewide IPM Program.)

New Tools Aid in Monitoring for Beneficials in the Orchard

By **CECILIA PARSONS** | *Associate Editor*

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DECISION SUPPORT AND MANAGEMENT tools for insect pests in walnuts and almonds continue to be refined by University of California Cooperative Extension Integrated Pest Management (IPM) specialists and farm advisors.

In research projects over the last few years, UCCE Area IPM Advisor Emily Symmes and UCCE Kern County Entomology Advisor David Haviland have demonstrated effectiveness of using yellow sticky cards in almond and walnut orchards to determine presence and population levels of sixspotted thrips, an important predator of spider mites.

Spider mites are a production concern in walnuts and almonds as very high numbers can cause early defoliation of the trees, reducing nut yield and quality in subsequent years, in addition to interfering with harvest and drying operations in the current year. When present in an orchard, SST feed almost exclusively on spider mites and thrive in spider mite webbing.

Symmes said using yellow sticky cards throughout the growing season to monitor for predator insects is a practice that is being adopted by pest control advisors and growers to back up their visual inspection of leaves for the presence of spider mites and other predators, such as Western predatory mite.

Sixspotted Thrips

Spider mite colonies can build rapidly as summer temperatures begin to rise, trees may experience more water-stress, and dusty conditions become more common in the orchard. Monitoring for their presence as well as predators beginning early in the season (April), and continuing until all spider mite treatment decisions have been made for the season can give growers an idea of the pest pressure in their orchards as well as which predators are present and their abundance. This can help with decisions on whether spray applications are needed and when, as well as inform which pesticides should be used to best protect the predators present. The research project showed that in both almonds and walnuts, the

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yellow sticky cards proved to be more efficient and a reliable means to for detecting SST and tracking their populations than traditional visual leaf counts (although leaf counts are still necessary to track spider mite and predator mite populations).

In orchards, spider mite colonies develop on the underside of leaves. Once hot weather sets in, mites reproduce rapidly and can produce many generations per year.

Spider mite predators can keep spider mites under control, depending on the populations of each. Sixspotted thrips can be effective in reducing high numbers of spider mites, but can be late to the game, especially if disrupted early in the season, moving into orchards only when mite populations are high. Both the adult and juvenile SST stages prey on spider mites.

Research done by Haviland in almonds in the southern San Joaquin Valley suggests that each SST consumes an average of 50 spider mite eggs per day at 86 degrees F. Populations levels of SST can double at twice the rate of spider mites. The average for spider mites is 7.6 days and 3.4 days for SST. This allows for rapid SST population increase and significant potential for reducing spider mite loads.

Symmes said the yellow sticky cards are effective for monitoring seasonal population growth of SST. The cards are double sided and tacky. Both large and small size cards were used in the walnut research project. The larger cards measured 6 by 12 inches and the smaller ones 3 by 5 inches. The larger size cards provided slightly higher pest detection rates, but Symmes said that using more of the smaller cards is a good option because they are easier to work with. Great Lakes IPM and Trece both carry the cards.

Symmes noted that there was no significant difference between the numbers of SST detected on cards hung high in the tree canopy and the cards placed on lower branches in walnuts. This differs from the standard practice of monitoring with sticky cards for codling moth and walnut husk fly by placing them high in the canopy, and can make using the cards for SST monitoring more efficient.

More data will be collected in future walnut work, examining several additional factors. Those include placement of yellow sticky cards in the orchard (border rows, middle or hot spots), variability in monitoring method efficiency at different SST populations, relationships among orchard, landscape and management feature and SST populations and their impacts on spider mites. Researchers will also validate or refine 2019 data including SST population doubling time and spider mite population doubling time, and numerical impacts of SST on spider mites to predict future spider mite abundance based on SST levels caught on the yellow sticky cards.

The trial is aimed at development of SST monitoring guidelines and best practices, identification of cultural and management practices for growers that can be used to conserve and enhance SST in orchards and the development of economic thresholds for spider mites based on improved SST monitoring practices.

Scale and its Enemies

Another pest to consider monitoring is walnut scale. Symmes said scale became a concern because it predisposes branches to Botryosphaeria infection.

Magnified sixspotted thrips are found on yellow sticky cards placed in an orchard to monitor for their presence. These predator insects can keep mite populations under control if their numbers are allowed to build in the absence of pyrethroid insecticides.

Monitoring for the presence of walnut scale and natural enemies can help with determining treatment need and timing spray applications.

Monitoring for scale should be done during the dormant season. It is found in crusted layers on older branches and scaffolds. Walnut scale eggs are laid under the protective cover in spring. The crawlers emerge, find a feeding location, and secrete the waxy cover that protects them. Walnut scale can complete two generations a year.

Treatment timing is important for good scale control. Traditionally, a delayed dormant spray has been used to control scale and cause less harm to beneficial parasitoids. Natural enemies can reduce numbers of walnut scale if they are present in the orchard. Two predators, the twicestabbed lady beetle Chilocorus orbus and anther small beetle, Cybocephalus californicus, can control low numbers of scale. Two parasitic wasps, Aphytis and Encarsia are effective in reducing scale numbers if not disrupted.

Dormant monitoring should be done prior to shoot growth. Double-sided sticky tape can be taped around limbs near adult scale to monitor for crawler emergence and time treatments in spring if delayed-dormant applications were not applied. The tape should be inspected weekly for the presence of crawlers using a magnifying lens, and crawler sprays targeted to peak emergence.

The UC IPM online Pest Management Guidelines provide information about the commonly-used pesticides in the almond and walnut systems and their impacts on natural enemies (predators and parasitoids). When visiting these webpages, look for the link above the treatment table ("the most effective and least harmful to natural enemies, honeybees") which will send you to a summary table.

Adult sixspotted thrips can serve as a dependable biological control for spider mites once numbers are high.

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New Research Includes Focus on NOW and Tree Physiology in Pistachio

Sterile navel orangeworm females call to males as part of the study on Sterile Insect Technology for NOW in pistachios (photos courtesy H. Wilson.)

By **HOUSTON WILSON** | *Entomology Extension Specialist, UC Riverside*
and **MACIEJ ZWIENIECKI** | *Professor, UC Davis*
and **LOUISE FERGUSON** | *Extension Specialist, UC Davis*

The California Pistachio Research Board's 2020 $1,946,070 research grant funding reflects the major problems currently facing the California pistachio industry. The 30 funded projects prioritize, in this order, controlling navel orangeworm (*Amyelois transitella*) (NOW), improving understanding of pistachio physiology including characterizing tree carbohydrate status, dormancy, salinity and drought management, pistachio rootstock improvement, and emerging soil borne fungal diseases and other insect pests. This article will discuss the projects focused on NOW and pistachio physiology.

Navel Orangeworm Research

Navel orangeworm (NOW) is the primary insect pest of California pistachios. Effective management of NOW involves a combination of winter sanitation, monitoring and well-timed sprays, timely harvest and, most recently, mating disruption. In the wild, NOW females emit a plume of pheromone in order to attract males, who follow these plumes to locate females and mate. Mating disruption uses various types of emitters to dispense a synthetic form of NOW pheromone throughout orchards, which effectively diminishes the males' ability to successfully locate females. Interfering with NOW ability to mate and reproduce can lead to reduced populations and, subsequently, lower crop infestation/damage.

Monitoring NOW in orchards under mating disruption remains a key challenge though, since the synthetic pheromone used to confuse males also shuts down pheromone traps commonly used to monitor NOW males. As such, Luisa Cheng (USDA Agricultural Research Service) is investigating the use of plant volatiles produced by pistachio mummies as a potential monitoring lure for orchards under mating disruption. In a related project, Dr. Tiziana Bond (Lawrence Livermore National Laboratory) is investigating the use of RAMAN spectroscopy to detect the synthetic pheromones used for monitoring NOW and mating disruption, and potentially natural pheromones emitted by female NOW them-

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Continued from Page 52

selves. If successful this highly sensitive detection method could be used to improve our understanding of how both synthetic and natural pheromones are distributed across orchards, which could lead to improved monitoring and mating disruption.

Mated female NOW deposit their eggs on pistachio nuts, and the larvae that emerge make their way into the nut in order to feed on the kernel. This not only reduces crop yield and quality, but NOW infeststation has been associated with increased incidence of aflatoxin. While research to date has determined that NOW females prefer to deposit eggs on nuts with reduced hull integrity later in the season, it remains unclear exactly what physical and chemical changes in the nut actually elicit this response when hull integrity declines. Furthermore, there is little known about why changes in hull integrity occur – some years hull integrity is good and other years it is poor – new information is needed to help growers predict the timing and extent of changes in hull integrity.

Three complimentary projects will investigate how changes in hull integrity attract NOW females. In the first project, UC Davis Assistant Professor Dr. Barbara Blanco-Ulate and Extension Specialists Dr. Giulia Marino and Dr. Selina Wang will be investigating the seasonal progression of pistachio nut maturity, split and hull senescence as a function of heat accumulation. In the second project, UC Davis Assistant Professor Dr. Georgia Drakakaki will investigate shell and hull development, growth and senescence at the cellular level. In the third project, Extension Specialist Dr. Houston Wilson (UC Riverside) and Dr. Chuck Burks (USDA Agricultural Research Service) will investigate how these factors influence the timing and extent of NOW female egg deposition.

Finally, the CPRB recently initiated a major project to investigate the use of sterile insect technique (SIT) for NOW, and are currently funding research efforts in this area led by Dr. Houston Wilson and Dr. Chuck Burks. The sterile insect technique hinges on the ability to introduce large numbers of sterile NOW into orchards that will then mate with wild NOW. Mating between a sterile and wild NOW leads to inviable offspring – while a female can still deposit eggs, they will never produce a larva. Over time, introductions of sterile NOW could lead to reduced NOW populations and subsequent crop infestation/damage. The CPRB-funded initiative makes use of a USDA mass-rearing and irradiation facility in Phoenix, AZ. This facility was originally developed for a pink bollworm SIT program, but with the eradication of that pest it became available for use with NOW. The facility currently produces upwards of 750,000 sterile NOW per day, but there are many challenges associated with the collection, irradiation, transport and release of these sterile moths. As mentioned, the facility was developed for pink bollworm, and changes are now needed to adapt it to NOW. Over the past two years, Wilson and Burks have carried out a series of laboratory and field experiments to improve the quality and dispersal capacity of sterile NOW. Findings to date indicate that cold storage, transport and

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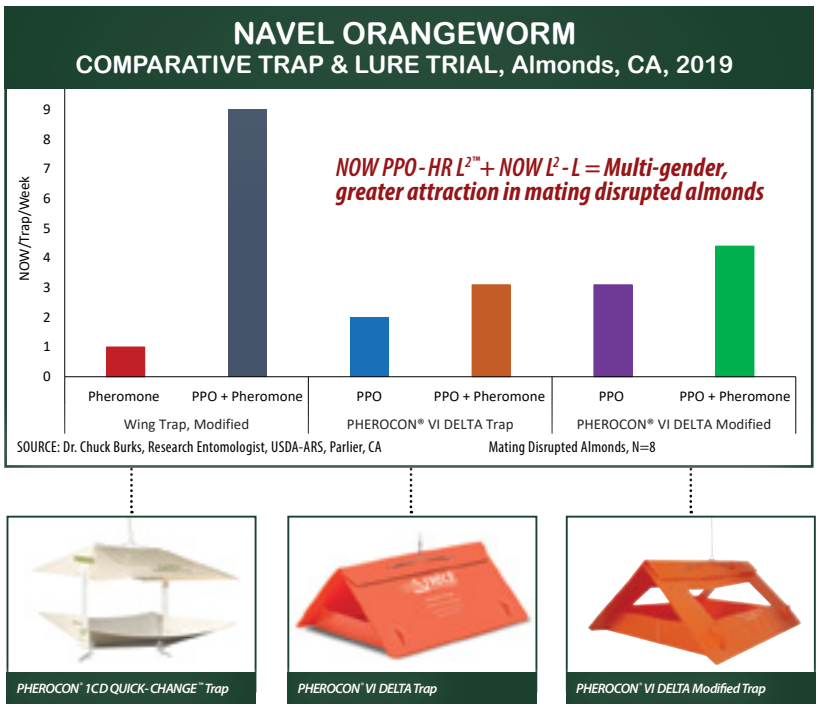

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release methods for sterile NOW are having a negative influence on moth performance, and this will be the focus of their CPRB-funded research in 2020.

Pistachio Physiology Research Projects: Carbohydrate Observatory

Understanding the whole tree physiology, to facilitate a better understanding of dormancy, bloom, set, yield potential and response to the abiotic stresses of temperature, salinity and drought is another top priority. The core of this set of projects is support to the ongoing ***Carbohydrate Observatory*** project of Dr. Maciej Zwieniecki of Plant Sciences: https://psfaculty.plantsciences.ucdavis.edu/plantsciences_faculty/zwieniecki/CR/cr.html.

Nut producing trees rely upon photosynthesis, the process by which plants use sunlight to synthesize starches and sugars from carbon dioxide and water. These sugars and starches, referred to collectively as **N**on-**S**tructural-**C**arbohydrates, (NSC), support the tree's growth and annual bloom that produces the nut crop.

The ***Carbohydrate Observatory*** uses a citizen science approach, the citizens being the almond, pistachio and walnut growers who send monthly wood and bark samples from their orchards to be analyzed for sugars and starch. The results are made available through a website that each grower has access to. Growers can then track the carbohydrate levels of their nut trees throughout the year while pairing it with their orchard climate and management records and their records of dormancy, pollination, bud break, flowering, fruiting, harvest and leaf drop. The goal is to build a better biological understanding of the role of carbohydrates and to use this dataset as a tool to predict yield and understand how the environmental stresses such as lack of chilling hours, salinity and drought affect tree growth and yield.

The specific goals of the ***Carbohydrate Observatory*** are to:

1. Understand how annual patterns of starch and soluble sugars carbohydrates concentration in orchard trees differ throughout the Central Valley as atoll for improvement of spring/fall management practices and our understanding of chilling requirements.

2. To develop a tool that uses (NSC) levels as a predictor of yield for the following year and to understand variable crop yields.

3. Create an easy interactive (NSC) data sharing online platform so growers can see how their orchard is performing relative the regional average.

This long-term project will result in a comprehensive understanding of

how pistachios grow and produce nuts using (NSC) as an indicator of tree status. Once the basic model has been completed the effects of the environmental stresses of extreme temperatures, drought, salinity can then be examined for their effects upon the trees (NSC) status. A beginning example of the how the baseline date from the ***Carbohydrate Observatory*** could be used is discussed below.

UC Davis Department of Plant Sciences Professor, Dr. Maciej Zwieniecki and recent PhD graduate, Dr. Jessie Godfrey, demonstrated how this tool can be used to determine the effects of sodium on (NSC) reserves. Specifically, they found that active retrieval of sodium from xylem sap may allow for the preservation of (NSC), particularly starch, pools in mature xylem tissues by limiting the demand for carbon-based osmoticum, sugars. In plants subjected to salinity the plant responds by using (NSC), primarily the sugars, to increase the osmotic pressure of the xylem fluid and increase the ability to extract water from the saline soil water. They found that the young growing tissues like bark and fine roots were found to counteract salinity by degrading their carbon dense, primarily starch, tissues, into osmotically active sugars, increasing the osmotic strength of the Xylem fluid.

On a practical, production level these results demonstrate a tree's most distal or external parts, such as bark and fine roots, are replaceable. However, while sacrificing these young bark and root tissues to concentrate and maintain (NSC) in a tree's core is a viable short salt tolerance strategy, it needs to be determined if this is a viable strategy for maintaining yields. This also suggests that an orchard monitoring strategy that measures only total (NSC) may not be effective as monitoring the transient sugar and starch levels within growing tissues, which are affected before total (NSC) reserves. This may prove to be the best practice for utilizing carbohydrate measurements to manage pistachio orchards using saline irrigation. This hypothesis is supported by the earlier work of Tim Spann who demonstrated that a transient drop in total (NSC) appears to precipitate the floral bud abscission that results in alternate bearing.

In closing, the CPRB, in supporting these major NOW projects, is developing the knowledge required to address the threat of NOW. With the ***Carbohydrate Observatory,*** a long-term project, the CPRB is developing the knowledge to better produce pistachios in a changing climate. Future articles in this series will discuss additional CPRB funded research projects focused on pest and disease management, young tree training, dormancy, salinity management and website development.

Comments about this article? We want to hear from you. Feel free to email us at article@jcsmarketinginc.com

MANAGING ANTS IN ALMONDS THROUGH HARVEST

By **CECILIA PARSONS** | *Associate Editor*

Southern fire ants can quickly consume exposed almond kernels (photos by Jack Kelly Clark, University of California Statewide IPM Program.)

PROTEIN FEEDING ANTS CAN ACCOM-plish a task few other insect pests even attempt. Given an opening in an almond shell, they can, in very small bites, eat an entire kernel, leaving an empty peel behind.

Ant feeding, reports Blue Diamond's Director of Grower Relations Mel Machado, can steal a good portion of an orchard's crop yield in a short time – before a grower is aware of the problem.

His advice to growers is to "look down."

"Growers tend to look up, at the trees, but they need to look at the orchard floors and see if they have an ant infestation."

Know Your Ants

Machado cited a well-known tactic to determine if the ants present in an orchard are protein feeders- the species that feed on almonds as they lay on the ground after shaking, waiting for the pickup machines.

"Secure a snack size chip bag or a hot dog in a zip lock bag to the floor of the orchard where ants are spotted. If you come back and find they have devoured the chips or hot dog, these are the ants that feed on almonds," Machado said.

Once that determination is made, growers can apply ant bait to knock down ant populations. The catch, Machado said, is that depending on the bait used, control can take 8-9 weeks. Determining the extent of the ant infestation and implementing appropriate control has to start well before harvest.

The University of California Statewide Integrated Pest Management (IPM) Program explains that the two ant species that can pose the most threat to a harvested almond crop on the ground are the pavement and southern fire ant. The pavement ant is more common in the northern San Joaquin and Sacramento valleys. It prefers to nest in sandy or loam soils. This ant is dark brown in color, has a single node, and has coarse hairs on its body.

The southern fire ant tends to be found more in the San Joaquin Valley. It has an amber colored head and thorax with a black abdomen. This ant species swarms out of the nest when disturbed and can deliver a painful sting. Where drip or micro sprinklers are used, the southern fire ant will nest on the edges of the wetted area. Nests are made on berms in flood irrigated orchards with heavy soils. In lighter soils, nests can be both on berms and middles. This ant species prefers to nest in weedy areas. The UC IPM Program notes that damage potential appears to be less in orchards with clean floors. Minimizing weed seeds also eliminates a food source for ants.

Both ant species have peak activity during the morning hours and just prior to sunset.

The southern fire ant can cause more crop damage than the pavement ant. The amount of damage increases the longer the nuts are on the ground. Almond varieties with a tight shell seal or with shell splits less than 0.03-inch-wide typically will have less ant damage. A lighter crop with larger size nuts increases the potential for ant damage.

Depending on anticipated harvest timing, April and May are the recommended times for surveying orchards for ant infestations.

Orchard floors should be surveyed 2-3 days after an irrigation to determine the level of ant activity. The IPM program recommends choosing five survey areas per block, each about 1000 square feet, including soil areas from mid-alley to mid-alley beneath trees. Total colony entrances in all five survey areas. Fifteen or fewer colonies total, and nuts on the ground for four days will result in 0.9 percent damage.

The figure increases to 4.9 percent by 21 days. At 45 total colonies the damage increases from 1.4 percent at four days to 7 percent at 21 days.

Choosing Your Bait

Baits are advised to manage potentially damaging ant populations, but they need time to work. To maintain bait quality in the orchard and maximize bait ingestion by ants, the soil surface should be dry when bait is applied. How bait is stored prior to use is also important as the soybean oil that is used as an attractant can become rancid over time. Bags stored for more than a few weeks should be turned over to disperse the soybean oil throughout the cornmeal carrier.

Some of the most common baits are pyriproxyfen (Esteem), and methoprene (Extinguish). These are insect growth regulators. They do not immediately kill foraging worker ants as do abamectin (Clinch) and metaflumizone (Altrevin). Existing foraging worker ants must die off naturally before there is a noticeable decrease in ant numbers. Weed seeds, particularly spurge may attract ants away from baits if their

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The pavement ant is more common in the northern San Joaquin and Sacramento valleys.

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active ingredient degrades rapidly after application.

Kris Tollerup, UCCE Integrated Pest Management advisor said there is a bait product that provides a faster knock-down of ant infestation for growers who are bumping up to harvest. Meta-flumizone (Altrevin) can downsize ant populations in almond orchards in less than a week, Tollerup said. The UC IPM web site has guidelines on use of this product. The pre-harvest interval is three days. A permit from the county agricultural commissioner is required for purchase or use of the product.

Metaflumizone is a corncob grit and soy oil bait. It is only effective against fire ants because they are attracted to the soy oil. This bait should be applied when ants are most active and when soil temperature is above 60 degrees F. The UC IPM guidelines report that treatments are most effective if applied 2 days after irrigation, when ant activity is at a maximum. Irrigation should not resume until at least 24 hours after application. Do not apply if rainfall is anticipated within 4 to 6 hours after application. This bait can be broad-cast using properly calibrated ground equipment, but spot applications at the location of the ant colonies are advised. Re-treatment should be considered after three to four months.

Dry weather and warmer temperatures going into March are likely the causes of southern fire ant early season activity. Tollerup said that as temperatures warm this spring, southern fire ant colony numbers will begin to build. That does not necessarily mean the total number of colonies will increase.

Tollerup said mating flights occur in May, July, and late Sept in many ant species. It takes about four to six weeks before the nascent colonies become noticeably active.

Knowing your ant species, how they behave and matching them to the right bait can help bring season long control.

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3rd leaf	Oakdale	130 trees/ac	1,600 lbs/ac
3rd leaf	Turlock	130 trees/ac	1,200 lbs/ac
3rd leaf	Turlock	130 trees/ac	1,100 lbs/ac
4th leaf	Fowler	132 trees/ac	2,058 lbs/ac
4th leaf	Dinuba	124 trees/ac	2,400 lbs/ac
3rd leaf	Riverdale	132 trees/ac	1,700 lbs/ac
6th leaf	Firebaugh	135 trees/ac	3,694 lbs/ac
3rd leaf	Sanger	136 trees/ac	1,325 lbs/ac
3rd leaf	Modesto	138 trees/ac	1,503 lbs/ac
4th leaf	Modesto	138 trees/ac	3,138 lbs/ac
3rd leaf	Shafter-Wasco	124 trees/ac	1,138 lbs/ac
8th leaf	Salida	138 trees/ac	3,145 lbs/ac
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Almond Flower, Foliar and Fruit Diseases and Their Management

By **JULIE R. JOHNSON** | *Contributing Writer*

IN THE FIGHT AGAINST FLOWER, FOLIAR and fruit diseases in almonds, there are key components growers need to be aware of as they decide what strategy fits best in the battle to protect their investment.

First growers must know what disease they are up against, Dr. James E. Adaskaveg, professor and plant pathologist at UC Riverside told a group of growers at the North Valley Nut Conference. Spring and summer foliar, flower and fruit diseases include brown rot blossom blight, scab, rust, green fruit rot/jacket rot, shot hole, anthracnose, bacterial spot, bacterial blast, alternaria leaf spot, hull rot, or phytopthora root and crown rot. Once the problem is identified, growers can decide how to best manage the problem.

Adaskaveg explained that for a disease to become a problem it has to have all components of disease triangle: 1) The host, which is the cultivar, its physiology, growth pattern, and disease susceptibility; 2) The environment and its climatic and micro-climatic conditions, such as temperature, wetness, irrigation programs, air movement and wind; and 3) The pathogen, which might not be in the orchard at the start, but then gets

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The first step to controlling spring and summer flower, foliar and fruit diseases in almonds is proper identification (Photo by J. Johnson.)

introduced by being blown in by the wind, coming in from adjacent fields, or during planting.

"You have to have all three components of the triangle in order to get foliar disease into an orchard, and that is the critical thing to remember," Adaskaveg said. "In addition, interactions between the components affect the amount of the disease and its spread."

He added that environmental and host components of the triangle can give clues to which pathogens may be encountered, such as temperature and wetness, phenological stage of the host, host cultivar and presence of inoculum from previous seasons.

There are initial tools a grower can use in disease management, including the choice of tree variety, planting designs, irrigation systems and other practices. However, once these decisions are made and implemented, the orchard is what it is from that point forward, Adaskaveg said, and once disease is introduced into that orchard the grower has to look at other tool options.

Adaskaveg said there are an increasing number of fungicides being introduced to the market, and some in ongoing development, with many of the new developments being pre-mixtures.

Generally, Adaskaveg said, all of

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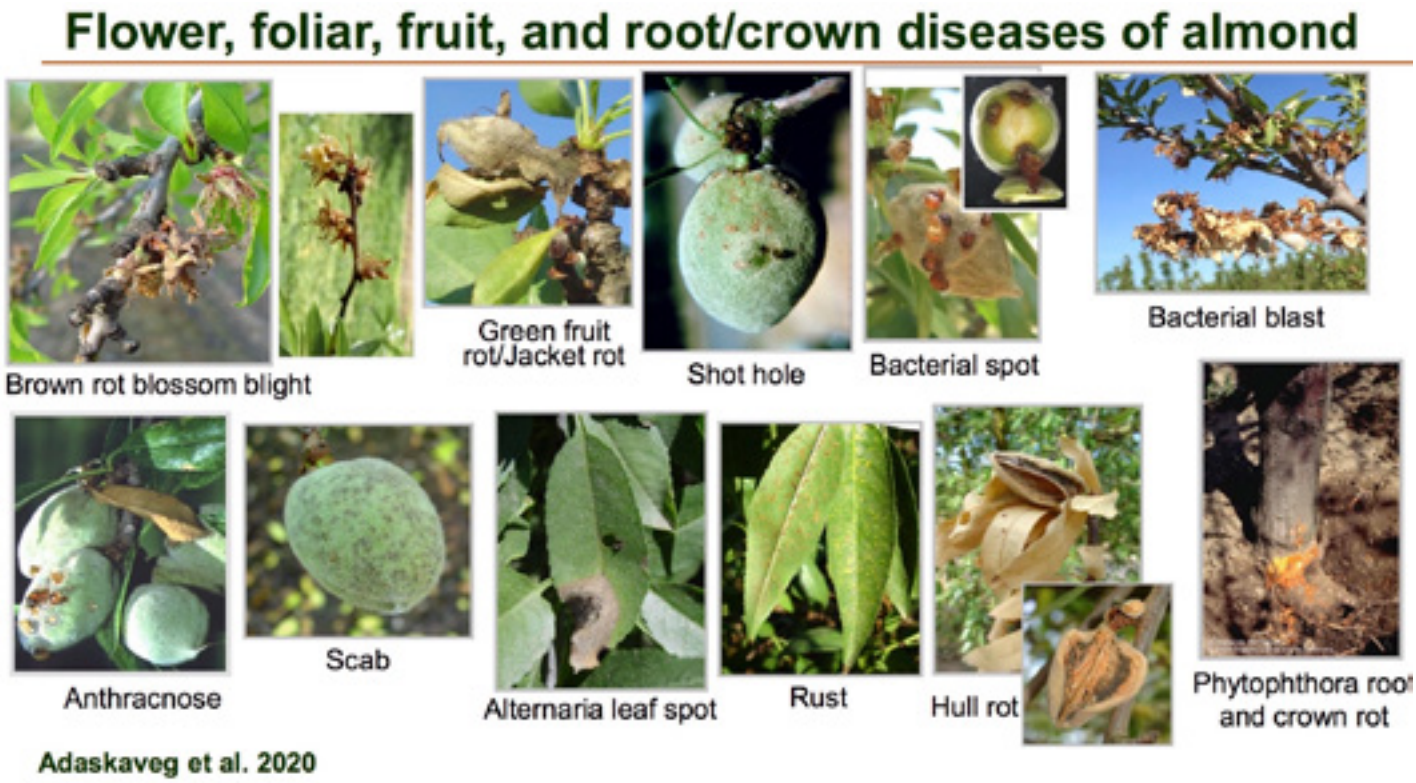

Almond flower, foliar and fruit diseases come in a wide range and assortment, but all have to have all three components of the 'disease triangle' – host, environment and pathogen (photo courtesy J. Adaskaveg.)

Continued from Page 63

the new reduced-risk fungicides do not affect bees.

He gives the following cautions concerning fungicide applications and the health of bees:

- Fungicides applied at bloom should not be mixed with adjuvants, such as penetrants, spreaders, stickers nor tank-mixed with insecticides, or fertilizers.
- Avoid bloom application of older multi-use fungicides such as chlorothalonil, Captan, and iprodione.
- Apply treatments to trees when bees are in the hive and not in flight (when temperatures are below 55 degrees F). Do not spray near hives.
- Apply fungicides after daily pollen release is exhausted (late afternoon, evening, or night).
- Follow UC guidelines for fungicide applications – delayed bloom applications under low disease pressure; two-bloom applications under high disease pressure; follow the "rules" for fungicide resistance management.

Brown Rot Blossom Blight

"Brown rot blossom blight, many growers know this disease well," Adaskaveg said. "Prevention is the best way to manage this disease. Try not to ever let this disease get established in an orchard because to get rid of it with our minimal pruning practices is very difficult."

Brown rot infection period is well-defined as the bloom period of seven to 14 days for each variety in the orchard. Risk of infection is determined by environmental conditions, such as temperature and wetness. There are varietal differences in susceptibility (Nonpareil the least susceptible) and those varieties need to be treated accordingly.

The disease spores are airborne and disseminated by wind or wind-driven rain, Adaskaveg said.

Wetness from rain, fog or dew allows germination within hours and infection when temperatures are be-

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"Brown rot blossom blight, many growers know this disease well. Prevention is the best way to manage this disease. Try not to ever let this disease get established in an orchard because to get rid of it with our minimal pruning practices is very difficult. "

—Jim Adaskaveg, UC Riverside

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Continued from Page 64

tween 64 to 77 degrees F. Because these conditions commonly occur each year during bloom, risk of disease is usually present, he added.

Green Fruit Rot/Jacket Rot

Green fruit rot/jacket rot comes in varieties of Botrytis *cinerea* (gray mold), *Monilinia* spp. (brown rot) and *Sclerotinia sclerotiorum*, and is associated with the latter part of the bloom period when the fungus infects senescent blossom tissue.

Secondary infections can occur in jacket rot when infected petals fall onto leaves.

Infection in anthers can spread and spread from both petal and anther infection can result in damage to nut clusters.

Shot Hole

Shot hole of almond is a fungus that primarily infects leaves, fruit and green shoots, but rarely stems. Adaskaveg said shot hole infections are rare on traditional almond varieties, but common on some newer ones.

"With shot hole, when you get into trouble is when the infection occurs at bloom-time when the leaves are just coming out and they are small, and if infected they drop and even the fruit can drop, so it can be an economic problem disease like brown rot or jacket rot," Adaskaveg said.

There are a number of "best treatment" fungicides for each of the diseases, including those used as single application at delayed bloom when environmental conditions are less favorable for infection.

Adaskaveg recommends the use of pre-mixtures for highest efficacy, consistency, and resistance management.

Also included among the best treatments are the biologicals.

Determining factors in choosing a fungicide include environmental conditions, such as rainfall, and fungicidal properties.

"Timing of bloom applications is based on host phenology and environmental conditions," Adaskaveg said.

One of the goals in the treatment of these diseases is to use each class of fungicide only once per season or rotate between pre-mixtures containing different classes.

Adaskaveg provides the following advice on fungicide application:

- Many of the newer brown rot fungicides have some locally systemic activity and subsequent pre- and some post-infection activity.
- During less favorable environments, a single application at delayed bloom (20- to 40-percent bloom) is sufficient for good disease control.
- During highly favorable conditions, a two-spray program with applications at pink bud and full bloom is recommended.

Bacterial Blast and Canker

Bacterial Blast and Canker are springtime diseases of many fruit tree crops, such as citrus, pome and stone fruits.

Symptoms of the blast phase of the pathogen, Pseudomonas *syringae* pv. *syringae*, develop typically in early spring. The disease can be very destructive to flowers and spurs and has no fungal mycelium as is found in brown rot and jacket rot.

Canker phase symptoms of the disease develop typically in late winter and early spring on the tree's truck and scaffold branches. It can be very destructive to trees two to eight years old. A sour smell is associated with canker which shows itself by necrotic flecks which often merge to form large cankers that do not extend below a graft union.

The bacterial blast and canker pathogen are a ubiquitous epiphyte of plants and is disseminated by rain to natural plant openings, Adaskaveg said.

The disease develops on trees weakened or stressed primarily from frost damage and nematode damage. Varieties Mariana 2624 and the peach/almond hybrids Hansen, Nickels, Cornerstone, Titan and Bright's are more susceptible to the disease, but all cultivars of almond are susceptible to various degrees.

Adaskaveg said it is important

for growers to maintain health and vigor of their trees to avoid bacterial blast and canker through nutrition, pre-plant fumigation, post-plant nematicides and removing die-back.

Laboratory studies have shown all strains of the pathogen are sensitive to kasugamycin, but less so to copper, he said.

In February the EPA accepted a Section 18 petition to allow the use of Kasumin (kasugamycin) to control bacterial blast and canker in almond. This action provides almond growers a significant tool in the arsenal against the disease and the damage it causes to trees and crop loss.

Kasumin is an antibiotic treatment that has a different mode of action compared to other antibiotics and breaks down to near zero levels within 30 days. In addition, Adaskaveg explained, it offers no worker safety issues, is virtually non-toxic to mammals and there is no concern of resistance in human/animal bacterial pathogens with plant use.

UC Riverside Plant Pathologist James E. Adaskaveg gives a presentation on Almond flower, foliar and fruit diseases during the North Valley Nut Conference (photo by J. Johnson.)

Hull Rot

Warm and humid summers can make almond orchards more susceptible to diseases such as hull rot, especially with current planting practices causing almond orchard canopies to be denser with less light penetration.

There are two major hull rot pathogens, Monilinia *fructicola* and Rhizopus *stolonifer*, with Aspergillus *niger* and Botrytis *cinera* occasionally causing the disease.

Adaskaveg said it is often difficult to determine the pathogen in the field.

"Fruit have to be incubated or isolations have to be done to identify the pathogen," he added.

In surveys of 12 orchards in the last two years in Butte, Colusa, Sutter, San Joaquin, and Stanislaus counties, Rhizopus was found to be the predominant cause of hull rot in 11 of the orchards. Aspergillus was found in one orchard in Stanislaus County at a low incident, Adaskaveg reported.

Inoculum of both Rhizopus and Monilinia are air-born, with Rhizopus found in soil and Monilinia originating from almond and other stone fruit.

Hull rot infects fruit and causes dieback, and is most severe under high humidity conditions in the orchard.

Timing of fungicide application for management is different for each of the two main pathogens.

For Rhizopus hull rot, early hull split applications when susceptibility is high should be done as the pathogen generally infects senescent tissues. Fungicides are applied most effectively with navel orangeworm applications. For Monilinia hull rot, applications should be done earlier, in late spring. Adaskaveg said fungicides, alkaline fertilizers, and, potentially, bio-controls can reduce the incidence of hull rot, as does planting, irrigation, sanitation and pruning practices.

Comments about this article? We want to hear from you. Feel free to email us at article@jcsmarketinginc.com

For Better Yields,

Get Personal With Your Trees

By **ALMOND BOARD OF CALIFORNIA** | *Contributing Writer*

Observing the trees through the season for spur balance can provide important information for growers (photo courtesy Almond Board.)

MANAGING ORCHARDS IS A BIT LIKE marriage: It's a long-term relationship. A mistake today could stay with you for a while, but care and attention to detail can pay benefits year after year.

This analogy demonstrates a vital truth that Sebastian Saa, senior manager for Agricultural Research at the Almond Board of California (ABC), stresses upon growers each year: Attaining optimal yields requires taking the time to get to know your trees – it's a marathon, not a sprint.

"Everybody wants to experience good yields, and that's important," Saa said. "But understanding how to read the tree, how to interact with the tree, is what leads to sustainable yields year after year."

That means paying attention to what the tree is telling you at each stage of growth, understanding what certain changes or circumstances mean and reacting appropriately. Reading your trees' signals is particularly important under challenging conditions, as signals can help a grower determine if they need to adjust certain practices. Missing a signal from the trees — or misinterpreting it — could lead to the wrong decision when it comes to fertilization, irrigation or foliar sprays, Saa said.

Misinterpreting your trees' signals could also mean you'll miss an opportunity for quality yields, not only this year but next year. This is because while the tree is producing this year's crop, it's also getting ready for next year.

In each tree, branches carry fruit-bearing spurs (compacted shoots no longer than 2 inches) that harbor most of the tree's almonds. These spurs are constantly changing — new ones being born, others bearing fruit, still others dying off, etc. Identifying the different population of spurs in your tree, and what other key parts of the tree are up to, will provide a wealth of important information, Saa said.

Furthermore, understanding and calculating yield comes down to a simple equation: the number of flowers multiplied by the percentage of fruit set multiplied by kernel weight:

No. of flowers × % of fruit set × kernel weight = Yield Potential

But don't let the simplicity of this formula fool you — the importance of

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your final count is hardly trivial.

"The formula may be straightforward, but its implications are significant, especially if you can figure out how to manipulate the variables," Saa said.

Strong Spring Bloom Depends on Previous Year's Practices

What is it about what is arguably almond trees' most beautiful feature that makes them so vital to optimal yield?

"More flowers are better, but it's not just density – flower quality is also important because healthy and fertile flowers are more likely to set fruit," said Saa. "The flowers you see this year began to develop last year, between August and October. Management during that time is critical."

One key management practice growers can employ to encourage fruitful flowering involves keeping a healthy canopy of leaves on the tree after hull split and after harvest so that the tree can continue to gather the energy it needs to develop the buds for the following year's flowers. Conversely, overly stressing the trees before and after harvest can lead to premature defoliation and have a detrimental impact on flower development.

> **"Everybody wants to experience good yields, and that's important. But understanding how to read the tree, how to interact with the tree, is what leads to sustainable yields year after year."**
> Sebastian Saa, Almond Board

Because growers irrigate at a deficit to induce conditions that facilitate harvest, the tree is already stressed by harvest, when irrigation is shut down completely. Mild, controlled deficit irrigation during this period is fine, but the problem occurs when the deficit is too long and intense. To prevent early leaf drop, growers should irrigate as soon as possible after almonds are harvested, Saa said.

"We understand growers are very busy during harvest, and that irrigating can be tricky at that time of year, but trying to irrigate as soon as possible should be a priority," Saa said.

Another key driver of abundant, healthy flowers is the number and type of spurs (compacted shoots no longer that 2 inches) on the tree branches. Flower buds are formed on spurs and therefore spurs are the fundamental bearing structure of almond trees. Trees are constantly cycling through these fruit-producing structures. Each year some spurs are just beginning to grow, some are "resting" after producing fruit the previous year, others are producing fruit, and some are dying after producing fruit in previous seasons. Therefore, observing your trees throughout the season for spur balance can provide important information.

"Manage your trees to keep balanced populations of almond spurs. Make

Continued on Page 70

Maximizing kernel weight depends on timely delivery of water and nutrients during the summer months, along with the tree's ability to successfully harvest sunlight to produce carbohydrates (photo courtesy Almond Board.)

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sure that in any given season your tree has recently formed spurs, spurs producing fruit and spurs resting," Saa said.

Ensuring a good balance of spurs, with fruit for this year and growth for future years, is important to ongoing sustainable yields. Generally, the tree takes care of this balance, so long as it is cared for properly.

"Imbalance managements — i.e. overuse of water and nutrients — result in imbalance spur populations and lack of sustainable yields," Saa said.

Saa recommends growers use the California Almond Sustainability Program (CASP) Nitrogen Calculator to guide rates and timing of nitrogen applications. Similarly, the CASP Irrigation Calculator provides growers with key guidance to manage their trees for optimal balance of spur populations and therefore sustainable yields.

Nutrients' Role in Favorable Fruit Set

In mid-April, almond growers will start to see the fruits of their labor — literally. After bloom season, almond trees enter a period where some flowers set fruit, while others fall to the ground.

There are a full range of factors that contribute to converting flowers into harvestable fruit on the tree, both pre- and post-petal fall. The start of petal fall marks the onset of an important competition between different parts of the almond tree, ultimately impacting the percentage of fruit that will set.

"At that point, everyone is growing — the roots, leaves and fruit — and they are each trying to be the winners," Saa said. "How do we mitigate the competition, which isn't necessarily bad, in the tree? How do we manage it, so the tree isn't perplexed and starts dropping fruit?"

With almond trees grabbing significant amounts of nutrients and water through their roots in April, supplying them with the right quantities is paramount to meeting their biological functions. In addition to feeding trees the appropriate nutrients, attention to water management at the beginning of the irrigation season is essential. Saa says it can be tricky for growers to calculate evapotranspiration (ET) at this stage of early fruit growth, when the tree canopy is still growing.

"You don't want to apply too much water and starve the roots of oxygen. Too little or too much water can be detrimental," Saa said.

He recommends tools, such as soil moisture monitors and a pressure chamber, to help growers calculate water demand. ABC's Almond Irrigation Improvement Continuum provides detailed information for use of both tools to help effectively and efficiently manage irrigation and scheduling practices.

Provided that tree nutrient and water demand was properly managed, growers should see nice new shoots, with good leaf size and complete hull development around the first week of May.

"The hull is like a balloon. You want large balloons on your tree in early May and then the process of filling up those balloons with kernels begins," Saa said.

"Filling Up the Balloon" to Maximize Kernel Weight

Once April comes to a close, growers will start to see those hull balloons reach full size, which generally occurs by the first week of May. Management decisions related to water and nutrients from then until July will largely determine the success, and size, of kernel development inside the hull. Again, growers have access to ABC tools and resources, such as the Nitrogen Calculator and Almond Irrigation Improvement Continuum, to help quantify and meet tree nutrient and evapotranspiration demands.

"Inflating the balloon is relatively cheap for the tree, but essential. However, it's an expensive proposition, as trees require a lot of energy, i.e. carbohydrates, to develop good quality kernels," Saa said.

Through photosynthesis, sunlight is harvested to produce carbohydrates, which provides energy to grow the kernel. Referencing Dr. Zwieniecki's work out of UC Davis, Saa likens carbohydrates to currency. The tree has to buy the food necessary to fill the hull balloon.

So how do growers ensure their trees will have enough carbohydrate dollars during the summer months to feed kernel growth?

"Since carbohydrates are produced by the leaves intercepting light, we want to have a canopy that covers 80% of the orchard floor in midsummer," Saa said.

As with most aspects of farming, present-day success relies on good decision making in the past. Reaching the desired 80-percent canopy size in midsummer depends on management decisions made during the spring following petal fall and leading up to early fruit growth. As noted previously, all aspects of the tree are growing during the same time — the roots, leaves and fruit — and each part wants to come out on top; they are all competing for resources. Satisfying tree nutrient and water demand, therefore, not only increases the percentage of fruit set, it also leads to the growth of healthy and abundant leaves, which will ultimately harvest sunlight to feed kernel growth during the summer.

"It's all management that defines the potential for the tree to capture water, light and nutrients. The final kernel will be the direct reflection of those three factors," Saa said.

Growers with questions regarding optimal yield are encouraged to reach out to Sebastian Saa at ssaa@almondboard.com.

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Pictured are gummy exudates exuding from almonds after brown marmorated stink bug feeding (photos courtesy J. Rijal.)

Brown Marmorated Stink Bug Emerging as Significant Pest in Almonds

By **MITCH LIES** | *Contributing Writer*

THE GOOD NEWS FOR California tree nut producers is the brown marmorated stink bug is not widespread in commercial production areas. The bad news is, where it has shown up, crop damage can be severe.

In one instance, in responding to a call from a grower in Stanislaus County, UCCE Farm Advisor Jhalendra Rijal said he was shocked to see the damage.

"It looked like somebody came through with a shaker and shook these trees on the borders," Rijal said. "All these almonds were on the ground like a blanket."

Later on, at harvest, Rijal said the orchard suffered losses approaching 30 percent. "It was mostly on the outside rows," Rijal said, "but the other rows were affected, as well."

The brown marmorated stink bug, or BMSB, is an active hitchhiker, having made its way from Pennsylvania, where it was first discovered in the U.S. in 1998, to the West Coast by the early 2000s. And it is a voracious feeder with a host range of approximately 170 known plants. The pest was discovered in California in 2006. Until just recently, it was almost solely concentrated in urban areas.

Making its Way into Nut Crops

Researchers first documented it in a commercial crop in 2016, when they found it in a peach orchard in northern San Joaquin Valley. It now has migrated to other commercial crops, including almonds.

Rijal's discovery of it in the Stanislaus County almond orchard came in 2017. Since then, BMSB has spread steadily, if slowly, into other Stanislaus and Merced county almond orchards. "In 2018 and 2019, several almond orchards had BMSB damage," Rijal said.

Rijal believes the early season feeding, particularly through April, is the most damaging, as small nutlets are highly susceptible to drop. Feeding damage after May has less effect on nut drop, he said, but mid-to late-season feeding on the nuts results in damaged and gummy kernels.

Depending on the temperature and the year, the pest can migrate into almond orchards from overwintering sites as early

as mid-March and can feed on nuts from that point through harvest, Rijal said.

"I have seen a lot of nut drop from that early season damage," Rijal said, "especially on the couple of rows on the border near potential overwintering sites or alternate host trees, like the Tree of Heaven. That tree is a magnet for BMSB. I've seen almond orchards where there is a Tree of Heaven nearby, and those orchards were hammered by BMSB throughout the season."

Other overwintering host sites can include houses, barns and wood piles – essentially anywhere the BMSB can find warmth during winter. Orchards close to overwintering shelters or near riparian or urban areas are at a higher risk than orchards situated far from overwintering shelters, Rijal said.

Steps to Mitigate Damage

Where growers can remove overwintering host sites, Rijal advises they do so. Where that isn't an option, he said a grower's best option is to proactively trap, and spray when necessary.

"At this point, the best thing a grower can do is to put out traps starting in mid-March and see whether they see any activity," Rijal said. "If they see anything that is alarming, they need to be in contact with their PCA and make a decision whether to treat or not, what to use and the timing."

Controlling the pest is difficult, Rijal noted, primarily because of its ability to switch hosts and move from an orchard into nearby shelters or other host plants. Pyrethroid insecticides, for example, which are the most effective compound currently available for controlling BMSB, will knock down the population, but only for ten days or so, after which the BMSB will return at infestation levels equal to or greater than before the treatment. Also, he said, the broad-spectrum insecticide can harm populations of beneficial predators, disrupting integrated pest management programs.

Still, he said, at times a pyrethroid may be a grower's best option. He added: "In California, crop damage (from the pest) is new, and we are still work-

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The population south of Sacramento and in Sacramento and in the almonds has persisted, so I would say, yes, it is adaptable to our climate.

Peter Shearer, Cal Poly State University

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Damage caused by brown marmorated stink bugs to almonds.

Continued from Page 73

ing on providing recommendations if growers need to treat."

Rijal cautioned growers from treating orchards simply because they suspect they have a problem with BMSB. "It is critical to put the BMSB traps out, do the scouting of the orchard for live bugs and damage, and follow the control activities, if warranted, based on your trap counts and scouting activities," he said.

To supplement the use of insecticides, researchers are studying alternative methods for controlling the pest, including the samurai wasp, or *Trissolcus Japonicus*, a parasitoid that attacks the eggs of BMSB and that has been found in Los Angeles County. More recently, they have been researching the viability of incorporating into control measures a microsporidia pathogen, *Nosema maddoxi*, that Cornell University researchers found was crashing BMSB populations in labs.

Peter Shearer, an entomologist for the Strawberry Center at Cal Poly, San Luis Obispo, who started working on BMSB while he was at Rutgers University in 2003, just five years after it was first found in the U.S., said for years researchers were stumped as to why populations sometimes crashed in laboratories. "It turns out it was this microsporidia pathogen, *Nosema maddoxi*," he said.

Shearer, who continued to study BMSB for several years while he was at Oregon State University, said he believes BMSB could be a long-term pest in California agriculture, but added a caveat.

"The population south of Sacramento and in Sacramento and in the almonds has persisted, so I would say, yes, it is adaptable to our climate," Shearer said. But, he said, there are pockets on the East Coast, such as in coastal areas of North Carolina and Virginia, where it has not been found, giving rise to hopes it may not be adaptable to the Central Valley's heat.

"We don't know why it hasn't established in those areas," he said. "Not even the experts over there know. Maybe it is too hot." In keeping with Shearer's caveat, Rijal speculated that its slow rate of migration into commercial crops could be the result of the Central Valley's heat.

"Establishment wise, it is not spreading like it has on the East Coast and in Oregon," Rijal said. "That could be because our summer temperatures and climate are completely different. We are dry and hot. And although BMSB might be adaptable to those kinds of environments, maybe it just takes a little more time. We just don't know."

> **At this point, the best thing a grower can do is to put out traps starting in mid-March and see whether they see any activity. If they see anything that is alarming, they need to be in contact with their PCA and make a decision whether to treat or not, what to use and the timing.**
>
> **Jhalendra Rijal, UCCE**

Rijal added that while the pest has flourished in cooler areas of Europe and in the country of Georgia, where it is a serios pest in hazelnuts, BMSB has not been found in extremely hot areas, such as in areas of South America. The pest is native to China and occurs in Korea and Japan, as well.

As to whether the pest poses a problem for other tree nuts, such as pistachios, Rijal said research suggests it does.

"Based on lab work in Riverside and in the Kearney Ag Center in Fresno, we know that they feed on and can damage on pistachios," Rijal said, "but we have not seen the population in commercial pistachio orchards yet."

To date, researchers also have not seen damage in walnuts.

At this point, Rijal said, BMSB is established in urban areas of several counties in the Central Valley, including from Glenn to Fresno. He added, however, that damage to crops has not been reported to date, except in the northern San Joaquin Valley, where BMSB is damaging peaches, as well as almonds.

"Whether it will be established in orchards throughout California, we aren't sure of that at this point," he said.

One thing he is sure of is that growers need to keep an eye out for the pest and be prepared to respond if necessary. He added that clear sticky traps with a BMSB lure are commercially available.

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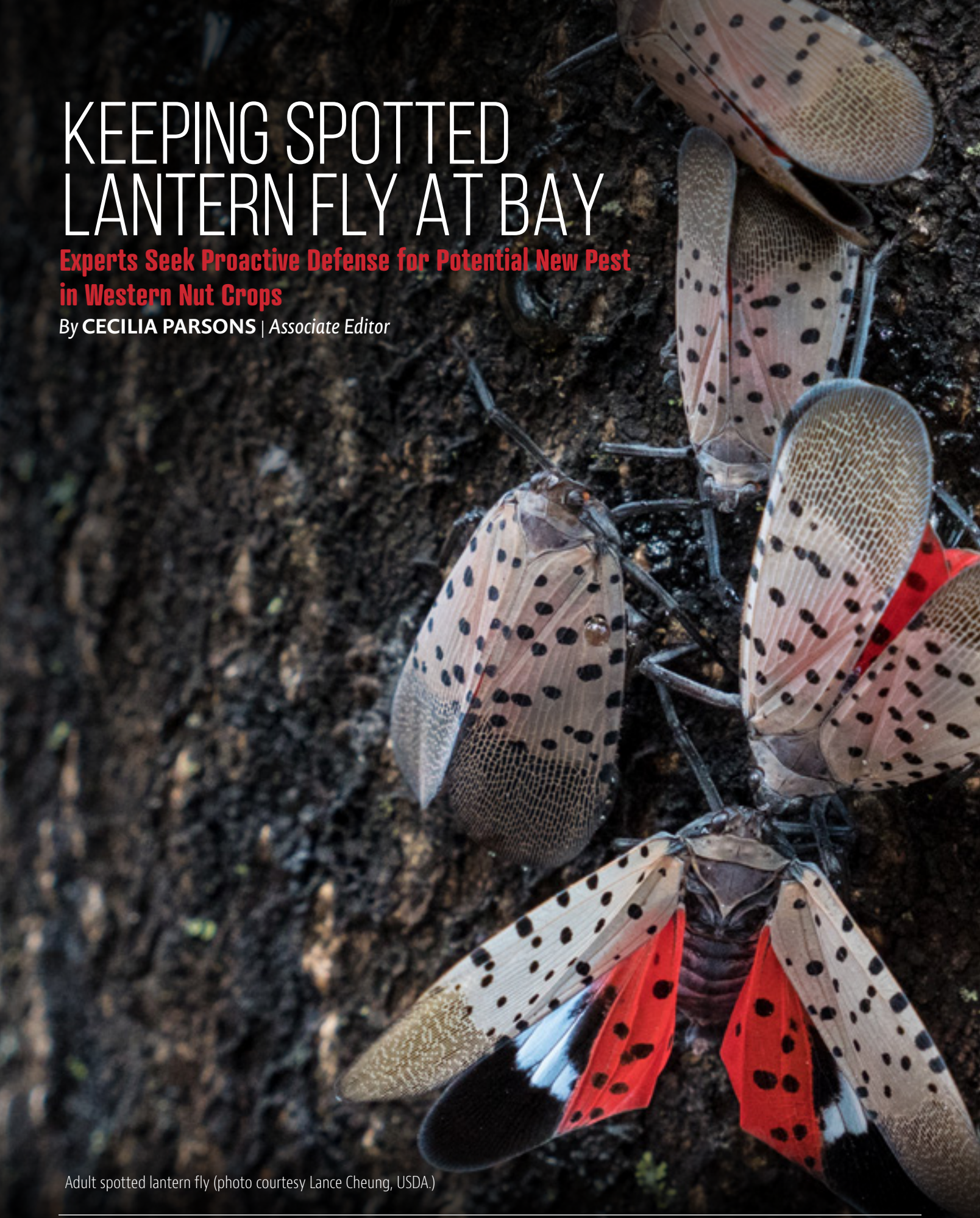
Adult BMSB feeding on almond fruit.

KEEPING SPOTTED LANTERN FLY AT BAY

Experts Seek Proactive Defense for Potential New Pest in Western Nut Crops

By **CECILIA PARSONS** | *Associate Editor*



Adult spotted lantern fly (photo courtesy Lance Cheung, USDA.)

THE SPOTTED LANTERN FLY IS JOINING the list of invasive insects that have the potential to impact California agricultural crops. This pest insect from China has not yet become established in California, but it has been known to arrive here as a hitchhiker on aircraft. Spotted lantern fly has become established in several east coast areas and has been proven a threat to apples, cherry and grape crops as well as hardwood trees. There is evidence in South Korea that it can attack walnut crops. University of California Riverside researcher Dr. Mark Hoddle said there is reason to believe SLF feeding has the potential to impact tree nut crops in California.

According to invasion biology specialists, the SLF is likely to make its way from the east coast to California.

Spotted lantern fly was first detected in the United States in Pennsylvania in 2014. Last year, California Department of Food and Agriculture inspectors looking for Japanese beetles in cargo planes reported that dead spotted lantern flies had been found at airports in Sacramento, Stockton and Ontario. It is believed they flew into the planes during loading activities in Allentown, PA. and died enroute.

A Proactive Approach

Hoddle said that rather than wait to see if SLF will become established in the west, proactive efforts in biological control have already begun. A goal of the CDFA's Proactive IPM Solutions grant program is to anticipate which exotic pests are likely to arrive in California and to identify and test IPM strategies, including biological control, that can be rapidly implemented if the pests become established in California. CDFA is responsible for preventing and mitigating invasive pests in California. Techniques resulting from the Proactive IPM Solutions Program in advance of anticipated pest invasions will allow for rapid deployment of future management plans.

Funding for the three-year project to develop biological controls for SLF stems from the pest's potential to economically impact high value specialty crops including almonds, walnuts and pistachios. Similar work is already underway on the east coast, Hoddle said. Biological controls for invasive species are favored over the adoption of intensive insecticide spray programs which may disrupt low-pesticide use integrated pest management programs.

Hoddle and Dr. Kent Daane at UC Berkeley are leading the project that involves testing an egg parasitoid as a biological control agent. One of the first parts of the project is to determine if the egg parasitoid, a small, stingless

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A female spotted lantern fly egg parasitoid, *Anastatus orientalis*, ovipositing into an egg contained within a SLF egg mass (photo courtesy Robert Nehme Malek, University of Trento.)

Continued from Page 77

wasp also native to China, will pose an ecological threat- that is will it affect populations of beneficial insects and species native to the western US.

Interestingly, there are native lantern flies in Arizona that feed on juniper and oak trees. Hoddle said his research team has collected eggs from native lantern flies and native eggs are being exposed to the Chinese parasitoid to see if they will attack the eggs.

Completing this research before SLF hits, Hoddle said, will allow for rapid response if this pest becomes established in California and causes crovp damage.

Spotted Lantern Fly Biology

Adult spotted lantern flies do have wings, but are not a type of fly or moth. Closely related to brown marmorated stink bug, aphids and leafhoppers, SLF is a planthopper in the order Hemiptera and is a true bug.

Dr. Surendra Dara, University of California Cooperative Extension advisor in San Luis Obispo County said there is no record of an established population of SLF in California, but this pest is known to be an efficient hitchhiker. Dara said the likely route for its arrival in California is in the form of egg masses on packages or vehicles. Adults may also hitchhike but they may not live long enough without plants to feed on to accidentally reach California.

Like all hemiptera, SLF have piercing-sucking mouthparts that enable them to drill into the phloem of a plant to feed on plant juices. As they feed, they also excrete honeydew, attracting ants and other insects. Honeydew promote sooty mold growth which reduces photosynthesis. Heavy feeding across a two-year period has apparently killed vineyards in Pennsylvania despite insecticide applications.

In Pennsylvania, SLF has one generation per year consisting of four nymphal stages, an adult stage and overwintering as egg masses. Spotted lanternflies molt to progress to the next stage.

SLF eggs hatch over an extended period of time with first instar nymphs emerging in May and June. Mating takes place late in the summer and eggs are laid throughout the fall, ending with the first freeze event.

First instar nymphs are a quarter of an inch in length and black with white spots. The second and third instars have the same coloration, but the fourth takes on a reddish color and is nearly an inch long when it becomes an adult. Adults have two sets of wings. The forewings are greyish brown. Hind wings are mainly red with black spots, a white band and black tip. The body of SLF is mainly black but the abdomen appears yellow with black bands. Though they have functioning wings, SLF jumps to move around more than it flies.

Spotted lantern fly has been documented to feed on more than 70 species

SLF eggs laid on a wooden pallet (photo courtesy L. Cheung.)

Spotted lanternfly nymphs (photo courtesy Stephen Ausmus, USDA ARS)

of trees and plants. They can hitchhike on packages or vehicles, but are able to move three to four miles on their own. Egg masses, juveniles and adults can be found on trees and other plants as well as bricks, stone, metal or other smooth surfaces.

> "WE DON'T WANT THIS PEST TO BECOME ESTABLISHED HERE. ALL IT TAKES IS ONE EGG MASS TO GO UNNOTICED."
>
> --SURENDRA DARA, UCCE

Signs of a SLF infestation can be detected by inspecting plants. This pest tends to gather in large groups at dusk and at night. One of their preferred hosts is the invasive tree of heaven. Egg masses laid on tree trunks or other surfaces can be camouflaged as the female SLF covers her eggs with a white putty-like substance that becomes pinkish gray as it dries. Weeks later, the covering will look like a patch of mud.

Biological controls for long term management of this invasive pest is preferred, Dara said, but pesticides are available for short term control or to knock down infestations.

Studies in Pennsylvania have found two naturally occurring fungal pathogens controlling SLF. One (*Batkoa major*) cannot be cultured and would be only a natural microbial control agent. Multiple commercial formulations of the other fungus (*Beauveria bassiana*) are available for use.

Dara said anyone encountering an SLF egg mass should contact their county agricultural commissioner's office.

"We don't want this pest to become established here. All it takes is one egg mass to go unnoticed," Dara said.

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American Pistachio Growers Eye New Markets to Move Record Crops

MORE THAN 1,300 ATTENDEES HEAR MARKETING AND RESEARCH PRESENTATIONS AT 13TH ANNUAL PISTACHIO CONFERENCE

By **MARNI KATZ** | *Editor*

The American Pistachio Growers is working to expand international markets to keep pace with record crops on the horizon as nonbearing acreage comes into production in the next few years. A panel of experts at the American Pistachio Growers Annual Conference in Monterey, Calif., said there is tremendous untapped potential in India for California pistachios among a consuming public that is culturally adapted to snacking on nuts, appreciates and pays for premium quality, identifies with the California brand, and is growing in economic buying power.

More than 65 percent of California pistachio production goes to export markets, with Europe and China leading consumption. Still, APG President Richard Matoian said there is tremendous room for growth.

Pistachios are now the fifth largest commodity in California, and number three in exports behind dairy and almond. Exports of California pistachios more than doubled in 2018-19.

"The domestic market continues to be a very stable market," Matoian said. "In the last three years we have exported record shipments overseas, and especially in the last year."

He told the 1,300 conference growers that APG will continue to fund and publicize nutrition research globally to discover, validate and publicize the health benefits of pistachios. Keynote speaker Dr. Oz said there is no reason Americans shouldn't be making nuts a regular part of a daily diet given the health benefits of pistachios and other nuts.

"Consumption of nuts in this country is 1/28th what it

Dr. Oz, from left, speaks with Haiying Zhang, director of Asia markets for American Pistachio Growers, and Adam Orandi, CEO of ARO Pistachios and outgoing chair of APG member services committee (photos by M. Katz.)

is in other countries, we have a ways to go," Oz said. He noted that pistachios fit into his worldview of preventive heart health and believes they also help with sleep and weight loss. The more consumers know about those benefits, the more inclined they will be to eat nuts.

"It's part of your responsibility as growers to wake us up and get the American consumer to eat more nuts," he said. "You guys should partner with all the other nut guys and figure out why we are not eating more nuts in America."

Developing Markets in India

Tapping into new and emerging markets will be especially important as processors look to continue handling record crops. Bearing acreage continues to grow, to about 300,000 bearing acres and the country's 800 growers expect to produce their first ever billion-pound crop in 2020. Even the off-year of 2019 produced 748 million pounds, which was the third largest crop in history despite being on an off-year cycle. According to a recent study, that production could reach 1.4 billion pounds by 2026 as growers continue to plant an average of 15,000 acres of pistachios annually and young acreage every year comes into production.

Developing new and diverse export markets will be key to moving that new production, Matoian said.

"We see India as the new frontier," Matoian said. "In the last year we have tripled our shipments to India from 6 million pounds to 18 million pounds."

Judy Hirigoyen, vice president of global marketing for APG, led a panel of nut suppliers and marketers in India

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> **"We see India as the new frontier. In the last year we have tripled our shipments to India from 6 million pounds to 18 million pounds."**
>
> **—Richard Matoian, American Pistachio Growers**

Joel Siegel, of USDA ARS, speaks with attendees following a talk on Navel Orangeworm.

APG Vice President of Global Marketing Judy Hirigoyen shows some of the advertising targeting consumers in India in a panel featuring suppliers and marketers including Ritesh Bajaj, at left, of KBB Nuts.

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who said there is tremendous potential in India. Only 1 to 2 percent of the population currently eats pistachios on a regular basis, so there is unlimited opportunity for growth, the panelists said.

Gunjan Jain of VKC nuts, a fourth-generation nut and dried fruit processing company in India, said India used to consume only almonds, walnuts and raisins but is broadening its tastes to pistachios and other nuts and dried fruits. And as other California nut crops made their way into India in the 1990s consumers there have developed a taste for quality and recognition of the California brand. He noted that India is a diverse country with a growing middle class. Even with 120 percent tariffs, he noted, California walnut consumption has exploded in India as Indian consumers develop a taste for nuts. Pistachios tariffs are currently at 10 percent.

"When you start looking at what India has, that's when the opportunities start to be more clear," Jain said. "The market is bound to increase. And the good news for you is that California as a brand already exists."

Ritesh Bajaj of KBB Nuts, a foodservice supplier in India, noted that the average age in India is 38, with young decision makers who value health and are into cuisine.

"Today in India, being in the food business is the best business in India because food consumption is going up," Bajaj said.

He noted that about a third of the country is vegetarian, and plant-based proteins are in high demand. Consumers there have grown accustomed to consistent, high quality, and processors must be vigilant about color, safety and other quality attributes, he added.

"Indian consumers buy with their eyes."

Hirigoyen noted that APG is working with top quality processors to export for its India sales and marketing promotions using the trademarked California Pistachio brand.

"We don't want to get off to a bad start in India," she said.

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APG President Richard Matoian addresses record attendance of more than 1,300 at the 13th annual American Pistachios Growers Conference.

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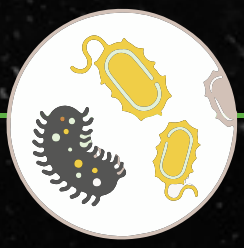

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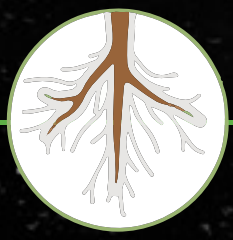

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