

WEST COAST NUT

September 2018 Issue

SPOTLIGHT:

Walnut Growers Consider Quality & Quantity of This Year's Crop
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In This Issue:

Brown Marmorated Stink Bugs Found in Commercial Pistachio Orchards

Distribution of Chlorosis in Almond Orchards May Help Assess Potential Irrigation-Related Issue

Declining Walnuts, What's the Deal?



South Valley
Nut Conference
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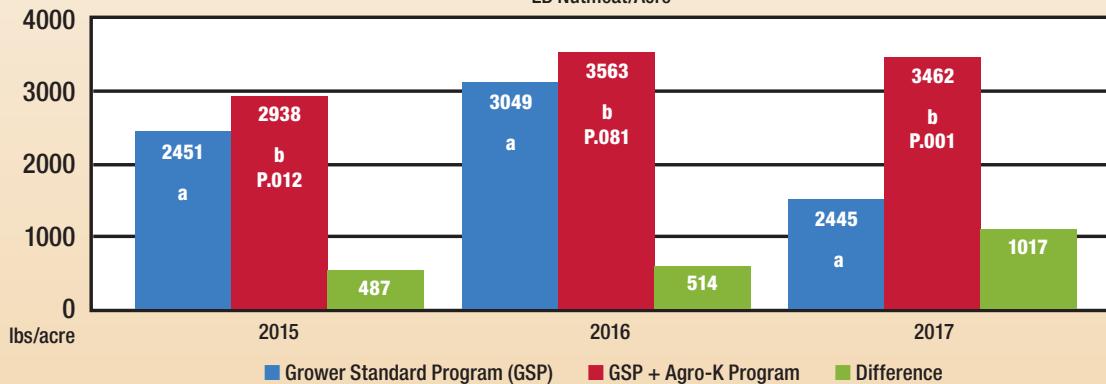
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Maximizing yield starts with nut set and post bloom nut retention. Ensuring peak nutrient demand is met leads to increased yields through better set, nut retention and larger nut size. Agro-K's post-harvest nutrient program utilizes proven products like **Sysstem Ready**, **Zinc Plus +5 D.L.**, **Top Set DL**, and **AgroBest 0-20-26** to ensure the tree has sufficient early season nutrients to support bloom and set as well as initial leaf and root development. By beginning to manage next year's nutrient needs now at post-harvest you set the stage for better tree health, stronger set and size and higher yields while working to minimize alternate bearing issues.

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WEST COAST NUT

By the Industry, For the Industry

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*JCS Marketing would like to express our heartfelt sympathy
to our colleagues, friends and family who have been
impacted by recent and ongoing fires in California.*



WALNUT GROWERS *Consider Quality & Quantity* of This Year's Crop

By: Julie R. Johnson

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Walnut blight continues to be a problem for many growers in the state, according to Luke Milliron, UCCE farm advisor for Butte, Tehama, and Glenn counties. Photos 1, 2, and 3 courtesy of Luke Milliron.

During the heat of the summer months it was a little too early for growers to predict what this year's walnut crop was going to look like.

Luke Milliron, University of California Cooperative Extension (UCCE) farm advisor for Glenn, Butte and Tehama counties, agrees, however, he had heard complaints the crop looked light compared to last year.

"There have also been concerns for quality due to excessive heat (another summer of on-going triple-digit temperatures), sunburn and over-irrigation," he added. "But there are factors for high quality as well, such as smoky conditions from wildfires protecting against sunburn and carefully managed irrigation."

Over the past 10 years California growers have added 70,000 bearing acres of walnuts. In 2017 the state harvested about 615,000 tons of walnuts from about 365,000 acres, reported the United States Department of Agriculture. And the development

of new walnut orchards continues to increase as researchers produce walnut varieties conducive to marginal soil quality. Today rows of walnut trees can be seen growing in the rolling foothills along the Sacramento Valley, ground once considered usable for livestock grazing and not much more.

Brad Call, walnut grower in Los Molinas, said he is expecting a good harvest in both quality and quantity.

"My crop looks good so far, my main concern right now is pricing," he added.

"It is too early to know at this time what prices will be, but I really don't think they will be as good as last year. Time will tell."

Last year the grower price was about \$1.30 per pound, a 30 percent increase from the previous year. However, the fear of government tariffs looms heavy in the process.

Visalia walnut grower, Jeff Rachel, said his crop has been so heavy this year he has had to do some summer tipping,

which he didn't do last year.

"I had to go in and trim the limbs or I was going to lose some," he added.

Weather

"The full effect of this year's weather won't be realized until the crop is in," Milliron said. "An unusual pattern of winter temperatures, such as a warm December, may have contributed to the wide spread of bloom, leaf-out and subsequent nut size."

Dani Lightle, UCCE farm advisor for Glenn and Butte counties, said she had heard of very few reports of winter kill this year.

"There wasn't much in the way of cold damage to the susceptible young orchards that we have seen in some years," she added.

Milliron explained, a wet spring, with rains during bloom and leaf-out may have led to another year of high walnut blight pressure in some regions.

Dani Lightle, UCCE farm advisor for Glenn and Butte counties, said she has heard very few reports from walnut growers of winter kill to young trees this year.

Photo courtesy of Julie R. Johnson



While Luke Milliron, UCCE farm advisor for Tehama, Butte and Glenn counties, hasn't received many reports of sunburn on walnut trees and developing nuts during this summer's triple-digit temperatures, it is still occurring as seen on trees near Corning and Vina.
Photos courtesy of Julie R. Johnson



Milliron also had concerns about sunburn during an anticipated hot August.

"Last year the lab of Themis Michailides at Kearney Agricultural Research and Extension Center found that some black, moldy blighted walnuts submitted by UCCE Farm advisors were positive for *Aspergillus niger*, a mold that is favored by the sustained >100 degree Fahrenheit periods we experienced last summer," he said.

The mold *Aspergillus niger*, unlike *Aspergillus flavus*, is not associated with the food safety concern of producing aflatoxins, he stated.

"With similar hot conditions, it remains to be seen how quality issues across the industry will fare in comparison to last year," Milliron said.

Both Call and Rachel were pleased to say, so far this year, their orchards had not suffered sunburn.

Continued on Page 6

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Call believes keeping his orchard well irrigated on a sprinkler system is a factor in reducing sunburn.

Rachel feels an overcast of smoke in this area from the Ferguson wildfire is helping to protect his trees from sunburn.

Milliron agrees, "The smoke from fires across the state can protect the trees from sunburn. In speaking with Bruce Lampinen, University of California (UC) Davis walnut and almond specialist, and Janine Hasey, farm advisor UCCE Sutter-Yuba and Colusa counties, past summers with prolonged smoke have lead to low sunburn and improved walnut quality. Therefore, the smoke could theoretically mitigate some of the fears surrounding quality concerns from a second particularly hot July and August.

However, Lampinen warns that the reduced evaporation, transpiration demand under smoky conditions could lead to growers over-irrigating.

Over-irrigating can lead to its own quality problems, such as dark pellicles. He said, under these circumstances it is best to monitor trees with a pressure chamber and ensure they are not being over-irrigated.

Pests and Disease

Milliron said so far walnut blight, which was extensive in 2017, has been bad in many of the same orchards this year. "Rains during bloom and leaf-out may be the key driver. I have mainly seen end blight which typically results in a dropped nut in June and July," he added.

According to UCCE, walnut blight appears as black lesions on any green tissue of the tree, including the developing nut. Early-leaving varieties are most severely affected, and the disease tends to be more severe in Northern California.

Rachel said his orchards haven't suffered from blight or any other significant pest or disease problem this year. "For which I am very grateful," he added. "But you

always have to be prepared for next year."

Call reports, while he also hasn't had a blight problem, he is having to deal with a mite problem. "Following the advise of Rick Buchner (retired UCCE farm advisor Tehama County), I did a good job spraying early and thoroughly for blight and I have found it to be successful," he said.

His management of the mite problem may sound unconventional, but is something he learned from veteran walnut grower Fred Spanfeler. "I found the mites were heavy in the bindweed on the orchard floor and they typically stayed there if they had bindweed to infest instead of going into the trees," Call said. "So, when I mowed my orchards, I would leave a swathe of bindweed in each row for the mites to enjoy instead of moving into the trees. The bindweed served as a trap crop."

Next year, Call said he plans on combining a miticide with his herbicide when he sprays.

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Irrigation

Rachel said he has had plenty of water for irrigation purposes this year. "We had an adequate snowpack melt which provided us with adequate water in the river," he added. "I use a sprinkler system to irrigate and I received 100 percent of my water requirements this year."

Call also irrigates on a sprinkler system and he too has had adequate amounts of water to keep his orchards healthy.

Milliron said he hasn't received any reports from growers suffering from a lack of irrigation water. "I haven't heard of any issues with adequate water supply or quality of irrigation water," he stated.

Harvest

Harvest timing is difficult to predict, Milliron said.

Speaking with Janine Hasey, she agreed that with a prolonged bloom this year, we may be at least delayed in reaching packing tissue brown. She reiterates that

the weather during the rest of the season will have a large impact on exact harvest timing.

Rachel said the prolonged cooling cycle during bloom confused the trees, especially during the second and third sets. "I did have some June drop as there was no catkin available to pollinate during the late bloom," he explained. "The extended bloom could have an impact on harvest timing."

Lightle said with the cool spring, it was initially believed harvest would be a bit late, however, with temperatures remaining high throughout the summer, harvest timing should be relatively standard. "But we still aren't sure," she added.

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

Over-irrigation can lead to a number of problems as seen in these photos taken in walnut orchards this year.

Photos courtesy of Luke Milliron.



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A phid infestation and damage to pecans has become worse in the past five to six years.

Mild Winters

Larry Blackwell, New Mexico State University researcher and program coordinator College of Agricultural, Consumer and Environmental Sciences, said that pecan producers in New Mexico are dealing with higher aphid numbers in their pecan orchards due to lack of freezing winter temperatures in recent years.

"We have had really mild winters and thus no kill off," said Blackwell. The high numbers of aphids in pecans is the result of the climate, and not just due to population build up, Blackwell added.

This year blackmargined aphid population pressure for the first summer peak in the Mesilla Valley of southern New Mexico was high for what should be an off or lower yield year. Blackwell said pressure built in mid-May, approximately two weeks earlier than normal and populations declined at the end of

INSECTICIDE EFFICACY for Pecan Aphids

By: Cecilia Parsons | Associate Editor

APHID LIFECYCLE

Photos courtesy of Cecilia Parsons.



June. This six-week period was unusually long for an off year where peaks in the summer typically last two to three weeks. Likely causes are a warm spring and a relatively heavy off-year crop.

Species of Aphid

There are two distinct species of aphid that cause damage in pecan production. The yellow pecan aphid complex consists of the yellow pecan aphid (*Monelliopsis pecanensis*) and blackmargined pecan aphid (*Monellia caryella*). Both are found throughout the US pecan growing belt.

The black pecan aphid is a completely different species than the yellow pecan aphid complex. The damage done to pecan crops by each species is different.

The black pecan aphid is the only black colored aphid that damages pecan foliage. According to the University of California Integrated Pest Management guidelines, the feeding of the black pecan aphid on pecan leaves causes bright yellow, angular quarter-inch spots to appear on the leaves between the veins.

Leaf damage and subsequent defoliation affects both nut quality and crop yields the following year.

The black pecan aphid is pear-shaped and may be winged. Nymphs are dark green and may also be winged. The populations begin to build in spring and increase rapidly in August and September.

The yellow pecan aphid complex includes the blackmargined aphid and the yellow pecan aphid. The Blackmargined aphid has a black stripe along the outside margin of its wings, which are held flat over the body. The yellow pecan aphid lacks the black stripe along the wing margin and holds its wings in a peak over its body. Immature aphids are difficult to identify because they lack wings.

Yellow pecan aphids that have been parasitized will turn black and can be confused with black pecan aphids. However, the parasitized aphids are dead and stuck to the leaf surface. Live black pecan aphids will fly quickly when disturbed.

Both species of the yellow aphid have mouthparts that pierce and suck plant juices, removing water and plant nutrients from the leaves. As they feed, they excrete large amounts of honeydew, which collects on the leaves. Both species feed on the underside of leaves with the blackmargined aphid feeding on major leaflet veins while the yellow aphid feeds on the network of small veins throughout the leaflet.

Damage

This species does indirect damage to nut crops. Blackwell said until populations are very high, growers or pest control advisors who are scouting may not realize the crop damage caused by aphid feeding.

Yellow aphid eggs overwinter in bark crevices on tree trunks and branches. After hatching in the spring, the aphid feed on new leaf growth and in a short time give birth to live young—all females—which reproduce at a rapid rate as temperatures warm. This species is

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bi-modal with two population peaks, in June and again in September.

Infestation Rates

Blackwell noted the blackmargined aphids population peaks and infestation rates have trended upward since 2011. Not only are the pest densities higher, but the infestations begin earlier and last longer in the year. Peak population timing is close to historic dates, but numbers of blackmargined aphids per compound leaf have risen dramatically. In off years from 2012 to 2017, at the July 15-31 peak, counts were at 23 per leaf while historically, they were at 12. The September-October peak levels in 2017 were at 27 per compound leaf while historically they were at six.

Numbers during on years were also higher from 2012-2017. The early peak was one to two weeks later, but the numbers were up with 73 aphids per compound leaf compared to a historic rate of 43. In the September-October peak,

numbers soared to 96 per compound leaf compared to the historic rate of 29.

The high numbers can have a significant impact on nut quality. During on years, there is an increased likelihood of a higher percentage of lower grade nuts. There is also a considerable reduction in blooming terminals and yield for the next growing season.

Blackwell said that control in past years has been mainly with contact insecticides though some

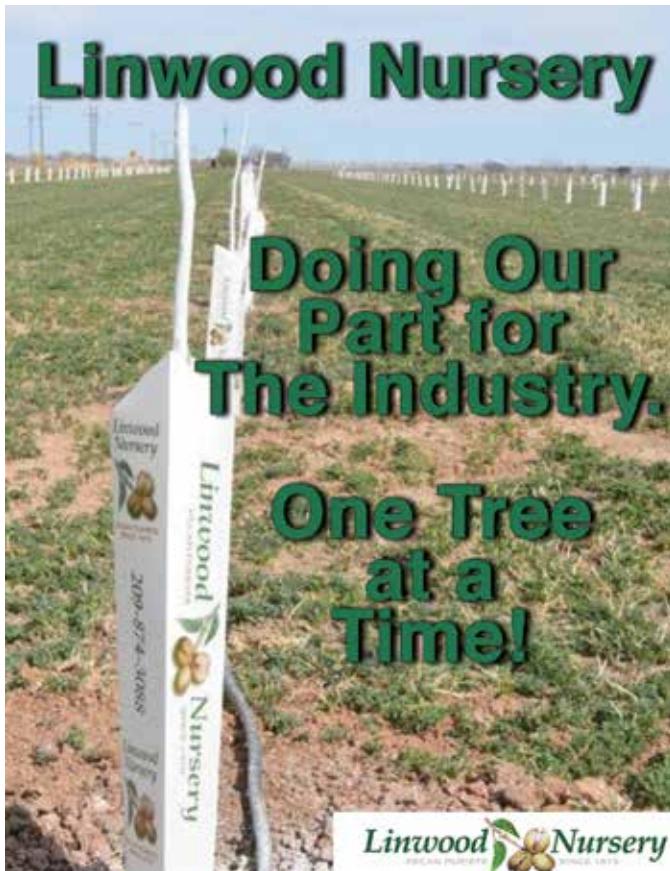
contact /translaminar products were used. University of California (UC) integrated pest management (IPM) guidelines for control warn that insecticides do not consistently control either species of yellow aphid and they may become resistant if insecticides are not rotated.

With higher aphid numbers, Blackwell said that pecan growers are having to spray more than once during the season to achieve control. Because populations can quickly blow up scouting for infestations is important. Results are better, he said if spray applications start before higher numbers are found. The target is 10-20 per compound leaf. Numbers can climb rapidly and at that point sprays are basically rescuing the crop rather than protecting. If populations can be knocked back during the June peak, Blackwell said, the outlook for the second populations peak in September could be better.

Chemical Control

His control recommendations for the June peak is Closer, sulfoxaflor product with translaminar activity or Beleaf, a flonicamid product with translaminar activity. Sivanto or Movento are also good, he said. Closer and Beleaf both had higher mortality rates on blackmargined aphids in a 2013-2016 trial. Since these are systemic insecticides, Blackwell said they need time to distribute in the leaves because the product has to be ingested by the aphid to be effective. All four chemistries are from different IRAC classes. Blackwell said that rotation of classes of insecticides is critical as it will help with resistance management. Failing to rotate among the different classes will lead to resistance and reduce the number of products that are effective.

There can be performance inconsistencies with insecticides. Environmental factors including rain and humidity and wind can cause less of the product to be taken up by the plants. Timing is another critical factor in the aphid control



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success rate.

Achieving sufficient coverage of spray applications depends on tree architecture and canopy. Blackwell said there is evidence that a more concentrated solution can produce better results.

Higher spray volumes are required with legacy products to achieve coverage of both sides of the leaves. Admire, Belief and Movento have label volume recommendations of 50 plus gallons per acre. There is no label volume recommendation for Closer.

Blackwell noted that surfactant use is needed to improve spray coverage. It may also improve initial spray deposits, redistribution and weatherability. He said there are very little statistically significant differences between surfactants. Any surfactant use is better than none, he said.

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Brown Marmorated Stink Bugs

Found in Commercial Pistachio Orchards

By: Cecilia Parsons | Associate Editor

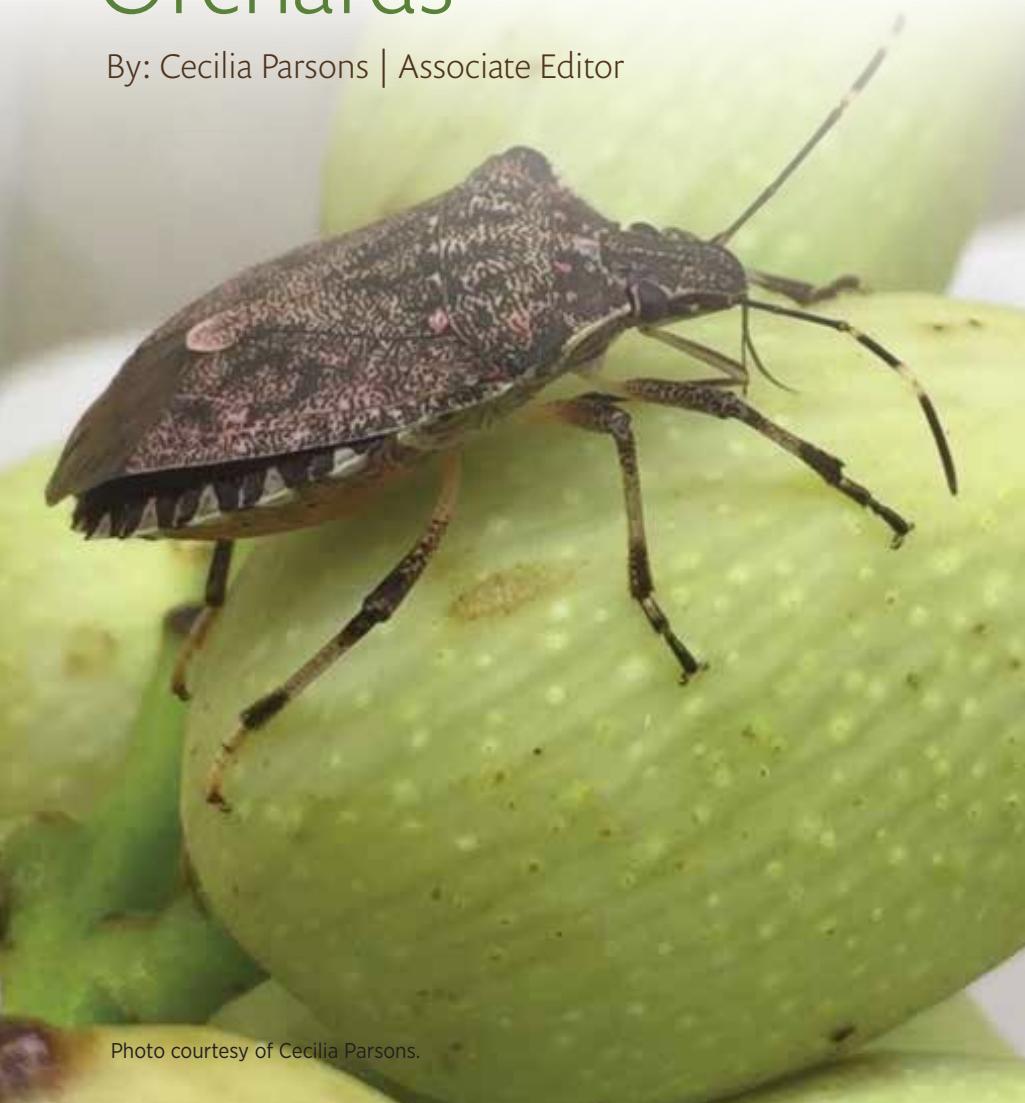


Photo courtesy of Cecilia Parsons.

Since 2017, brown marmorated stink bug (BMSB) has been recognized as a pest of known economic importance in many different agricultural crops. Recent research has confirmed this invasive, polyphagous insect from Asia can inflict damage in pistachio nuts.

While breeding BMSB populations have not been found in commercial pistachio orchards, there have been reports of BMSB finds in pistachios from pest control advisors. This pest has been found in a commercial almond orchard in Sutter County, commercial kiwifruit in Butte County and in commercial peach production in Stanislaus County—all in the last two years. In total BMSB has been recorded from 34 CA counties. In 2016, monitoring traps deployed by Jhalendra Rijal (University of California

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(UC) Area IPM Advisor) in a Stanislaus County caught BMSB in a peach orchard.

University of California Riverside (UCR) researcher Ricky Lara, along with Mark Hoddle, UC Extension specialist in entomology, continue to study the potential for BMSB to affect commercial fruit and nut crops in California. The UCR research is part of a nationwide United States Department of Agriculture (USDA) Specialty Crop Research Initiative funded program to monitor and control BMSB. Funding from California Department of Food and Agriculture (CDFA), Specialty Block Grant Program has also been crucial in advancing BMSB management research for the benefit of California stakeholders.

Brown marmorated stink bug is similar in shape to other large bug pests in nut crops, but is distinguished by white bands on antennae and legs and a

prominent light-dark banding on the abdomen. BMSB eggs are white to light green in color and are barrel shaped. They are laid in clusters on leaves. Newly hatched nymphs are difficult to distinguish from other large bug nymphs.

Adult BMSB overwinter in protected areas including wooded areas, and structures. In the spring they leave and disperse into vegetation to feed and reproduce. Unlike eastern states and areas of Oregon and Washington where BMSB is also found, much of California's agricultural land lacks nearby wooded areas and this may be one reason BMSB has not made rapid advancement.

The brown marmorated stink bug feeds on a wide variety of fruit and nut crops and ornamental plants. It was first found in the eastern United States in the 1990s and has since spread into California, Oregon and Washington. Apple, hazelnut and pear growers in Oregon and Washington have reported crop damage from BMSB. The apple industry



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in the Mid-Atlantic States reported losses totaling \$37 million in 2010 due to BMSB feeding on fruit. This pest is also gained notoriety as a nuisance in urban areas, aggregating on structures.

In California since 2002, BMSB does pose a threat to pistachio crops, Lara said. Since BMSB has been trapped in two of the largest pistachio producing counties in the state, there is chance the pest could become established in the growing areas. There is some hope that the hot San Joaquin Valley summers may be a limiting factor to BMSB establishment.

As numbers of BMSB build, Lara said it is possible the pest can adapt to the hot and dry climate in the San Joaquin Valley. The pest has been slowly spreading, he said, and is gaining footholds in urban areas. It has been observed in high numbers in urban parks, including Fresno and since it is a strong flyer, it is possible for it to move to nearby agricultural areas.

Lara has been conducting laboratory feeding trials in quarantine and under permit.

The trials indicate that adult BMSB stylets can penetrate developing pistachio shells and the feeding on kernels can cause necrosis mid to late season. The trials also suggest that there is probable risk of higher feeding damage due to female BMSB feeding compared to male BMSB feeding.

Researchers have compared BMSB to other hemipterans that also feed on pistachio nuts and have been implicated in causing nut infection by disease causing pathogens at feeding sites.

BMSB Control

Control of BMSB, like other large bugs, can be difficult—and expensive. According to Administrative Committee for Pistachio, heavy use of pesticides to knock back BMSB can have negative effects on natural enemies of pest bugs and cause secondary pest outbreaks. Resistance to pesticides can also devel-

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op with heavy use. Pest management strategies can be affected by BMSB migrating into crops, making area wide treatments necessary.

Biological control of BMSB could come in the form of parasitoids and a wasp. Lara said that the wasp, *Trissolcus japonica*, better known as the "samurai wasp" is a native insect from the same parts of Asia where BMSB originated.

Populations of *Trissolcus japonica* have been found in parts of Oregon and Washington where BMSB are found. Its range in California has not expanded with BMSB, Lara said, and it is considered a pest here because it is known to attack native stink bugs. The wasp has been found in Los Angeles areas where BMSB have aggregated.

The wasp lays eggs on BMSB egg masses, which will turn a dark color three to five days after being attacked. The

parasitoids emerge from the BMSB eggs leaving distinguishing uneven circular holes. Lara said part of the research into parasitoid control of BMSB is placing sentinel egg cards where BMSB has laid eggs to determine wasp population levels in California. If BMSB begins to cause economic damage in valuable nut crops, Lara said the case could be made to mass raise the wasp and release them here to control BMSB.

Studies of BMSB movement patterns have shown this pest has preferred hosts at different times of the year.

Lara's Study

Degree day models have projected that the first generation of BMSB adults in pistachio growing regions could be expected in late June to early July. In Lara's feeding study, collection of rachis was synchronized with the first flight. In this phase of pistachio development shells begin to harden and expanding kernels cause shells to split.

A total of seven sets of pistachio rachises, each set with 10 rachises were used for the BMSB feeding trials at UCR. The trial had only pistachio nuts and stem tissue available for feeding.

When it feeds, BMSB produces a gel-like salivary sheath surrounding the plant tissue and its stylets to minimize loss of plant juices. The presence of salivary sheaths was used as evidence of BMSB feeding on the pistachio nuts. Additional confirmation of feeding was provided by daily observation during the trial.

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Distribution of Chlorosis in Almond Orchards

May Help Assess Potential Irrigation-Related Issues

By: Elizabeth J. Fichtner | Farm Advisor, UCCE Tulare and Kings Counties

Mae Culumber | Farm Advisor, UCCE Fresno County

Bruce Lampinen | Extension Specialist, UC Davis



Figure 1A. Chlorosis of end tree indicates excessive water on last tree in row. Photos courtesy of B. Lampinen.



Figure 1B. Chlorosis of overall orchard with healthy tree at end of row indicates overwatering at orchard level, and appropriate water to end tree.



Figure 3. The terminal tree has a microsprinkler adjacent to the trunk that is not shared with an adjacent tree. The chlorosis and subsequent decline of the terminal tree is consistent across the orchard. Red arrows point to microsprinklers.

The first step in assessing the cause of canopy chlorosis and decline in an orchard is mapping the distribution of the symptoms. If a pattern of chlorosis is similar across irrigation lines, then the cause of the problem may be related to over—or under—watering. Two scenarios present themselves regularly during summer farm calls: a) terminal tree chlorosis, and b) within row tree chlorosis (*Figure 1A and B, above*, and *Figure 2, right*).

Terminal Tree Chlorosis

In some orchards, the terminal tree along the irrigation line may become chlorotic and decline in advance of mortality. If terminal tree chlorosis is a trend throughout the orchard, it is worth assessing the sprinkler distribution at the end of the irrigation lines. In some orchards, the terminal tree is outfitted with a sprinkler that is not shared with a neighboring tree (*Figure 2A, right*). This terminal tree receives 1.5 x the amount of water as the other ‘healthy’ trees down the irrigation line.

In an otherwise adequately-irrigated orchard, these terminal trees are over-irrigated and develop chlorosis and decline. Sometimes the terminal sprinkler is positioned adjacent to the trunk (*Figure 3, left*), resulting in direct wetting of the trunk, a condition that predisposes the tree to Phytophthora infection, particularly when surface water is utilized.

Correcting Terminal Tree Chlorosis

To correct the over-irrigation of the terminal tree, the micro sprinkler head can be changed to a lower flow rate. Sprinklers should be placed away from the base of trees to prevent direct contact of the trunk with the stream of water. Additionally, when replanting dead or declining trees at the end of rows, consider that the irrigation needs of the replant are considerably lower than that of the neighboring older tree in the row.

Within-row Chlorosis

If canopy chlorosis is consistent

throughout the orchard, but terminal trees appear healthy, assess the distribution of sprinklers around the terminal tree in comparison to the trees along the irrigation line. If the terminal tree receives less water (*Figures 1B, left* and *2B, right*) than adjacent chlorotic trees, consider the potential that the orchard, as a whole, is over-irrigated. To test this hypothesis, growers and orchard managers can use a pressure chamber to assess the midday stem water potential of the trees. Almond trees maintained from -6-10 bar are under low water stress, but may be more susceptible to disease. Maintenance of almonds at -10-14 bar (mild stress) from mid-June through hull split, minimizes risk of disease (i.e. hull rot) and supports shoot growth. For information on use of a pressure chamber for enhanced irrigation management of almond, walnut and prune, download UC ANR Publication #8503 (<http://ucanr.edu/datastoreFiles/391-761.pdf>).

Correcting Within-row Chlorosis

If the orchard at large is over-irrigated, a change in the overall irrigation strategy is warranted. A combination of pressure chamber use to measure tree water stress, and consideration of weekly crop transpiration may enhance irrigation scheduling. The California Department of Water Resources and University of California Cooperative Extension have teamed up to provide Weekly ET (Evapotranspiration) Reports to agricultural water users to assist with irrigation scheduling. The reports include

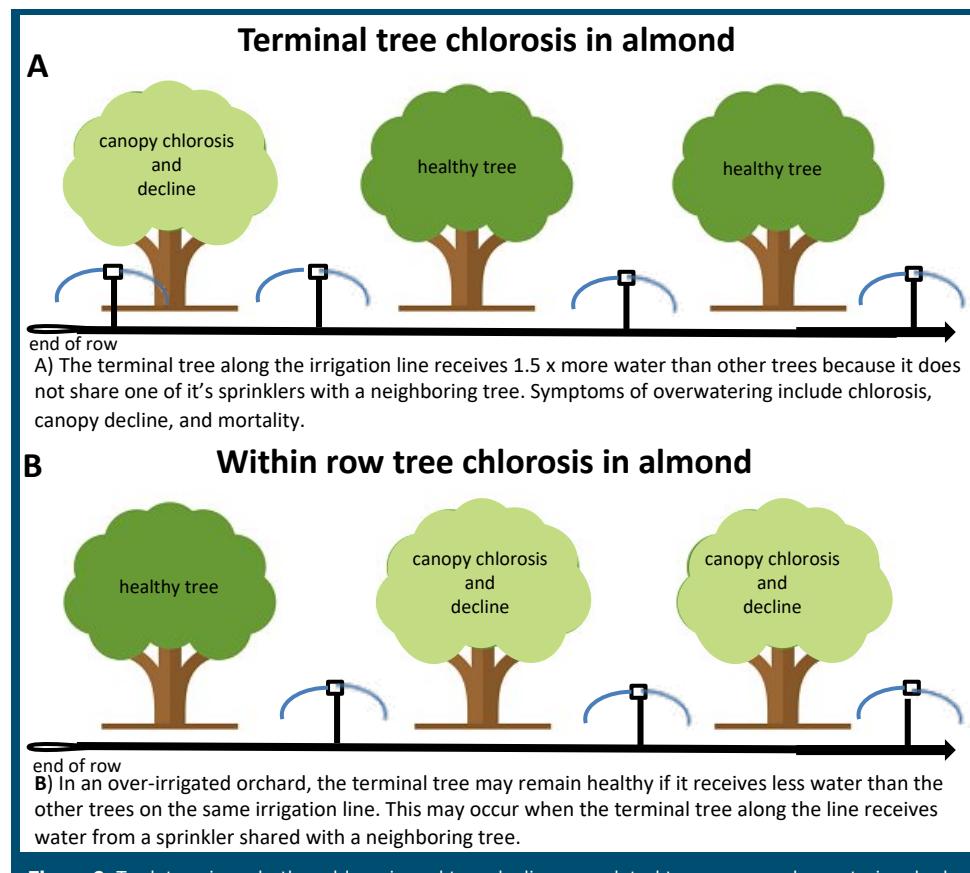


Figure 2. To determine whether chlorosis and tree decline are related to over-or under-watering, look for consistent patterns across rows.

water use information for a variety of crops including almonds, pistachios, walnuts, grapevines, citrus, and stone-fruit of mature bearing age. Adjusted on a weekly basis, water use estimates account for the changing growth stage and weather conditions at the Madera, Parlier, Lindcove, Stratford, Panoche, and Five-Points CIMIS weather stations. Each report gives crop-specific evapotranspiration (ET_c, total crop water use including soil evaporation) estimates for the previous and coming week. To

learn how to use these reports, please refer to the following article: <http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=26858>. Crop ET reports can be found online (ie: http://cetulare.ucanr.edu/Agriculture782/Custom_Program911/).

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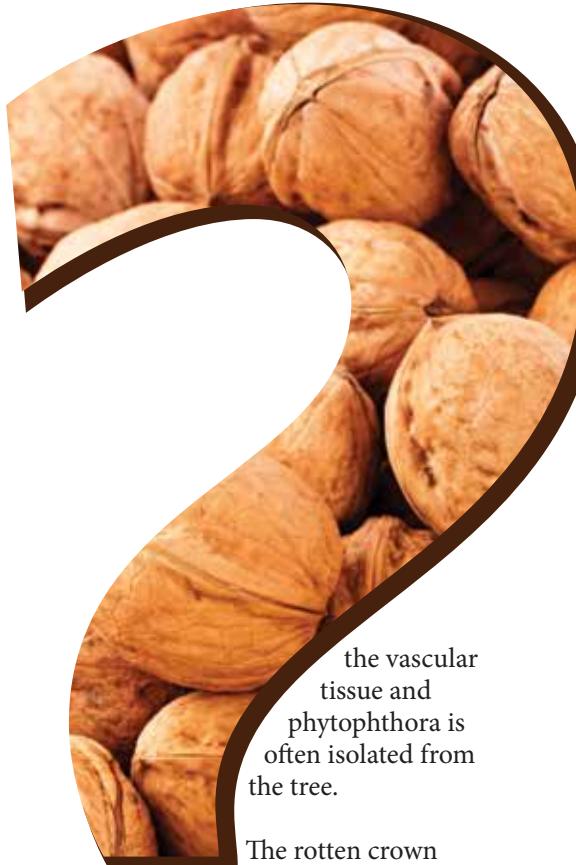
Declining Walnuts, What's the Deal

By: Kari Arnold, UCCE Farm Advisor

There are a number of reasons walnuts turn yellow and begin to decline. Sometimes the root system becomes root bound, due to improper planting or pockets of heavy soil. Other times walnuts can be infected with phytophthora, a fungus like organism that grows well in pro-longed periods of standing water and cooler temperatures. Irrigation can also play a role in yellowing walnut trees, not in the sense of under watering, but instead over watering. Walnuts are known to do best in fertile, deep, well-drained, loamy soils—really what doesn't? Walnuts do not like “wet feet” and begin to yellow, bronze and decline when exposed to inadequately irrigated soils, which growers might be observing in their orchards now. The question stands, what is adequate?

Research

A recent study performed by Allan Fulton University of California Cooperative Extension (UCCE) farm advisor, Tehama County, Ken Shackel University of California (UC) professor, Department of Plant Sciences, Davis, CA and Bruce Lampinen, UC Integrated orchard management\walnut specialist, Davis, CA show that over aggressive, early irrigation may saturate the soil, depriving roots of oxygen. This condition is easily observed during the summer to fall months, when trees yellow above ground and roots are blackened on the inside, sometimes showing a metallic blue hue on the outside, which can be seen in *Figure 1, page 23*. The crown may appear rotten when cutting into



the vascular tissue and phytophthora is often isolated from the tree.

The rotten crown and roots then limit the transportation of water and nutrients thus leading to a yellowed, stunted appearance above ground. Fortunately, ongoing research shows a delay of

irrigation in the spring regulated by the weekly repeated measurement of midday stem water potential (SWP) can benefit walnut orchards. The idea here is that irrigation is not applied in the spring until the trees begin to express a certain level of stress. This stress level is measured using a pressure chamber like that shown in *Figure 2, page 23*, is expressed in negative bars of pressure and referred to as stem water potential, or SWP.

SWP

So, what is SWP? To answer that question, a discussion of basic plant physiology is required. Water moves from the soil to the atmosphere through plants. Plants, or walnuts in this case, suck water from the soil, utilize some for photo-



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Figure 1A. Please note the metallic blue hue present on this gall. The color is likely related to a lack of oxygen brought on by inadequate irrigation. Delayed irrigation may benefit this orchard, promoting a healthier root system which may in turn be able to compensate for some root galls.



Figure 1B. Rotting tissue under the bark, possibly related to inadequate irrigation.



Figure 2. Pressure chamber for measuring stem water potential (SWP).

tosynthesis (a process by which plant cells convert light energy into chemical energy) as well as nutrient transport and cellular turgidity, but eventually lose quite a bit to the atmosphere when stomates are open. Stomates are like very tiny doors on the underside of most leaves, that open to allow carbon dioxide in (for sugar production, via

photosynthesis), and oxygen out (a by-product of photosynthesis). While those stomates are open, water also exits the plant leaf as water vapor, this is called evapotranspiration. This water vapor is being pulled from the leaf at a certain level of negative pressure, which is dependent upon the level of suction required for the roots to pull water out of the soil. This atmospheric pull changes based on the level of moisture in the soil because of the ease, or lack

thereof, for roots of the plant to extract water from the soil. This atmospheric pull, or tension, is reflected as stress on the plant, and can be measured in negative bars of pressure, using a pressure chamber. Because the measurement reflects the atmospheric pull's potential, the term stem water potential, or SWP, provides a proper description.

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Measuring SWP

So, how is SWP measured? SWP is measured during hottest, driest periods in the day when the tree is under the most stress, between the hours of 1:00 pm and 3:00 pm. Leaves are wrapped inside mylar bags which are typically provided with the pressure chamber, and available in multiple sizes, although the smallest bags tend to fit the chamber best. The terminal leaflet of a walnut is bagged and allowed to hang enclosed for at least fifteen minutes. During this time, the tension of the water in the leaf becomes equal to the tension of the water in the tree. For most trees the best leaves to measure are on branches closest to the trunk in the lower canopy, *Figure 3, left*. The idea here is to reduce the distance from root to shoot so that the value properly represents the tree. The further away from the roots, the more variable the value becomes. The stem of the bagged leaf is then inserted into the top piece, tightened down,



Figure 3. Choose terminal leaflets that are in the lower canopy, nearest the trunk of the tree and bag for SWP measurement.

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and the stem is cut flush with the chamber top with a sharp razor blade (be careful!). The top is tightened down by either a clockwise motion for screw top models, or sturdy push pins provided in box chamber models, and pressure is applied either by pump action, or nitrogen gas canisters.

Always read all safety precautions and perform safe practices when operating this equipment. Pressure is applied until a small amount of fluid is excreted from the cut stem. The value shown on the dial is recorded, and compared TO BASELINE, which is the most important, and often easily misunderstood, part.

Baseline

So, what is baseline? Baseline is a value that generally represents a fully irrigated tree. This value varies depending on the crop, relative humidity and temperature. Please see *Table 1, below* or visit http://informatics.plantsciences.ucdavis.edu/Brooke_Jacobs/index.php for date specific baseline values calculated using CIMIS weather stations.

informatics.plantsciences.ucdavis.edu/Brooke_Jacobs/index.php for date specific baseline values calculated using CIMIS weather stations.

So, what does this all mean? Typically, over-irrigated trees will show symptoms in mid-summer, when the tree is experiencing high levels of stress not due to a lack of water, but instead due to over irrigation resulting in rotting roots and crowns. Although irrigation can still be mitigated at this time, quite a bit of damage has been done. To try to avoid this damage, a delay in irrigation in the springtime is expected to improve tree health.

Further Studies

Further studies by Allen Fulton, Ken Shackel, and Bruce Lampinen have observed recent improvement in tree health related to a delay of irrigation in the spring. Initial field trials compared

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Table 1. Values of midday stem water potential (SWP in Bars tension) to expect for fully irrigated walnut trees under different conditions of air temperature and relative humidity. Table courtesy of Ken Shackel, Department of Pomology, University of California Davis.

Air Temp (F)	Air Relative Humidity															
	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
60	-3.8	-3.7	-3.7	-3.6	-3.6	-3.5	-3.5	-3.4	-3.3	-3.3	-3.2	-3.2	-3.1	-3.1	-3.0	-2.9
62	-3.9	-3.8	-3.8	-3.7	-3.6	-3.6	-3.5	-3.4	-3.4	-3.3	-3.3	-3.2	-3.1	-3.1	-3.0	-3.0
64	-4.0	-3.9	-3.8	-3.8	-3.7	-3.6	-3.6	-3.5	-3.4	-3.4	-3.3	-3.2	-3.2	-3.1	-3.0	-3.0
66	-4.0	-4.0	-3.9	-3.8	-3.8	-3.7	-3.6	-3.5	-3.4	-3.4	-3.3	-3.3	-3.2	-3.1	-3.1	-3.0
68	-4.1	-4.1	-4.0	-3.9	-3.8	-3.8	-3.7	-3.6	-3.5	-3.5	-3.4	-3.3	-3.2	-3.2	-3.1	-3.0
70	-4.2	-4.1	-4.1	-4.0	-3.9	-3.8	-3.7	-3.7	-3.6	-3.5	-3.4	-3.3	-3.3	-3.2	-3.1	-3.0
72	-4.3	-4.2	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	-3.6	-3.6	-3.5	-3.4	-3.3	-3.2	-3.1	-3.0
74	-4.4	-4.3	-4.2	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	-3.6	-3.5	-3.4	-3.3	-3.2	-3.1	-3.1
76	-4.5	-4.4	-4.3	-4.3	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	-3.6	-3.5	-3.4	-3.3	-3.2	-3.1
78	-4.7	-4.6	-4.5	-4.4	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	-3.6	-3.5	-3.4	-3.3	-3.2	-3.1
80	-4.8	-4.7	-4.6	-4.5	-4.3	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	-3.6	-3.5	-3.4	-3.2	-3.1
82	-4.9	-4.8	-4.7	-4.6	-4.5	-4.5	-4.2	-4.1	-4.0	-3.9	-3.7	-3.6	-3.5	-3.4	-3.3	-3.1
84	-5.1	-4.9	-4.8	-4.7	-4.6	-4.4	-4.3	-4.2	-4.1	-3.9	-3.8	-3.7	-3.5	-3.4	-3.3	-3.2
86	-5.2	-5.1	-5.0	-4.8	-4.7	-4.5	-4.4	-4.3	-4.1	-4.0	-3.9	-3.7	-3.6	-3.5	-3.3	-3.2
88	-5.4	-5.2	-5.1	-4.9	-4.8	-4.7	-4.5	-4.4	-4.2	-4.1	-3.9	-3.8	-3.6	-3.5	-3.4	-3.2
90	-5.6	-5.4	-5.2	-5.1	-4.9	-4.8	-4.6	-4.5	-4.3	-4.2	-4.0	-3.9	-3.7	-3.6	-3.4	-3.2
92	-5.7	-5.6	-5.4	-5.2	-5.1	-4.9	-4.7	-4.6	-4.4	-4.3	-4.1	-3.9	-3.8	-3.6	-3.4	-3.3
94	-5.9	-5.7	-5.6	-5.4	-5.2	-5.0	-4.9	-4.7	-4.5	-4.4	-4.2	-4.0	-3.8	-3.7	-3.5	-3.3
96	-6.1	-5.9	-5.7	-5.6	-5.4	-5.2	-5.0	-4.8	-4.6	-4.4	-4.3	-4.1	-3.9	-3.7	-3.5	-3.3
98	-6.3	-6.1	-5.9	-5.7	-5.5	-5.3	-5.1	-4.9	-4.8	-4.6	-4.4	-4.2	-4.0	-3.8	-3.6	-3.4
100	-6.5	-6.3	-6.1	-5.9	-5.7	-5.5	-5.3	-5.1	-4.9	-4.7	-4.5	-4.2	-4.0	-3.8	-3.6	-3.4
102	-6.8	-6.6	-6.3	-6.1	-5.9	-5.7	-5.4	-5.2	-5.0	-4.8	-4.6	-4.3	-4.1	-3.9	-3.7	-3.4
104	-7.0	-6.8	-6.6	-6.3	-6.1	-5.8	-5.6	-5.4	-5.1	-4.9	-4.7	-4.4	-4.2	-4.0	-3.7	-3.5
106	-7.3	-7.0	-6.8	-6.5	-6.3	-6.0	-5.8	-5.5	-5.3	-5.0	-4.8	-4.5	-4.3	-4.0	-3.8	-3.5
108	-7.4	-7.3	-7.0	-6.8	-6.5	-6.2	-6.0	-5.7	-5.4	-5.2	-4.9	-4.6	-4.4	-4.1	-3.8	-3.6
110	-7.8	-7.6	-7.3	-7.0	-6.7	-6.4	-6.2	-5.9	-5.6	-5.3	-5.0	-4.7	-4.5	-4.2	-3.9	-3.6
112	-8.1	-7.8	-7.5	-7.2	-6.9	-6.7	-6.4	-6.1	-5.8	-5.5	-5.2	-4.9	-4.6	-4.3	-4.0	-3.7
114	-8.5	-8.1	-7.8	-7.5	-7.2	-6.9	-6.6	-6.3	-5.9	-5.6	-5.3	-5.0	-4.7	-4.4	-4.0	-3.7
116	-8.8	-8.5	-8.1	-7.8	-7.5	-7.2	-6.8	-6.5	-6.1	-5.8	-5.5	-5.1	-4.8	-4.4	-4.1	-3.8
118	-9.1	-8.8	-8.4	-8.1	-7.7	-7.3	-7.0	-6.7	-6.3	-6.0	-5.6	-5.3	-4.9	-4.5	-4.2	-3.8
120	-9.5	-9.1	-8.8	-8.4	-8.0	-7.6	-7.3	-6.9	-6.5	-6.1	-5.8	-5.4	-5.0	-4.6	-4.3	-3.9

Common ranges of SWP under cool weather conditions Common ranges of SWP under normal weather conditions
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Continued from Page 25

control trees to delay trees. The control treatment consisted of irrigation initiation based on a grower standard typically related to soil moisture meters and/or leaf out. The delay treatment in turn utilized SWP measurements of approximately 2 to 3 bars below baseline to initiate irrigation, which didn't trigger until the first week of June (site dependent). Yield measurements between treatments showed no significant differences, yet trees in the delay treatments appeared to improve in general overall health over time. Field trials have been extended to a few other counties, including Stanislaus, to incorporate variation across walnut growing regions in CA. Research is ongoing, and currently funded by the California Walnut Board.

The advertisement features a large, blossoming walnut tree against a blue sky. The text "Biological Controls for Anthracnose, Alternaria, N.O.W., and more..." is overlaid in a white, flowing font. A green button at the bottom right contains the text "BIO WITH BITE.®". At the bottom, there are logos for three products: REGALIA BIOFUNGICIDE, VENERATE BIOINSECTICIDE, and GRANDEVO BIOINSECTICIDE. Below these logos, text reads "Mid Valley Nut Conf. Visit us in Booth #25" and "marronebio.com".

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STEEL OR PLASTIC? *Understanding Material Options for Your Water Well*

By: Charlie Hoherd | Roscoe Moss Company

California growers rely on water wells to provide a consistent and sustainable water supply. Cyclical droughts can render surface water availability as unpredictable. Ground water is an increasingly important option, but rising pumping costs, rising energy rates, and dropping water table levels have left growers struggling to ensure a reliable and cost efficient water supply for their crops. While surface water provides many with adequate amounts for growing, the reality of ensuring water supply is uninterrupted means having access to ground water through a dependable, efficient and long lasting source. That source is a water well.

Most growers agree drilling a water well can be a confusing, and sometimes stressful, experience especially when it comes to deciding what well construction materials should be used. Some well owners are inclined to select casing with higher collapse strength and durability, while others may opt for a lower cost alternative. There is no correct one-size-fits-all approach when it comes to well design. The reality is the design of each well should be looked at independently; taking into account production requirements and desired life expectancy, while also understanding geology in which the well is constructed.

Material Options

Water well casing and screens are available in two materials; steel or PVC. As with any other valuable equipment on a growing operation, it is important to understand differences between these

Steel Casing Installation.
All photos courtesy of
Roscoe Moss Company.



Steel Casing Fabrication.

options. With steel casing, there are actually multiple steel types available differentiated by corrosion resistance. Some of these include Mild Steel, High-Strength Low-Alloy (HSLA) Steel, and Stainless Steel Type 304. For growers in California, Mild Steel is the most common option. No two water wells are identical, and the geology beneath our feet is ever changing, which differentiates one well from another. Changing water levels, flow rates, water quality, and formation type all impact how much water a well can produce, and also how long it can pump efficiently. These factors all influence the type of casing selected.

The Case for Steel Well Casing

Steel casing and screens have been used in water wells for California farmers for over 100 years. Steel represents the strongest and most durable well casing option. Some of its attributes include offering the highest tensile and collapse strength. Today's wells are drilled to increasing depths in order to access the ground water needed, so strength of casing plays an important role in ensuring the well longevity. Steel casing is available in a variety of corrosion resistant options, allowing the owner to properly select casing based on water quality.

Appropriate Applications for Steel Well Casing

Typically, wells drilled for California's growers are considered "large diameter," meaning they range from 12.75 inches to 18 inches in diameter. The strength of steel in these large diameter wells allows wall thickness to be between .312 inches to .375 inches. Wells continue to be drilled to deeper depths, often times surpassing 1,000 feet. In order to avoid failure during

Continued on Page 30

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Continued from Page 29

installation, well development, or pumping, the casing must meet a minimum collapse and tensile strength. Steel casing represents the strongest casing option available.

Limitations of Steel Casing

Well casing and screen made from steel can be more expensive than PVC casing. Steel casing joints are typically field welded during installation, which requires the drilling contractor to have a welder on site. The added cost of using a welder can deter some contractors from using steel materials.

The Case for PVC Well Casing

PVC (Polyvinyl chloride) casing is a synthetic plastic polymer that has the advantage of being essentially corrosion resistant to poor water quality. This corrosion resistance is the main advantage of PVC casing. Drilling contractors and well design engineers both acknowledge the virtual absence of corrosion within a PVC cased or screened well. PVC is also lightweight and is joined by threaded ends, making installation a quick process for the contractor.

Appropriate Applications for PVC Well Casing

PVC casing is designed for use in small diameter, shallow



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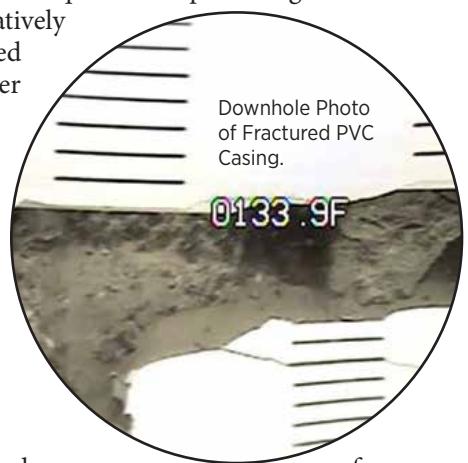
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wells. Private residential wells, sometimes referred to as domestic wells, are often constructed of PVC. Scientists and engineers working in the environmental field also rely on the advantages of PVC for their wells. Being readily available, easy to handle, and corrosion resistant have resulted in successful wells in these applications.

Limitations of PVC

While a benefit of PVC is its resistance to corrosion in aggressive water environments, PVC is not immune from scale buildup within the pipe and screen. For larger diameter and deeper wells, PVC casing lacks required collapse strength. Due to low collapse strength, relatively thick wall material is required for deep well settings. Thicker wall casing (typically 0.700 inches for 16 inch diameter) makes casing extremely rigid, often resulting in catastrophic cracks and fracturing. The wall thickness/slot size relationship also significantly increases clogging in slotted screens.



PVC should not be considered for large diameter wells (>12.75 inches) and deep wells (>700 feet). PVC joint connections are less reliable as they are threaded and not welded, and failures are likely in deeper wells due to weight of the column load. Lastly, physical properties of PVC vary with temperature. As the temperature rises (i.e. as cement seals cure), PVC working strength decreases by approximately 0.5 psi (pounds per square inch) per degree Fahrenheit above 70°F. Therefore, much care must be taken during cementing operations or in other high temperature environments to avoid casing collapse.

Summary

A water well should be viewed as capital investment into one's growing operation. As with any capital investment, choices made during construction will have a lasting impact on overall performance and longevity. When deciding what material to use, it is important to review anticipated well casing diameter, setting depth, and hydrogeologic variables, including pumping water levels and water quality. Drilling contractors and hydrogeologic consultants can provide helpful recommendations, but ultimately it is the well owner's responsibility to select material that is suitable for the amount of water desired, strength required, and expected useful well life.

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

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Almond Floor.

All photos courtesy of Jenny Holtermann.

ADVOCACY

Your New Adventure

By: Jenny Holtermann

Imagine going on a vacation, maybe to a foreign land. Being in awe over the architecture, the landscape, or the history. Maybe you went sight seeing in Italy to the ancient ruins, or the massive coliseum. Maybe you went to China and were overwhelmed by the massive Great Wall. Maybe your adventures took you to one of our many National Parks and the sense of wonder that can be found inside the huge redwood trees, or you felt the vast emptiness of the Grand Canyon.

These quests are all unique, and they leave you with a sense of wonder and admiration for the land around you. They seem so different from your everyday life. Something you aren't familiar with and your only connection to them may be a book you've read or an article you once glanced over. We are disconnected and removed from these destinations.

To many, this is no different than a farm, something the 99 percent of Americans are completely removed from. They gather their information from books, articles and the internet. If they ever have the opportunity to set foot on a farm, it is like visiting a foreign land. Something they would be in complete awe over. Where 20 acres of trees may feel like a massive coliseum.

Advocacy

This is where advocacy comes into play. Advocacy is a way for farmers and ranchers to share their lifestyle, their experiences, and their perspective. Advocacy is a way to give the general consumer a glimpse into your life, so it doesn't have to be so overwhelming, or intimidating. Advocacy is a way to show how farms are safe, necessary, and meaningful.

Continued on Page 34

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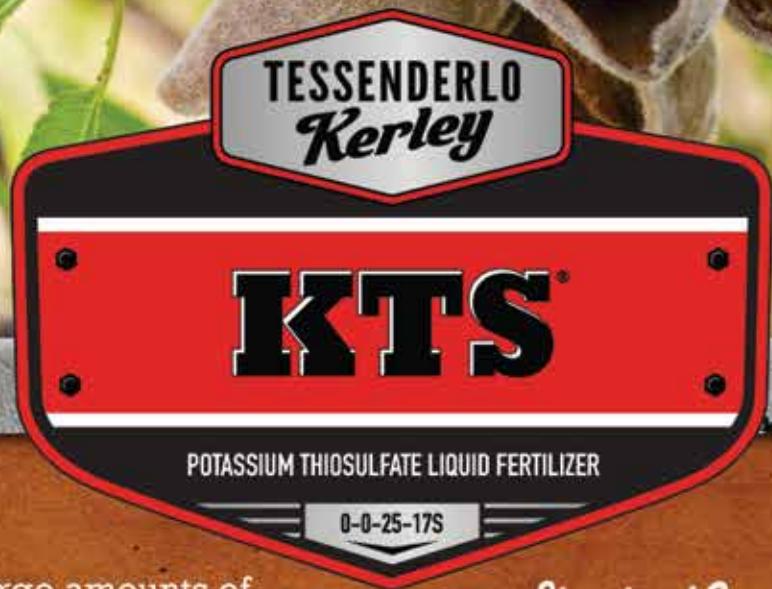
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Now, I understand many farmers think they have nothing to share. They don't do anything special. They don't do anything unique. Your farm is just like everyone else's. Once you've seen one almond farm, you've seen them all. But remember back to the great adventures. Are all those Italian ruins the same? Are all the redwood trees in our National Parks the same? Nope. Or else, you wouldn't feel the need to road trip across country to visit all the National Parks. So many people race to post pictures on social media of their amazing vacations, yet farmers are hesitant about sharing their daily lives.

We All Have a Story to Tell

Every farm is unique. Every farm is necessary. Every farm is different. When you jump on that tractor and do your rounds mowing before harvest, there are people out there that have no idea why, how or when you are doing that. You would be surprised to learn the amount of people that would tune into your story about mowing the same as they would to learn about how the Great Wall of China was built. It's a completely new experience to many and they are captivated by the story. Not only do you mow before harvest to help the machinery work more effectively and efficiently, but by cutting the weeds you conserve the water and nutrients the weeds would otherwise use to grow. To others, they just think you are doing it to make it look nicer.

Start Your Advocacy Journey at Harvest

Harvest is the perfect opportunity for you to start your advocacy journey. Harvest is the time of chaos, craziness and non-stop action on the farm. It is also the time where our finished crop that we have waited for all year, is visible. People get to see the product that they eat. That visual that you can relate to their morning granola, cup of almond milk, or afternoon snack.

Harvest is also the time of all the action. When you shake those trees, let's be honest, it's like raining nuts. Just to know nuts grow on a tree, could be baffling to others. The fact that there is a machine that shakes the nuts off, could be mind blow-



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ing. But watching a video of the shaker, might just be the thing that pulls in the consumer and gets them hooked on learning more.

Many Forms of Advocacy

There are many forms of advocacy and ways you can be an advocate. It can be as simple as being at the grocery store and talking to the person in the check out line about why it is so dusty this time of year, and how the drought is affecting harvest conditions. You could simply be in the produce aisle with a woman buying peaches and explain to her that an almond is more closely related to a peach than it is to other nuts, in fact they are like cousins of the fruit world.

Advocacy could be posting a video on Facebook of your drip hose slowly dripping water out for your trees while you are in the middle of harvest. You can explain how you are able to irrigate and harvest because of the special irrigation practices you have on your farm. You can explain how in the last 20 years almond farmers have managed to use 33 percent less water to produce almonds because of practices like drip irrigation.

Advocacy is Easy

Advocacy is as easy as sharing a picture of harvest on your Instagram and discussing the yield decreases and tariffs combined could be hurting your farm this year. Maybe you discuss the unstable market of this year's harvest and the uncertainty of your return. How that will impact your decisions with harvest and your farm. Share your struggles. Your struggles are what makes you relatable and compassionate. They also make others compassionate towards you.

Being an advocate just isn't about sharing your story to your neighbor, or church friend, or person in the grocery store. Being an advocate is also about sharing your story with the consumer miles away, across the country, the mom blogger, the city dweller, the millennial who is currently getting their farm knowledge from the Food Babe, Dr Oz, Chipotle Restaurant, or the latest

environmental activist study. These are the ones who need a face to the food they eat. These are the ones who would literally pay to come to your farm just to sit on a tractor. They want that sense of wonder, awe and amazement.

Sure, you might get some negative comments, questions or snarky responses. You're not going to make everyone happy. But the ones who want to learn, they will listen and appreciate you sharing. They are the ones who will come back for more videos, or pictures, and want to know more.

Get out your smartphone, snap a quick video and upload it to Instagram, Facebook, Linked In, YouTube, whatever you fancy and share a glimpse into your everyday life. You never know who will be ready for their next adventure.

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FSMA: PREVENTIVE CONTROLS for the Nut Industry

By: Safe Food Alliance | Contributing Writer

For our second installment in this series on the Food and Drug Administration's (FDA) Food Safety Modernization Act (FSMA) series, we're going to talk about the "Preventive Controls" rule, which is the main rule for food processors. It's similar to the Hazard and Analysis Critical Control Point (HACCP), with some notable differences which we'll address below, including some specific requirements that you may not have seen before.

Who's Covered

In general, facilities which register with FDA under part 415 of the FD&C act (that is, food processors) have to comply with the rule, unless specifically given

an exemption. There are a few available exemptions based on specific food industry sectors such as meat processors or alcoholic beverage companies, which already have other regulations in place, but there are no specific exemptions for the nut industry. But there are some modified requirements for certain situations such as a very small company that meets the definition of a "qualified facility". You can find out more here: <https://www.fda.gov/Food/Guidance-Regulation/FoodFacilityRegistration/QualifiedFacilityAttestation/default.htm>

Hullers

The key question for nut hullers is, are they now required to register with FDA

as a processor, and comply with the rule? There's been some uncertainty as to how hullers fit into the FSMA equation; it's long been a point of discussion, even while the rule was still being drafted. The good news is that in the final revision of the rule many nut hullers are considered a farm, and would therefore fall under the Produce Safety rule and have to comply with that rule. But there are some that fall under the Preventive Controls rule based on ownership.

"Primary Production Farms" are what many people would consider a traditional farm operation and always fall

under the Produce Safety rule. "Secondary Activities Farms", which includes some hullers, also fall under that rule. The Produce Safety rule applies to operations processing a "raw agricultural commodity", when the majority of nuts they handle belong to the same ownership. That is, the grower also owns the processor. A business that carries out farming-related activities such as hulling, but a majority of the services provided are on nuts owned by other parties, will fall under this Preventive Controls rule and will be required to have a documented food safety program in place. Required contents of the program are outlined later.

Currently, even those operations outlined above that fall under the Preventive Controls rule still get a temporary break from the rule for now, based on the Enforcement Discretion released by FDA in January. Based on this these operations they are only required to implement Good Manufacturing Practice (GMP) requirements, and not food safety plans. You can find out more here: <https://www.fda.gov/food/new-sevens/constituentupdates/ucm590667.htm> FDA has noted that they will be working to better align requirements for operations like hullers, where some fall under one rule and some under the other. The industry's hope, of course, is that they will eventually all fall under the Produce Safety rule.

Raw Nut Handlers & Produce Safety

One thing you may not know is that there are some operations which process only raw nuts, who based on what processes they apply, may technically fall under the less-demanding Produce Safety rule as well. The Produce Safety rule applies to operations processing a "raw agricultural commodity", when

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the majority of nuts they handle belong to the same ownership. That is, the grower also owns the processor. FDA allows, under the Produce Safety rule, for operators to conduct activities such as hulling, shelling, screening, and fumigation to control insects. Once a processor begins handling pasteurized nuts, conducting roasting, grinding, making butter, flavoring nuts, or similar operations they immediately fall under the Preventive Controls rule.

That being said, this is a typical case of the market expectations exceeding regulatory requirements. Most customers seem to have elevated their expectations for handlers in recent years and are requiring a food safety system similar to HACCP which complies with the Preventive Controls rule. So the conservative choice for any handler is to implement a program that complies with this rule.

The Produce Safety rule will be covered in a future article, but if you'd like to learn more about it now you can search our newsletter archive, using the search tool at the top of the page here: <https://safefoodalliance.com/resources/newsletter/> or you can visit the FDA web site here: <https://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm334114.htm> Most importantly, if your operation falls under this rule you'll need to attend a session of the one-day FSMA Produce Safety course. There are a few sessions publicly available now, but there will be many more after harvest this year. You can sign up for more information at our web site, <http://www.safefoodalliance.com>, or check at the Produce Safety Alliance web site at <https://producesafetyalliance.cornell.edu/training/grower-training-courses/upcoming-grower-trainings/>.

What's Required?

The rule is broken down into the following sections:

1. Updates to the GMPs
2. Food Safety Plan Requirements
3. Modified Requirements and Exemptions to the rule
4. Records requirements
5. Supply Chain Requirements

We can't cover all the details of the requirements in this article, as the rule itself is quite long. The best approach is to have someone in your operation who is responsible for food safety to attend the Preventative Control Qualified Individual (PCQI) course—this is a requirement of the regulation. We offer this on a periodic basis. Courses can be found at <https://safefoodalliance.com/events/> or at the Food Safety Preventative Controls Alliance (FSPCA) web site, <https://www.ifsh.iit.edu/fspca/courses> .

The new GMPs are very similar in overall structure and intent to the traditional GMP rules we've all gotten so familiar with. However they are a little bit less specific in their nature, and leave more responsibility on the processor to determine what controls are necessary. They also have a very intentional added focus on prevention of allergen cross-contamination, and for good reason—allergen is the leading cause of recalls in the U.S. Certain non-binding provisions in the old GMPs, such as training, have been made binding—that is, they expect to see a robust training program in all facilities.

The food safety plan requirements, or "HARPC" (Hazard and Analysis and Risk-Based Preventive Controls) include:

1. Hazard Analysis
2. Preventive Controls
3. Supply Chain Program
4. Recall Plan
5. Procedures for monitoring
6. Corrective Action Procedures
7. Verification Procedures

Specifics for the Nut Industry

Based on requirements in this regulation, the food safety plan for all food processors should now include evaluation of the risk of radiological hazards in their products. Of course the likelihood of this issue for most processors is extremely

low. However to not consider it in your hazard analysis is to potentially miss an important point in the regulation.

Based on FDA's guidance for the Preventive Controls rule, the following hazards must be considered in every nut processor's food safety plan, as applicable:

- Pathogenic E. Coli
- Salmonella species
- Listeria monocytogenes (for any nut butters produced)
- Mycotoxins (that is, aflatoxin)
- Recontamination with environmental pathogens during processing
- Undeclared allergens due to wrong label
- Undeclared allergens due to cross-contact
- Metal
- Glass (for shelled nuts)
- Unapproved colors and additives (for flavored nuts)
- Chemical hazards due to misformulation (i.e. for flavored items)

We hope this information was helpful. Please feel free to contact us if you have any questions regarding the rule, or would like to set up a personalized webinar for you and your team, or an on-site training. You can contact us at <https://safefoodalliance.com/contact/> .

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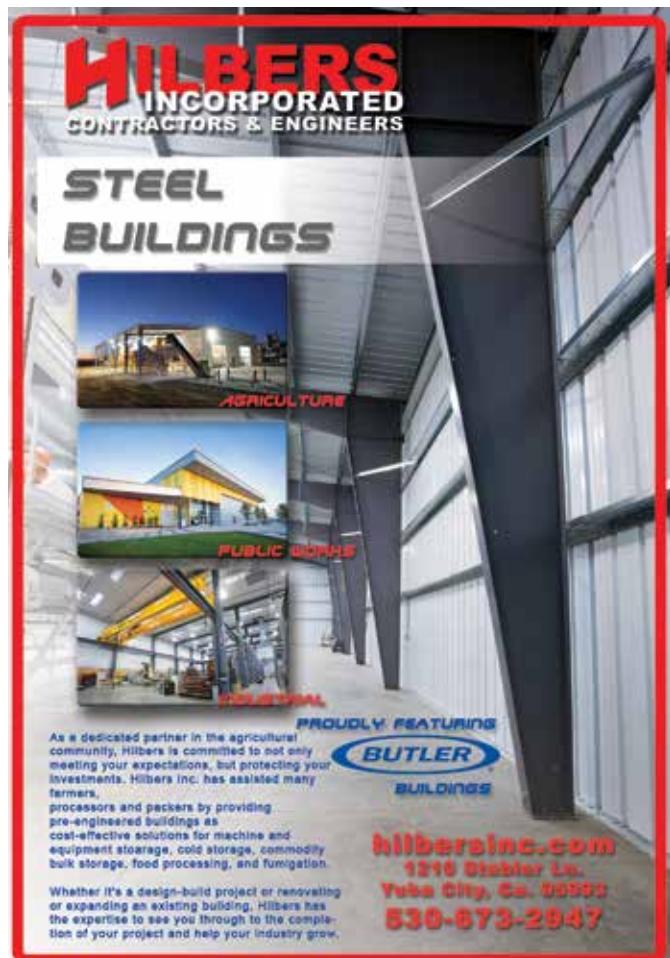
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Conducting an ***Incident Investigation***

By: Amy Wolfe, MPPA, CFRE | President and CEO, AgSafe

Agriculture is one of the most dangerous industries in which to work. According to the National Ag Safety Database (NASD), injuries on farms range from minor cuts and scrapes to amputations and death. Employers have a legal obligation to identify and eliminate workplace hazards. Thorough and compliant incident investigations give employers the ability to identify the cause of an injury and avoid future occurrences. When we identify the cause of an injury, we can improve our safety practices and procedures, and more importantly, create a safe work environment for our people.

With that said, where do you begin? First, take care of any immediate emergency. If an employee has had an injury, see to their care and ensure that the area in which the incident occurred is safe for others. Once the immediate emergency has been tended to, begin the investigation process. Time is absolutely of the essence in this process. The best practice is to begin your investigation no later than 24 hours after the incident.



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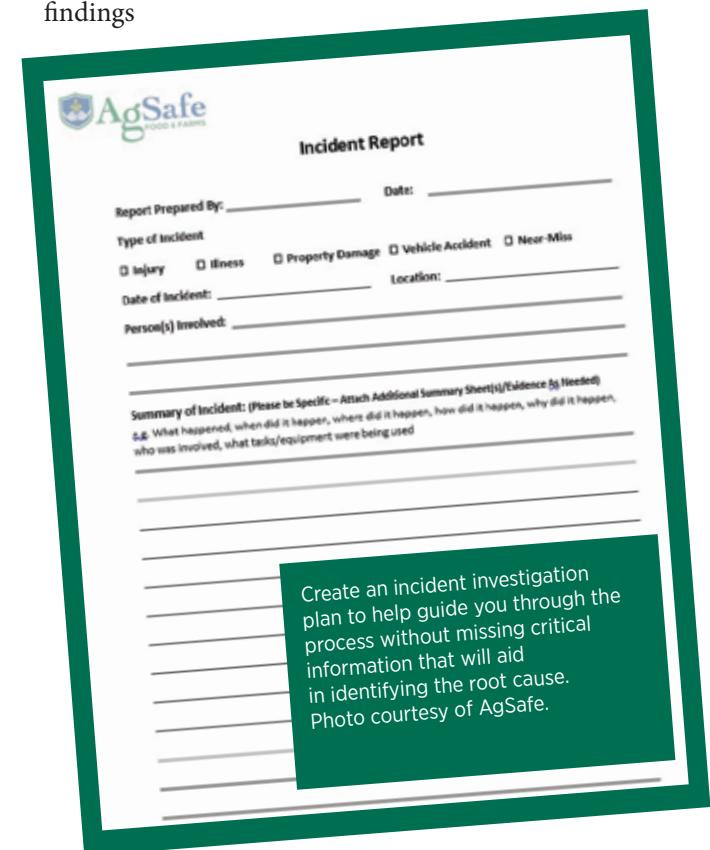
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Investigative Plan

To ensure you do not miss any steps or evidence crucial to your investigation, use an investigative plan to help guide you through the process. Your plan should have the following elements:

- List the potential causes/violations involved
- List the persons who need to be interviewed (e.g. injured person, supervisor, bystander, etc.)
- List evidence necessary to prove the elements of your investigation (e.g. permits, training records, pictures, diagrams, etc.)
- List agencies that may need to be involved in the investigation or have jurisdiction over the incident
- List persons who need to be provided with periodic updates
- List types of evidence that may need to be collected (e.g. photographs, permits, postings, broken equipment, damaged personal protective equipment, etc.)
- Write the investigative report
- Summarize findings
- Take appropriate actions/corrective measures based on findings



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Type of Incident
 Injury Illness Property Damage Vehicle Accident Near-Miss

Date of Incident: _____ Location: _____

Person(s) Involved: _____

Summary of Incident: (Please be Specific - Attach Additional Summary Sheet(s)/Evidence as Needed)
e.g. What happened, when did it happen, where did it happen, how did it happen, why did it happen, who was involved, what tasks/equipment were being used

Create an incident investigation plan to help guide you through the process without missing critical information that will aid in identifying the root cause.
Photo courtesy of AgSafe.

Incident Investigation—Interviews

Prompt interviews can be the key to useful information in an incident investigation. Based on your investigation plan, in which you have identified who needs to be interviewed, begin with precise questions that get to the heart-of-the-matter: what happened, how did it happen and who was involved.

When conducting the interview, set the tone by explaining the purpose of the interview. Ask open ended questions to allow the interviewee the opportunity to add details. Avoid leading questions. Begin each interview with a list of standard questions, to ensure you gather all of necessary information from each employee but be flexible and allow yourself to deviate from the questions or ask follow-up questions when needed. Take notes during the interview process to ensure that you can reference the information when you write the report.

Interview questions to help get you started:

- Where were you at the time of the accident?
- What were you doing at the time?
- What did you see and hear?
- What were the environmental conditions (weather, light, noise, etc.) at the time?
- What was (were) the injured worker(s) doing at the time?
- In your opinion, what caused the accident?
- How might similar accidents be prevented in the future?"

- Inspection forms
- Log sheets
- Postings
- Medical records
- Written procedures
- Permits
- Broken equipment
- Damaged personal protective equipment (PPE)
- Other company property—computer (emails), cell phone (text messages)

Investigative Report Writing Tips

Once you have gathered all of the evidence, take the time to organize it in a report to help you conclude the root cause and what corrective actions should follow. Begin the report with what prompted the investigation. Use a chronological-timeline approach to document what happened, always listing the facts objectively. When applicable, include interview statements and

Continued on Page 40

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A concise and organized report can help you identify the root cause of an incident and update procedures to help avoid the incident in the future.
Photo courtesy of Milwaukee Journal.

Continued from Page 39

evidence as reference to better support your findings.

Here are a few investigative report writing tips:

- Write using an active approach versus a passive approach
 - e.g. "He stated..." rather than "It was stated..."
- Write in a simple style versus something unnaturally formal or awkward
- Include facts not opinions
- Keep paragraphs brief and to the point
- Avoid repetition
- Ensure the information in your report is relevant to the overall report
- Reference any accompanying materials/supporting evidence
- Ensure report is comprehensive and complete
- Proof read the narrative carefully
- Ensure the report is organized and clear
- Have someone else review your report for grammar and comprehension

Correction Action

Take corrective action immediately. Once the cause or causes of the incident have been determined, take action to correct problems and prevent future accidents. Document the correction process. Outline the steps taken and who took them. Corrective action documents provide evidence to support the corrections made after the investigation.

Some examples of corrective measures may include:

- Replacement or repairs to machinery and equipment
- Posting signs as a reminder to wear personal protective equipment, warnings and other necessary precautions
- Training, retraining or possible disciplinary action
- Creation or updates of safety programs

This is merely a brief overview of an incident investigation. If you have questions about the specifics, including sample forms, visit www.agsafe.org, call (209) 526-4400 or send an email to safeinfo@agsafe.org.

AgSafe is a 501c3 nonprofit providing training, education, outreach and tools in the areas of worker safety, human resources, food safety, and pesticide safety for the food and farming industries. Since 1991, AgSafe has educated nearly 75,000 employers, supervisors and workers about these critical issues.

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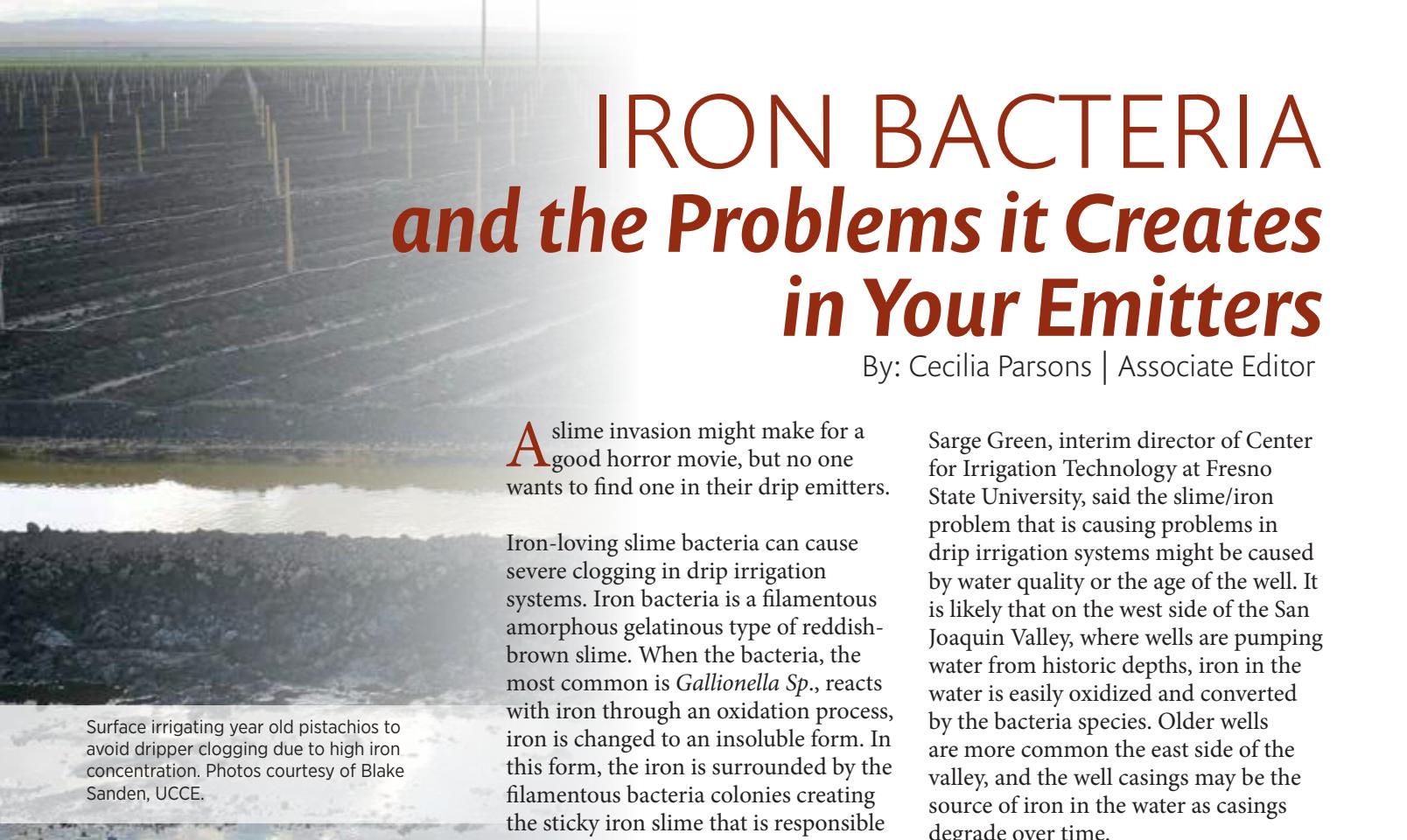
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IRON BACTERIA and the Problems it Creates in Your Emitters

By: Cecilia Parsons | Associate Editor

A slime invasion might make for a good horror movie, but no one wants to find one in their drip emitters.

Iron-loving slime bacteria can cause severe clogging in drip irrigation systems. Iron bacteria is a filamentous amorphous gelatinous type of reddish-brown slime. When the bacteria, the most common is *Gallionella Sp.*, reacts with iron through an oxidation process, iron is changed to an insoluble form. In this form, the iron is surrounded by the filamentous bacteria colonies creating the sticky iron slime that is responsible for clogging the dripper.

Sarge Green, interim director of Center for Irrigation Technology at Fresno State University, said the slime/iron problem that is causing problems in drip irrigation systems might be caused by water quality or the age of the well. It is likely that on the west side of the San Joaquin Valley, where wells are pumping water from historic depths, iron in the water is easily oxidized and converted by the bacteria species. Older wells are more common the east side of the valley, and the well casings may be the source of iron in the water as casings degrade over time.

Surface irrigating year old pistachios to avoid dripper clogging due to high iron concentration. Photos courtesy of Blake Sanden, UCCE.

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For a full agenda & more information, visit <http://ucanr.edu/sites/WalnutShortCourse/>

Dropping the bowls and pumping water from deeper depths can make the slime problem worse, Green said. Cleaning the well can help, but that can be an expensive option. Chlorination can kill the bacteria but over time it will return.

According to the irrigation system company Netafim, concentrations of ferrous iron as low as 0.15 to 0.22 parts per million (ppm) are considered as a potential hazard to drip systems. Concentrations above 1.5 are considered severe. Any water system that contains concentrations higher than 0.5 ppm iron cannot be used in drip systems unless it is treated chemically to dissolve the bacteria.

Recently retired University of California Cooperative Extension irrigation specialist Blake Sanden said the worst clogging he encountered was southwest of Buttonwillow where the water turned the reservoir red. He said the pistachio grower at the site tried aeration—which made the rust-colored reservoir, and acidification. In the end, he said the best tactic to stall off clogging is to finish the irrigation with fresh, non-iron canal water to flush out the high iron well water.

Sanden said the worst clogging issues in drip systems occur when iron-loving slime bacteria invade a well and irrigation system to create long strings of slime that even clog the louvers in the well casing.

University of California (UC) on maintaining micro irrigation systems provides guidelines for predicting if there is a need to treat for biological clogging.

Visual evidence of organic contamination, such as greenish color to the water or algae indicates water treatment may be necessary to prevent biological clogging. Filters in the system should be monitored and flush water should be filtered for evidence of a build up of organic contaminants. Sand media filters should be watched for build up of organic matter. Periodic biocide treatments of the filters via the access port on each of the media tanks can be made.

There is also the simple diagnostic step of running a finger around the inside of a drip tubing at the head or tail end of lateral lines to see if they feel slimy.

Treatment Options

Netafim offers two basic treatment options. The first is stabilization or precipitation inhibitors. The stabilization treatments keep the ferrous iron in solution by chelating it with sequestration agents (poly phosphates and phosphonate.)

The other option is oxidation, sedimentation and filtration. This treatment oxidizes the soluble or invisible ferrous iron into the insoluble or visible ferric iron. It will then precipitate so it can be physically separated from the water by filtration.

According to the UC micro irrigation management program, treating irrigation water with a biocide will



Bacterial slime, reddish color and collapsed/plugged soil structure resulting from excess dissolved iron in well water. (Buttonwillow, CA)

Continued on Page 44



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Continued from Page 43

minimize the growth of organic contaminants and often destroy the organic material, minimizing the clogging hazard.

Three biocide methods are commonly used to treat irrigation water. In addition, use of acid is sometimes recommended for biological clogging problems. There are also a number of water treatment devices on the market that claim to control biological clogging problems.

Chlorine is often added to irrigation water to oxidize and destroy biological microorganisms such as algae, fungi, and bacteria.

Forms of Chlorine

Common sources of chlorine are chlorine gas, sodium hypochlorite (a liquid), and calcium hypochlorite (a powder or granules).

Adding chlorine to water produces mainly hypochlorous acid and hypochlorite, both referred to

collectively as free available chlorine. Hypochlorous acid is the most effective agent for controlling biological growths. Its concentration depends on the pH of the water. Maintaining a pH of 7 or less means that at least 75 percent of the chlorine in the water is hypochlorous acid, while at a pH of 8 only about 25 percent of the chlorine is hypochlorous acid. At a pH of less than 3, chlorine gas predominates.

While using chlorine gas is generally considered the least expensive method of injecting chlorine, it is the most hazardous and requires extensive safety precautions. Trained personnel are needed for installing and using chlorine gas injection systems.

Sodium Hypochlorite

Sodium hypochlorite (liquid bleach) is usually available with up to 15 percent available chlorine. Household bleach is sodium hypochlorite with 5.25 percent

available chlorine. Most liquid fertilizer injection equipment is capable of injecting liquid chlorine. If the injection point is downstream of the filters, it may be necessary to manually treat the filters with chlorine.

Adding sodium hypochlorite to water produces hydroxyl ions, which raises the pH of the water and in doing so may decrease the effectiveness of chlorination. Acid injection may be necessary to reduce the pH and increase the chlorine's effectiveness.

Calcium Hypochlorite

Calcium hypochlorite normally contains 65 to 70 percent available chlorine. Note that 12.8 pounds of calcium hypochlorite dissolved in 100 gallons of water forms a 1 percent chlorine solution. A 2 percent chlorine solution therefore requires adding 25.6 pounds of calcium hypochlorite to 100 gallons of water. Any chlorine stock solution can be mixed following the same pattern. Use caution when dissolving calcium hypochlorite in water because of the possible formation of chlorine gas.

Desired Chlorine Concentrations

Continuous injection of chlorine should be used if the irrigation water has high levels of algae and bacteria, and biological clogging is a serious problem. The recommended level of free chlorine is 1 to 2 ppm at the end of the irrigation system. It is important to check the concentration at the end of the lateral line since chlorine is consumed when it reacts with organic constituents and any iron and manganese in the water. The chlorine concentration can be determined with a good quality swimming pool or spa chlorine test.

Super-chlorination (injecting chlorine at high concentrations) is recommended for reclaiming drip irrigation systems clogged by algae and bacterial slimes. Super-chlorination requires special care to avoid damage to plants and irrigation equipment.

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A Season of Change and Expectation for American Pecans

By: Alex Ott | Executive Director of the American Pecan Council

All photos courtesy of the American Pecan Council.

Certainty—it is something that remains in short supply in the world of agriculture. From severe storms and droughts to trade wars, regulation, and even consumer buying trends, things can change quickly and dramatically. We are undoubtedly in a season of change and uncertainty as an industry, and the impacts are far-reaching but also deeply personal.

I too find myself in a season of change. Over the summer, I transitioned from my role as executive director of the California Apple Commission, the California Olive Committee and the California Blueberry Commission. I moved from the West Coast to the heart of Texas to become executive director of the American Pecan Council (APC). While it is a real change for this California native, it's one that I made with great certainty. I am convinced that in spite of the big job ahead and the challenges inherent to modern agriculture, the future is bright for the American pecan industry.



Lexi Davidson of Lexi's Clean Kitchen shares her Pecan Popcorn Chicken with New Yorkers during the American Pecans brand launch.



The APC partners with food and nutrition influencers to create original recipes to showcase the versatility of pecans.

The Power and Potential of an Industry United

While pecans have been grown and enjoyed here since before our nation's founding, those who grow, process and sell this native nut have only recently united as an industry across the 15 pecan-growing states. My experience in leading category organizations has convinced me that together we are stronger, and that Federal Marketing Orders (FMOs) can have a powerful impact on an industry.

U.S. pecan production of about 300 million pounds per year has remained relatively steady for decades, while other nut industries with FMOs have seen significant growth. Look no further than California to see the positive impact of federal marketing programs on the tree nut industry. The successes of the FMO model for other categories—as well as the great taste, nutrition and versatility of the American Pecan—give us every reason to be optimistic about what the

new marketing order can do for the pecan industry.

The American Pecan Council is less than two years into its industry-leading role, but the progress to date is exciting and has us eager to build on current momentum. With APC staff and a council that represents each growing region across the Pecan Belt, we are working closely to push forward a variety of initiatives in support of industry. In addition to integrated marketing efforts to drive consumer awareness and demand, this includes industry data collection, education, and oversight of grades, standards and packaging.

Leveraging Research for Better Business and Marketing

Another increasing area of focus is research, from nutrition to market studies and beyond. The APC has been talking with industry, researchers and consumer marketing experts as we work

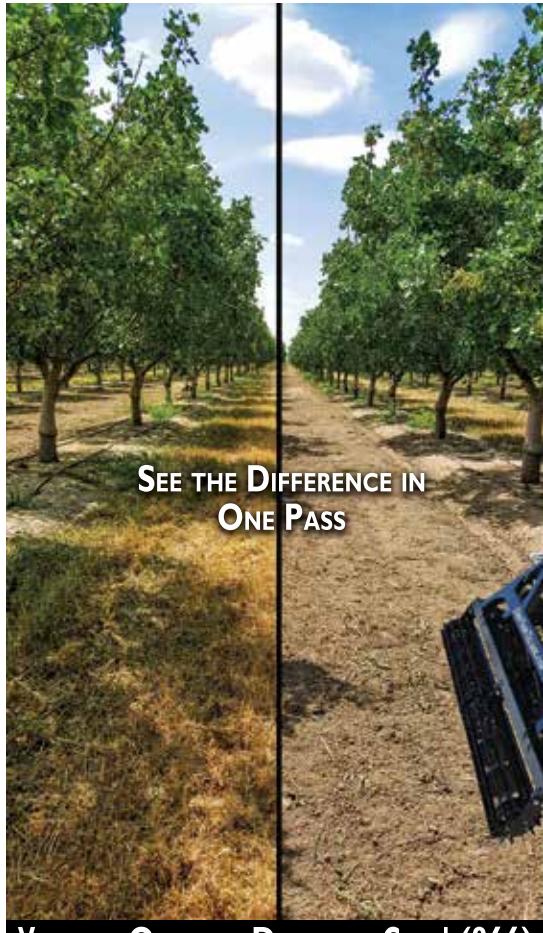
to establish our research priorities for this next season. All results of APC-commissioned research will be shared with industry to help make informed decisions about crops, business and marketing efforts.

A Nutrition Powerhouse

Specific to nutrition research, we see significant opportunity to dive deeper into the many nutrition benefits of pecans. To date, consumer response to nutrition facts about pecans has been powerful. National media, registered dietitians, consumer focus groups and recipe developers have been happily surprised to learn that pecans can help maintain a healthy heart and are a good source of fiber. Pecans contain 3 grams of protein, 10 mg of flavonoids, 18 grams of monounsaturated fats (only 2 grams of saturated fat), and a trio of minerals, per serving.

The many nutrition benefits of pecans

Continued on Page 48



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Continued from Page 47

can be found on our nutrition guide at AmericanPecan.com. This has been one of our most popular pieces of content on our website and for requests of printed copies, proving that pecans have a powerful story to tell when it comes to nutrition.



From a consumer marketing perspective, American Pecans is tapping into this desire to maintain a healthy lifestyle without sacrificing taste. If you follow our social channels on Facebook, Instagram, Pinterest or Twitter @

AmericanPecan, you have likely noticed that we are encouraging American shoppers to think about pecans in a different way by showcasing nutritious pecan recipes. We have also partnered with influential, nutrition-conscious food bloggers such as Erin Alderson of Naturally Ella and Lexi Davidson of Lexi's Clean Kitchen. Both gave recipe demos and samples at the American Pecans brand launch event

in New York City, and the samples of Davidson's Pecan Popcorn Chicken and Alderson's Pecan Roasted Beet Dip with Sage were a hit with consumers who stopped by the event.

New Recipes and Partnerships

Consumers can expect to see a wide range of new recipes and food influencer partnerships from the APC in the months ahead as we continue to engage food bloggers and nutrition experts to tell the American Pecans story. We recently added several new health-minded influencers to our partnerships roster, including Gina Matsoukas of Running to the Kitchen, an online recipe source with a strong following among runners and fitness enthusiasts, and Alex Snodgrass of The Defined Dish, who puts a wholesome spin on Texas favorites, like tacos, margaritas and barbecue.

In addition to our social channels, you can find all of our influencer-created recipes online when you visit AmericanPecan.com/recipes. Be sure to check back in the weeks ahead to see new seasonal pecan-inspired dishes in time for the holidays.

An advertisement for Green Tree Nursery. At the top, there is a collage of various fruits and nuts. Below the collage, a young boy in a plaid shirt gives a thumbs up while standing in a field. To his right is a sign for Green Tree Nursery. The main text on the right reads: "Reed Says: Even a young farmer knows... Green Tree Nursery is the place to buy your nursery stock! Call my Grandma for more information." At the bottom, contact information is provided: "Call Karlene Hanf: 209.401.0346", "karlenehanf@greentreenursery.com", and "GreentreeNursery.com".

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Building Momentum

The feedback from industry on recent partnerships, promotional efforts and the launch of the American Pecans, The Original Supernut™ brand has been encouraging. Having joined the organization soon after launch, I was amazed at how quickly the new brand is taking hold. From caps worn in the field to decals on trucks to new retail packaging, I am excited to see the American Pecans logo displayed frequently and proudly by members of our industry.

The team is working hard to ensure that consumers are also seeing and hearing about American Pecans frequently. Building on the momentum of the brand launch in April, we're promoting pecan stories and recipes in newspapers, magazines and websites across the country while developing engaging, visual content for promotion on social media. We are meeting our consumers where they are and showing all that pecans have to offer in the way of taste, nutrition and versatility.

A Source for Industry Updates

While we are making news and connecting with consumers, the APC also serves as a source of news for industry. We are working to share updates and information to support producers, handlers, and retailers as they assess plans and future markets for their product. We will continue to share relevant news as it relates to tariffs, new rules or other factors affecting export markets. We want and need this information sharing to be a two-way street, and we will continue to talk with members of industry to ensure the APC is providing the most relevant and helpful information to industry. To receive these updates, we encourage industry to register for our newsletter at AmericanPecan.com.

Growing for the Future

Although the American pecan industry is centuries old, we are in the early days as a united industry and on a journey toward an exciting future. Much like

a new pecan tree that will eventually live for generations, our young organization is an investment that needs nurturing and care for it to grow long after we have planted our roots. Our goal at the APC is to continually add value for industry for this generation and many to come. Like anyone in the business of agriculture, I expect much hard work in the days ahead, but I am highly optimistic about what we can—and will—achieve as a united industry.

If you are part of the pecan industry, the APC would love to hear from you—drop us a line at industry@americanpecan.com.

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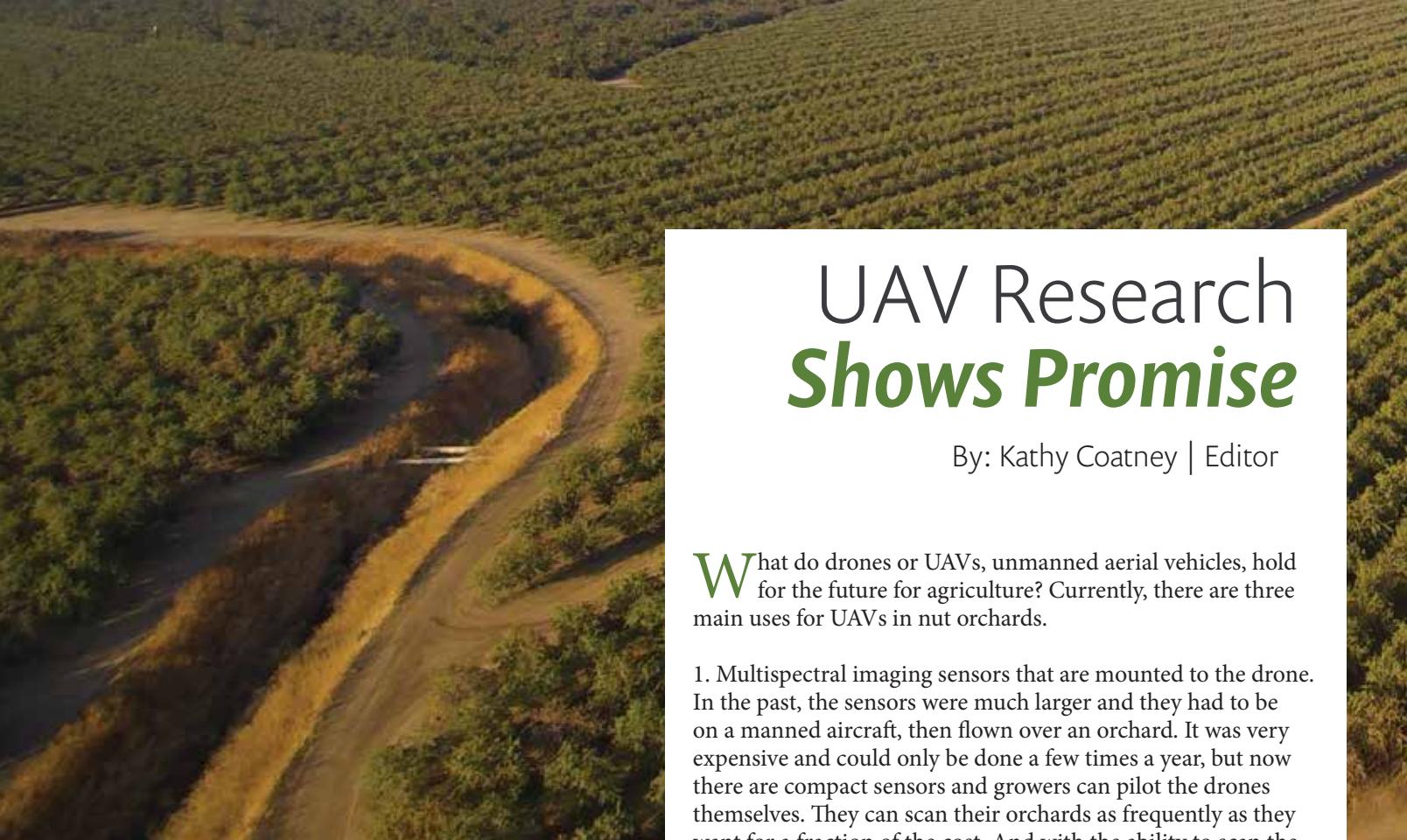
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UAV Research Shows Promise

By: Kathy Coatney | Editor

What do drones or UAVs, unmanned aerial vehicles, hold for the future for agriculture? Currently, there are three main uses for UAVs in nut orchards.

1. Multispectral imaging sensors that are mounted to the drone. In the past, the sensors were much larger and they had to be on a manned aircraft, then flown over an orchard. It was very expensive and could only be done a few times a year, but now there are compact sensors and growers can pilot the drones themselves. They can scan their orchards as frequently as they want for a fraction of the cost. And with the ability to scan the crop more frequently, they can evaluate crop health, and make better, more informed decisions.

2. Drones can create detailed GPS maps of an orchard using on-board cameras. From these images, orthomosaic maps can be created. Orthomosaic maps are smaller pictures that are stitched together to create one large picture. This gives growers a new perspective of their orchard and allows them to better maximize land, water, and fertilizer usage.

3. Heavy lift drones can carry large quantities of liquid giving them the ability to spray orchards with pesticides. UAV crop dusters are a fraction of the cost of manned aircraft and can be deployed autonomously.

UAV Research

David Doll, University of California Cooperative Extension (UCCE) farm advisor for Merced County has been doing research on UAVs.

"We were working with essentially droned aerial systems or autonomous aerial systems, and we were trying to determine the ability to use these to monitor water stress within trees, particularly nut trees, and more specifically almond trees," Doll said.

The project had five main objectives, but it really boiled down to determining different imaging techniques or strategies to identify water stress within the trees using low-cost imaging systems, Doll said.



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This really means we're excluding the use of a thermal imaging cameras because of the price, Doll said, which runs anywhere from \$10,000-20,000 dollars.

From there, researchers worked on data processing as well as developing a strategy to collect data from orchards that may not have reliable cell service, Doll said.

These different segments of the project were divvied up among multiple researchers that included collaborators from California State University (CSU) Fresno and the University of California (UC) Merced as well as within the Agricultural and Natural Resources (ANR), Doll said.

CSU Fresno

Gregory Kriehn at CSU Fresno, developed sensors that could be programmed to wake up the drone as it comes into proximity on the sensor, Doll said.

"It would be a real low power use data sensor that can collect a wide variety of whatever you're looking to collect," Doll said.

That could be soil moisture or air, but Kriehn developed this relay system where the drone flies into a perimeter, it pings, wakes up the data logger and begins to transmit the data to the drone, Doll explained.

"There are a variety of sensors that may be deployed in the field," Doll said, adding they collect the data, then the drone would serve as the data collection.

Continued on Page 52

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Continued from Page 51

If there is an area that has a poor cell phone signal so that the networks can't be relied on, that would provide the data uploading needed, Doll said.

Low Cost Imaging

Another aspect of the project was low cost imaging. "In that case, what we were looking to do again was try to find a way to develop or modify our vegetation index that we could use to determine water stress," Doll said.

"Most people are familiar with NDVI, which is a vegetation index that gives you an idea of canopy or just essentially how much vegetation is covering a piece of ground," Doll said.

But what Doll and his colleagues, as well as others have found is, NDVI does not correlate well with plant stress when dealing with perennial crops or three dimensional trees, and in particular, it doesn't correlate well with almonds.

"That's simply due to by the time almonds show a change in canopy due to stress, you're past the point where you want those trees to be. You want to catch that stress period earlier before it hits that point," Doll explained.

Researchers found that by modifying NDVI to certain formats,

to certain locations of the tree, they were able to get a better estimation of plant water stress, Doll said.

These were the two big objectives of the research, Doll said.

Research Status

"We're testing the imaging platform that has been developed," Doll said, adding the imaging and the data logger apparatus is actually in patent, and Dr. Kriehn is working on wrapping that up.

They are also evaluating other tree crops like walnuts as well as the vegetable crops this year, Doll said.

Currently, UAVs are still very expensive, and that is why Doll and his colleagues are searching for a lower cost imager that would help reduce the investment cost to growers.

Interest in UAVs

"I definitely think there's interest in the (UAV) technology. I don't know how many growers are into it more than a hobbying component, but our field day almost doubled in size from last year, so I do think there's people interested in the technology," Doll said, adding UAVs are still a little bit on the leading edge, and that's why we're trying to get it applicable to trees crops.

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"I think it does a good job of doing aerial imagery...But the flip end is, the data processing can be a bit cumbersome," Doll said.

"You also don't have the full toolbox that you'll see if you're pulling satellite images," Doll said.

Other potential uses for drones that are being marketed are aerial releases of natural enemies for pest control, crop pollination, and chemical applications.

There are drones that are large enough to do chemical applications, but they aren't to the level of crop dusters by any means, Doll said.

"But in issues with tight terrain or steep terrain, and high value crops, there are certain (UAV) systems that are able to make aerial applications," Doll said.

Learning Curve

What it comes down to is a drone may be applicable for certain growers, and for others, it's not, Doll said.

"It is expensive to utilize these tools. I mean it may not be expensive to buy them (drones), but to take and process images takes time, and time has value," Doll said.

Getting a drone up and running is much easier. Where it gets challenging is learning to how to properly and effectively stitch images together—the data processing, Doll said.

"The challenges really start coming along when you're trying to manage the data. You have to be familiar with different types of programs, with overlap, and stitching, and you've got to have the computer hardware to do all that," Doll said, and they're big files—huge, huge files.

"I think the image processing is still the bottleneck," Doll said.

"There's a learning curve on both ends, but steeper on the processing of the data," Doll said.

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It may come as a surprise, but the State of California has laws and regulations covering all radiation sources, including x-ray machines used in food processing operations. Then again, maybe it doesn't surprise you. This is California and what isn't regulated? Officially, Title 17, Division 1, Chapter 5 of the California Code of Regulations, sets forth the requirements for what facilities such as food processors have to do with their machines, and their programs. Over the past couple of years, nut processors in California have been cited for not having registered, or not having a written safety program covering the use of, x-ray machines in their facilities.

Each facility that has an x-ray



All photos
courtesy of WAPA.

machine, must register with the California Department of Public Health (CDPH), and must have a "Radiation Safety and Protection Program". This program must be sufficient enough to ensure compliance with the regulations.

Furthermore, the facility must implement procedures and engineering controls to minimize the radiation dose. In x-ray terms, this means reducing the dose "as low as reasonably achievable" (ALARA). Employees must be trained, warning signs and regulations must be posted, and the whole program must be audited each year.

The registration with CDPH for the x-ray machine is different from the "Food Facility Registration", that most processors are familiar with. The registration must be with the Radiologic Health Branch (RHB) with CDPH, and must be conducted using the form RH 2261N. It should be noted that vendors are required to notify you of this requirement when you purchase the x-ray machine, and they themselves are required to notify the RHB that they have sold an x-ray machine to you, thereby making CDPH aware of the fact that you now have an x-ray machine.

Radiation Safety and Protection Program

Each facility with an x-ray machine must create and maintain a Radiation Safety and Protection Program. A program for an x-ray machine in a nut processing facility should include the following:

- Organization and Administration
- ALARA program
- Area Monitoring and Control (including calibration and maintenance)
- Radiological Controls (including entry and exit controls and posting)
- Emergency Exposure Situations and Radiation Accident Dosimetry

Continued on Page 56

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Continued from Page 55

- Recordkeeping and Reporting
- Reports to Individuals
- Radiation Safety Training
- Internal Audit Procedures

This program must be written and readily accessible. X-ray machines pose a potential safety hazard to employees, visitors and contractors if the device is not used, maintained and/or stored properly. To minimize or prevent this risk, precautions must be taken. These include having adequate and clear entry and exit areas to ensure radiation safety. These areas must be posted and all radiation areas must be listed in the Radiation and Safety Program. In addition, the equipment must be labeled with "CAUTION X-RAY". Also required to be posted are the regulations (17 California Code of Regulations, incorporated sections of 10 Code of Federal Regulations (CFR) 20, and a

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION
CALIFORNIA RADIATION CONTROL REGULATIONS (CALIFORNIA CODE OF REGULATIONS, TITLE 17, SECTION 3025)

The California Radiation Control Regulations include standards for protection against radiation hazards. The California Department of Public Health has primary responsibility for administering these standards which apply to both employers and employees. Enforcement is carried out by the California Department of Public Health or its authorized inspection agencies.

EMPLOYEES' RESPONSIBILITIES

You should know and understand those California radiation protection standards and your employer's operating and emergency procedures which apply to your work. You should comply with these requirements for your own safety and the safety of others. Report promptly to your employer any condition which may lead to or cause a violation of these standards or employer's operating and emergency procedures.

SCOPE OF THE STANDARDS

The Standards for Protection Against Radiation define:

1. Limits on exposure to radiation and radioactive materials;
2. Actions to be taken after accidental exposure;
3. Working conditions requiring personnel monitoring, safety surveys, engineered controls, and safety equipment;
4. Proper use of caution signs, labels, and safety interlock devices;
5. Requirements for keeping worker exposure records and reporting of such exposures;
6. The requirement for specific operating and emergency procedures for radiation work; and
7. The rights of workers regarding safety inspections.

EMPLOYERS' RESPONSIBILITIES

Your employer is required to:

1. Comply with the requirements of the California Radiation Control Regulations, departmental orders, and license conditions;
2. Post or make available to you copies of the Radiation Control Regulations, any license issued thereunder, and your operating and emergency procedures;
3. Post any notice of violation of radiological working conditions; and
4. Provide you with information on your exposure to radiation.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. California Radiation Control Regulations require your employer to give you a written report if you receive an exposure greater than the limits set in the radiation safety standards. Basic limits for occupational radiation exposure can be found in section 30253 referencing title 10, Code of Federal Regulations, part 20 (10 CFR 20). Limits on exposure to radiation and exposure to concentrations of radioactive material in air are specified in 10 CFR 20, subpart C.
2. If the radiation protection standard, under 10 CFR 20 (subpart F) requires that your radiation exposure be monitored, your employer must, upon your request, give you a written report of your exposures upon termination of your employment, and make available to you the information in your dose records (as maintained under the provisions of 10 CFR 20.2106).
3. Your employer is required to provide you with an annual report of the dose you received in that monitoring year if the dose exceeds 100 millirem, or if you request an annual report.

INSPECTIONS

The Department or one of its contractors will inspect your workplace from time to time to ensure that health and safety requirements are being followed and that these requirements are effective in protecting you. Inspectors may confer privately with you at the time of inspection. At that time you may direct the inspector's attention to any condition you believe is or was a violation of the safety requirements.

In addition, if you believe at any time that any health and safety requirements are being violated, you or your workers' representative may request that an inspection be made by sending a complaint to the Department of Public Health or other official agency. Your complaint must describe the specific circumstances of the apparent violation and must be signed by you or your workers' representative. The Department is required to give your employer a copy of any such complaint. Names may be withheld at your request. You should understand, however, that the law protects you from being discharged or discriminated against in any way for filing a complaint or otherwise exercising your rights under the California Radiation Control Regulations.

Figure 1. California Department of Health Notice to Employees.

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copy of the operation and emergency procedures applicable to the specific x-ray machine. If you do not have those, please contact the manufacturer immediately. You must also post DPH Form RH-2364 (Notice to Employees) in a sufficient number of places for employees working in and around the area frequently to see the Notice (**Figure 1, left**).

Training

All employees who work with or around the x-ray machines must be trained on the operating procedures and the safety procedures of that particular x-ray machine. That includes the “Radiation Safety and Protection Program” as well as the specific safety procedures from the manufacturer of the x-ray machine. Not only must they understand how to operate and maintain the machine properly, they must clearly understand how to report promptly any condition which may lead to or cause a violation of the regulations or cause unnecessary exposure. Finally, each employee must be instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction.

Internal Audit

Annually, each facility must “audit” their “Radiation Safety and Protection Program.” These audits should include:

- Identification of inspection types and program audits
- Identification of individual(s) who are responsible for the inspections or audits
- Identification of where and at what intervals these inspections should take place by
- Procedures for conducting the

- inspections and/or audits
- Instructions on identification of proper use of instrumentation used for machine maintenance, such as performing leakage radiation test

Many of the nut processors have these conducted by the manufacturer or dealer. Whether it is done in-house or by the x-ray equipment company it must be documented and recorded. In fact, everything you do with the x-ray machine must be documented and recorded, including training, inspections and maintenance.

While x-ray machines may not be at the top of the compliance checklist for nut processing facilities, it is important to monitor and make it part of your regulatory compliance program.

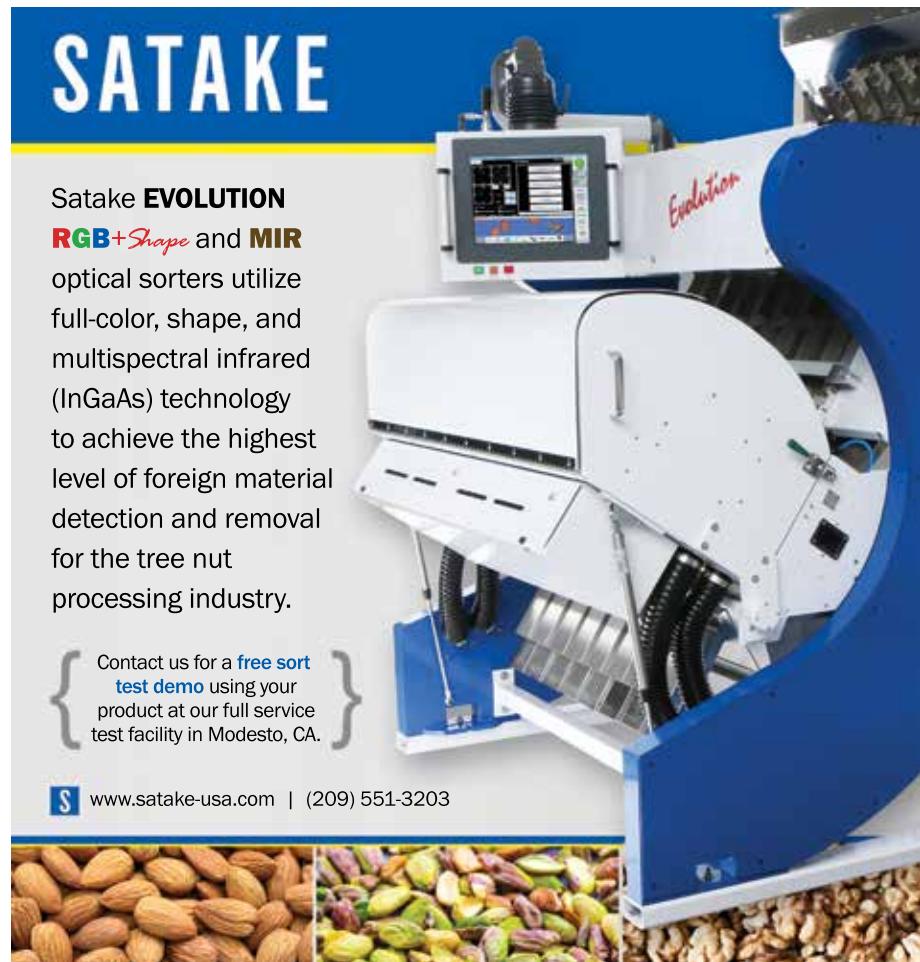
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During postharvest, trees' water need is significant and severe water stress can drastically reduce next year's bloom, fruit set and yield.

All photos courtesy of the Almond Board of California.

Optimizing Irrigation & Nutrient Management DURING POSTHARVEST

By: Spencer Cooper | Senior Manager, Irrigation and Water Efficiency
Sebastian Saa, PhD | Senior Manager, Agricultural Research

Harvest is a time of reaping last year's results and laying the foundation for the upcoming crop year. One opportunity you should take advantage of in preparing for next year's crop is supporting the formation of flower-bud differentiation in your orchard. From July to September, flower formation occurs inside the buds and next year's crop yield potential is set. The principle is simple: greater flower development in the current season may result in greater return the following season.

Among the various influences that impact flower development from July to September, irrigation and nutrient management are two of the most important factors to consider. Creating an irrigation and nutrient management checklist during these months can help you ensure that proper action is taken to prepare your trees for the following season.

Step 1: Ensure Optimum Irrigation

Think of late-season and postharvest irrigation as 'paying it forward' for next year's crop. During this critical time, trees' water need is significant and severe water stress can drastically reduce next year's bloom, fruit set and yield. Bud development is a gradual process, with beginning and endpoints that differ depending on individual buds. For example, in Nonpareil and Carmel varieties, the initiation of bud development spans from July through mid-August and bud differentiation is complete during pistil development, which occurs from August to mid-September.



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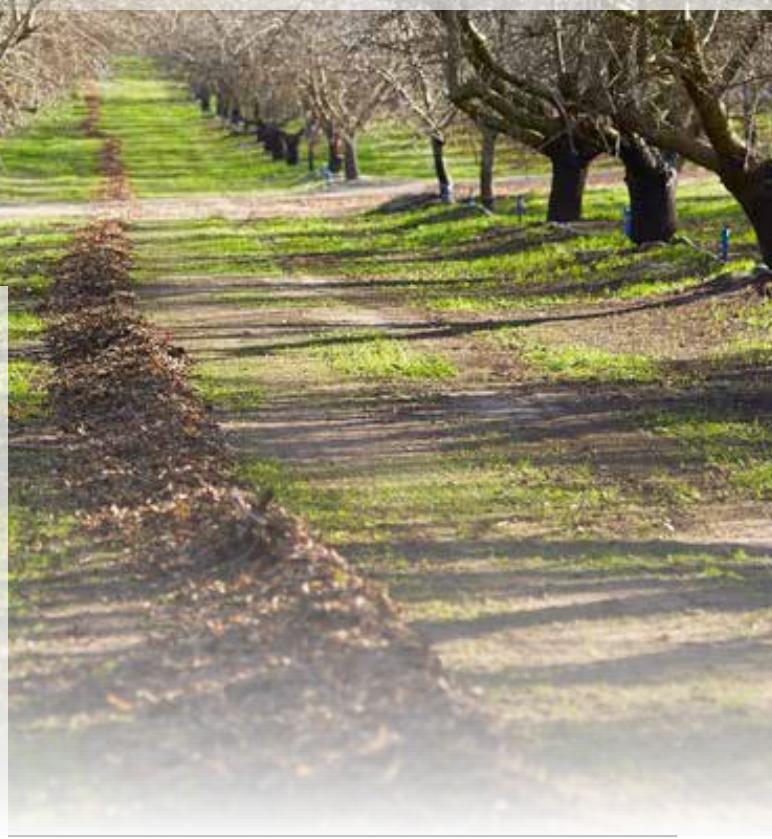
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If you want to have a better indication of your soil's N levels, you might consider conducting a soil sample.



An informative source to help growers better understand irrigation management—both postharvest and year-round—is the Almond Irrigation Improvement Continuum. The Continuum provides a wide-ranging look at a grower's site-specific irrigation system with the goal of improved efficiency and effectiveness. This resource, developed by the Almond Board of California (ABC) in partnership with respected technical experts, provides a step-by-step explanation of irrigation management and scheduling practices related to the following concepts:

- Measuring irrigation system performance and efficiency
- Estimating orchard water requirements based on evapotranspiration
- Determining applied water
- Evaluating soil moisture
- Evaluating plant water status

Spencer Cooper, senior manager, Irrigation and Water Efficiency, is available to help almond growers reach their goal of increased water efficiency. To schedule an irrigation consultation, email Spencer at scooper@almondboard.com or call (209) 343-3211.

Step 2: Take Extra Care in a Fall Nitrogen Application

Once you double check that your irrigation systems are functioning properly, it is time to evaluate whether any nitrogen (N) is needed in the fall. Postharvest nitrogen applications may be needed to supply your trees' N demand; however, N applications can also be inefficient and unhelpful, especially in any of the below situations:

1. Trees are already adequate in N levels per July/August leaf analysis: Leaf analysis is one of the best indicators to determine N status. If the July leaf N value is higher than 2.5 percent, a fall N application is likely not necessary.
2. There is sufficient soil N available to supply tree demand: If you want to have a better indication of your soil's N levels, you might consider conducting a soil sample. However, make sure to draw your sample from active roots and closely follow laboratory protocols.

Continued on Page 60

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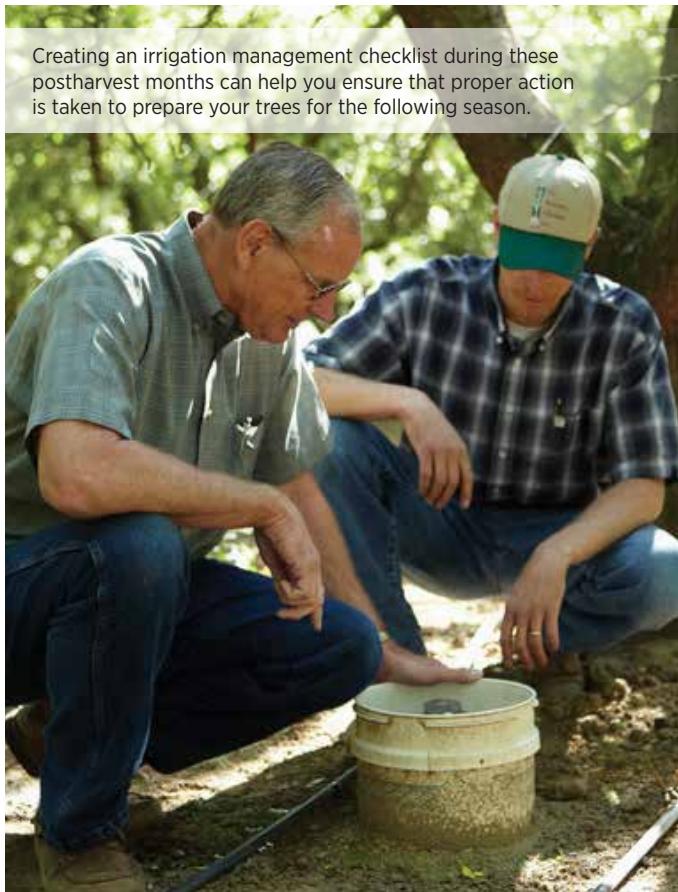
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Continued from Page 59

- Tree health is suboptimal when you plan to apply N: This may occur if, for instance, your trees are too stressed during harvest or will be too stressed postharvest due to dry down, water limitations, salinity, etc. Trees in suboptimal health will likely have very few leaves in the canopy and those leaves will look yellow.

If any of the above situations apply to your orchard, then any plans to apply N postharvest should be re-assessed, and you should consider reducing or avoiding application altogether. Applying N when your trees have poor health conditions, or when your trees and soils already have sufficient soil levels, will likely result in N loss through leaching or gaseous losses. N loss subsequently brings little-to-no benefit to flower development.

Step 3: Foliar Sprays: Boron and Zinc

Postharvest is also a good time to consider nutrient uptake through the trees' leaves via foliar applications. During this season, there are two key micronutrients to consider: boron and zinc.

Boron (B) plays a key role during flowering as it promotes the elongation of the pollinic tube, therefore promoting fruit set. Maintaining adequate B in your tree buds is especially beneficial during bloom. However, too much or too little B will have the opposite effect—reduced fruit set.

- Application Tip: Make sure B is only applied if needed—July hull samples are a good indicator of the tree's need. The adequate range for B is 60-160 ppm (parts per million), and B will likely not need to be applied if levels are at the upper end of this range.

Applying Zinc (Zn) in the fall has been the standard for many growers. Growers often apply large amounts of zinc sulfate spray in the fall to improve tree Zn status and promote leaf drop. However, while a fall Zn application may be beneficial to control rust inoculum by promoting leaf drop, research shows that this application does not increase the Zn concentration in trees. In fact, new findings suggest that Zn uptake in trees mostly occurs when Zn is applied in early spring.

- Application Tip: If choosing to apply Zn in the spring, take extra caution with the spray used and always follow label recommendations as leaf burn may occur.

For more information on nutrient recommendations and critical ranges, visit [Almonds.com/Nutrients](#) and UC Davis' Almond Nutrients & Fertilization page.

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The Dynamic State of Spurs in Almond

By: Elizabeth J. Fichtner, UCCE Farm Advisor, Tulare and Kings Counties, and Bruce Lampinen, CE Specialist, UC Davis

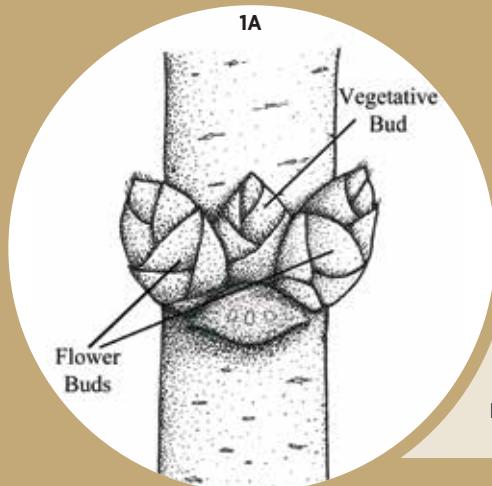


Figure 1. Buds form in leaf scars on vegetative shoots; a vegetative bud is generally positioned between two flower buds (**A**). On spurs, the terminal bud is always vegetative; the lateral buds may be either vegetative or floral buds (**B**). Illustrations courtesy of H. Hartzog.

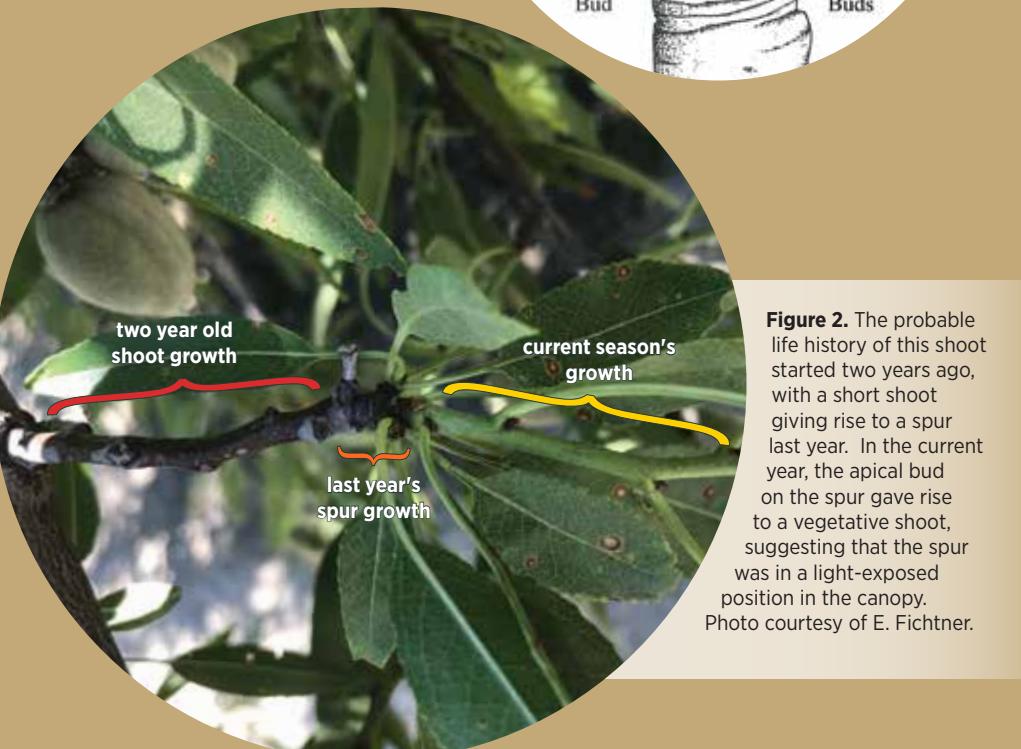
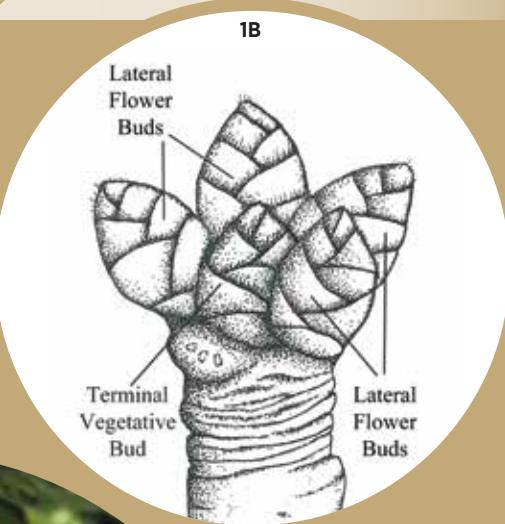


Figure 2. The probable life history of this shoot started two years ago, with a short shoot giving rise to a spur last year. In the current year, the apical bud on the spur gave rise to a vegetative shoot, suggesting that the spur was in a light-exposed position in the canopy. Photo courtesy of E. Fichtner.

Over 80 percent of the almond crop is borne on short, compact vegetative shoots called spurs. Each season, however, only a portion of the spur population on a given tree supports fruit production. Because of their role in supporting productivity and yield, maintenance of a healthy spur population contributes to the economic sustainability of an orchard. Understanding the dynamic states of spurs between seasons and the conditions promoting spur productivity and survival may enhance orchard management practices to maintain or increase yields in future years.

What are Spurs?

Spurs are short, compact vegetative shoots (approximately 0.5-2 inches long) that are borne on the prior season's wood. Spurs are either formed from lateral buds on vegetative shoots (**Figure 1A, top left**) or from vegetative buds on spurs (**Figure 1B, middle left**). When spurs give rise to further spur growth over sequential years, it may be difficult to visually evaluate the age of a spur due to the compact nature of growth (**Figure 2, bottom left**). The apical bud on a spur is always vegetative (**Figure 1B, middle left**); however, spurs can also support up to six flower buds in a season (**Figure 3B, page 63**). The duration of spur growth on almond is short and generally complete in April or early May.

Spurs Exhibit a Localized Carbon Economy

Spurs are considered semi-autonomous with respect to carbon supply, meaning that spurs serve as both the main source and sink of carbohydrates utilized in vegetative and reproductive growth. As a result, spurs remain vegetative (**Figure 3A, page 63**) for one to two years prior to flowering. Although not immediately productive, vegetative spurs with adequate leaf area produce and store carbohydrates for support of future flowering and nut development. In fact, the leaf area of spurs is a better predictor of potential for flower bud development than the number of leaves per spur. Spurs with less than 10 cm² leaf area are unlikely to support

viable buds (floral or vegetative); spurs with 10-12.3 cm² leaf area are likely to support only vegetative buds; and spurs with >12.3 cm² have a higher probability of supporting flower buds. Due to the carbohydrate demand of setting fruit, few spurs flower the year after bearing.

Spur Leaf Area Influences Flower Bud Development

Flower buds can be differentiated from vegetative buds by both shape and position. Flower buds are generally positioned on either side of a vegetative bud on shoots (*Figure 1A, page 62*), or in lateral positions on spurs (*Figure 1B, page 62*). Vegetative buds are triangular and pointy, whereas flower buds are thicker and more oval than vegetative counterparts. In early summer, buds manifest in leaf axils, but it is impossible to differentiate between floral and vegetative buds until late August or early September. Even in late summer,

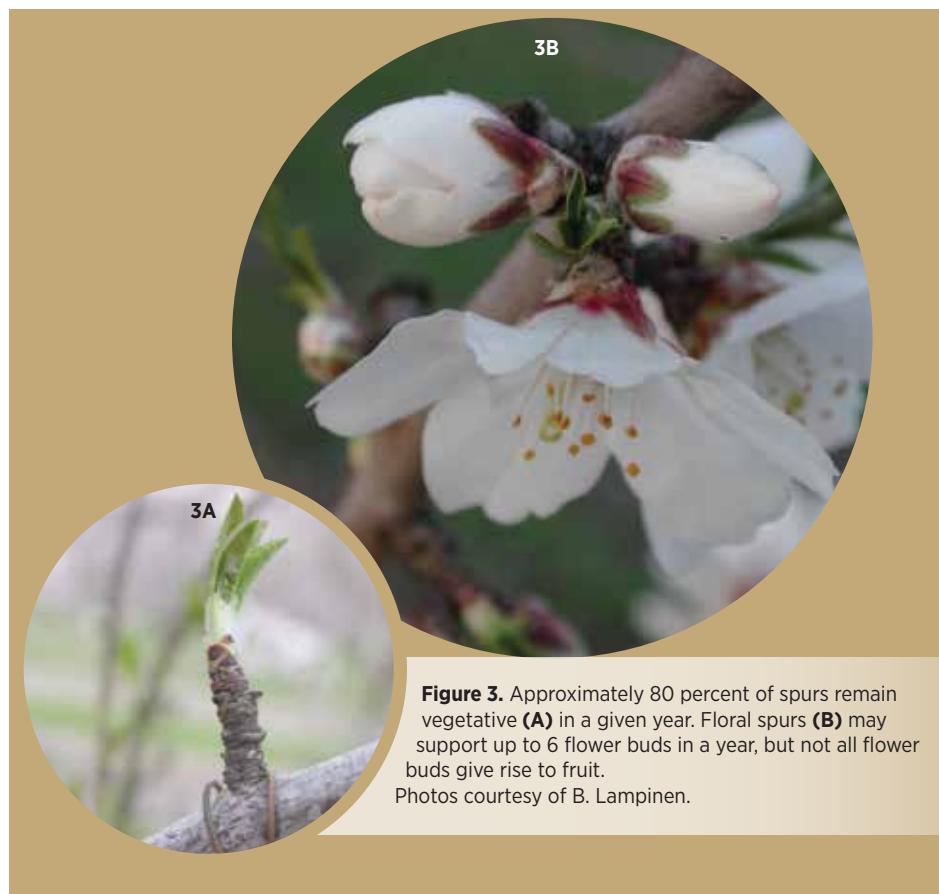


Figure 3. Approximately 80 percent of spurs remain vegetative (**A**) in a given year. Floral spurs (**B**) may support up to 6 flower buds in a year, but not all flower buds give rise to fruit.

Photos courtesy of B. Lampinen.

Continued on Page 64

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Continued from Page 63

identification of flower versus vegetative buds may require bud dissection and microscopy.

Flower bud development does not proceed at a uniform rate in a given block or tree, but varies dramatically between spurs. The rate of floral bud development is positively related to leaf area. Consequently, spurs supporting high leaf areas exhibit more rapid flower bud development than spurs with lower leaf areas.

Prior Year Spur Leaf Area Affects Flowering And Nut Set

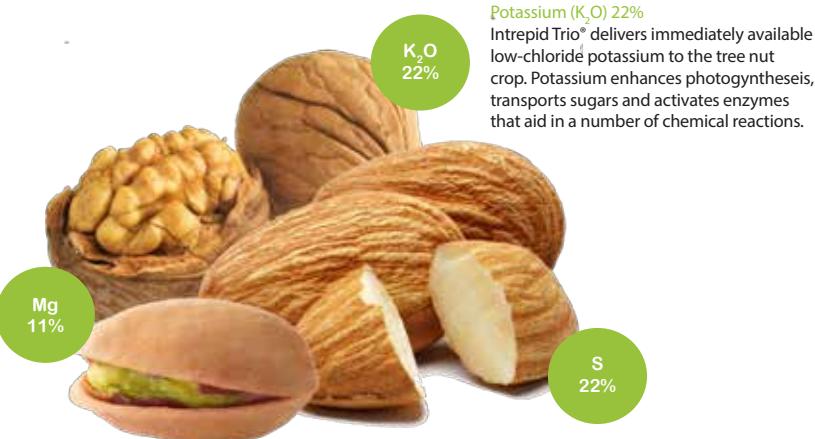
Spurs supporting high leaf area in a given year have enhanced potential to support flowering and nut set in the subsequent year. In fact, non-bearing spurs with >50 cm² leaf area have over an 80 percent probability of flowering the following year. Non-bearing spurs in lower light positions in the interior of the canopy may require more years in a vegetative state prior to supporting flower and fruit production.

Spur Survival

Spur survival is influenced by prior year leaf area and exposure to light. The literature suggests that spurs remain viable for three to five years; however, the survival potential of individual spurs is related to light exposure, bearing status, and prior season leaf area. We have found that spurs in well managed orchards in outer canopy positions can remain productive for more than 10 years. Regardless of bearing status, spurs with higher leaf areas are more likely to survive into the following season. Bearing spurs are more likely to survive into the following season when occupying light-exposed positions in the canopy. Conversely, the mortality of non-bearing spurs is generally not influenced by light interception in the canopy. These relationships are all explained by the reliance of spurs on a localized carbon economy.

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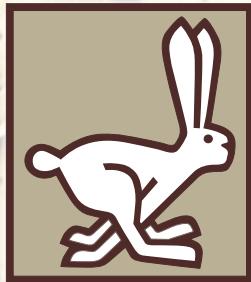


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Orchard Management For Enhanced Spur Survival And Productivity

Following best orchard practices, particularly in irrigation scheduling and nutrient management, will allow for canopy development and maintenance of tree health. However, consider that practices supporting excessive growth may cause shading, which may be limiting to spur survival. Promotion of modest annual growth will allow for production of new spurs, but be patient because new spurs may take two years to support flowers. Last, when managing the tree canopy, overlapping branches and dead wood should be removed to prevent shading and promote spur survival and productivity.

Select References:

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Post Harvest Nutrition: ***More Important Than We Used to Think?***

By: Rich Kreps CCA



Gypsum applied to almond trees.
Photos courtesy of Rick Kreps.

The crop is coming off. Long days and nights are comprised of shaking, raking, conditioning, sweeping, dumping bins, dehydrating, deliveries, moving irrigation lines, and the list goes on.... You're tired, and often overworked, so are your trees. They've just run a grueling endurance race and this year, most of it felt like it was through Death Valley. Our crops need some serious nutrition for refueling. The majority of our recommendations for post-harvest nutrition revolve around a percentage plan



of your total nitrogen budget for the year. But are we missing the big picture and neglecting the other 15 essential nutrients?

Nutrition is Key to Optimal Performance

Let's use an analogy with human beings, and athletes in particular. Endurance sports are sponsored by Gatorade, Power Bar, Cliff Bar, Powerade, Enduralyte, Hammer Gel, GU Energy Labs, hundreds more nutrition companies, and if they are really lucky, the finish line sponsor is a local brewery. The point is nutrition plays the key part of optimal performance. They burn energy and they need to replace it, quickly! Not properly rehydrating and eating balanced nutrition, their bodies won't recover. If enough energy wasn't replaced with carbohydrates, then fats and proteins are synthesized into fuel. This process means the muscles they are trying to feed are actually consumed by the body. But you never see an athlete at the victory podium face deep in a bowl full of sugar for optimal recovery. Protein and fats have to be balanced with vitamins, minerals, electrolytes (calcium, potassium, magnesium and sodium by the way...) and carbohydrates to properly get their bodies back to normal.

Let's look at a typical post-harvest nutrition plan:

25 percent of total annual N demand Zinc, boron and particularly in pistachios, some copper. Throw in a couple tons of gypsum, maybe some compost, 400 pounds of SOP (sulfate of potash) and call it good.

Plant Ready Nutrients

We've talked in previous articles

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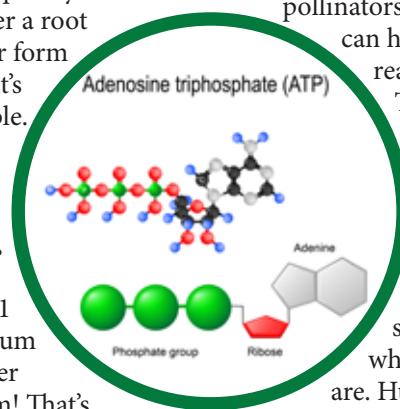
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about the importance of plant ready nutrients. What those nutrients are derived from often dictates the plants ability to absorb them quickly. Calcium and Nitrate love to enter a root system together. If your form of calcium is gypsum, it's only 0.26 percent soluble. While it's a popular soil amendment to condition ground and help water penetration, at 0.26 percent soluble, that math equates to 1.1 pounds of soluble calcium (23 percent calcium) per 2000 pounds of gypsum! That's not enough plant ready material to help your trees recover quick enough. We need soluble calcium. Sulfate of potash only boasts a solubility factor a little better at 7 percent. Four hundred pounds of SOP (50 percent K) will release 14 pounds of soluble potassium (K). Again, we need more for a quicker recovery. I'm not saying to not use these derivatives as they have proven

beneficial for years. However, our trees need to absorb nutrition quickly to optimize next year's crop. Immediately after harvest and even in between shakes from Nonpareil almonds to the pollinators, those irrigation events can have soluble and plant ready nutrition in them. Typically, we use smaller shots of water as well to not flood our fields before we are shaking our other varietals. That's a perfect time to inject nutrition that will stay high in the profile where our feeder roots are. Hungry roots will result in better total absorption of those nutrients.

As our trees recover, one of their main functions is to ramp up photosynthesis, store carbohydrates for winter and next spring's big push. The central element of chlorophyll is magnesium. Chlorophyll drives photosynthesis. Nut crops are very high in magnesium



levels which makes them great sources for human nutrition. That means a big percentage of magnesium is removed in our crops each year. We have to replace it. As photosynthesis ramps up so does the demand for the catalysts and enzymes that make it happen. Iron, manganese, cobalt and molybdenum have to be addressed as well, especially if you had an in-season deficiency on your tissue tests. It is very easy to address minor nutrients with a post-harvest, foliar applied, micro nutrient blend to keep these elements at optimal levels. Dusting off those leaves with a foliar spray and essentially cleaning those natural solar panels may go a long way to optimizing nutrient absorption.

Post-harvest Phosphorus

Many times, we tend to neglect post-harvest Phosphorus (P) nutrition. Phosphorus moves into a plant through root interception. Throughout the growing season much of our P nutrition may have been depleted. We need to bring those levels of P back up in our soils for our plants to facilitate storage of carbohydrates. Phosphorus, together with proper Magnesium levels in a plant helps drive the Krebs cycle through photosynthesis in producing adenosine triphosphate (ATP). Energy the plants need to recover.... However, trying to fertigate a good slug of post-harvest P over a big application of gypsum and you just tied up both of those nutrients you are trying to get into your trees.

As usual, it's been a long season. There is nothing easy about farming. Until your plants have been given what they need to recover we aren't done. Work with your plant nutritionist to create a plan to get as much nutrition into your trees as quickly as possible. Make sure simple blanket approaches don't end up tying up the nutrients your trees so desperately need. We work too hard to not get every last dollar out of the effort we put in. Don't put your trees to bed hungry. Proper post-harvest nutrition will ensure that your return on investment is optimized.

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