WEST COAST NUT

OCTOBER 2020 ISSUE

SPECIAL SECTION:
AGRICULTURE TECHNOLOGY
STARTING ON PAGE 28

IN THIS ISSUE:

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WEST COAST NUT

By the Industry, For the Industry

IN THIS ISSUE

SPECIAL SECTION: Ag Tech

This special section in West Coast Nut looks at how technological advances can improve production practices, from nutrition to irrigation and precision agriculture.

Starting on page 28

Almond Postharvest To-Do List

What to Look for as 2020 Harvest Comes to an End

By **KATHY COATNEY** | *Contributing Writer*

Potassium application in an almond orchard (all photos courtesy F. Niederholzer.)

AS HARVEST WINDS DOWN, IT'S TIME to focus on the postharvest to-do list. This includes everything from irrigation to nutrient applications to taking nut samples.

Get Water to Harvested Trees

UCCE Farm Advisor Franz Niederholzer, in Sutter, Yuba and Colusa counties, stressed, first and foremost, irrigation.

"Simply get your water back on as quickly as you can without damaging any nuts that are on the ground," Niederholzer said, adding adequate, not excessive, moisture is needed.

Almond growers are aggressively working their orchards as soon as the nuts hit the ground in the Sacramento Valley at harvest time, and those with double line drip are moving nuts away from the hose—not piling or windrowing—but rather blowing them away from the driplines, Niederholzer said.

Doing this allows them to start applying modest amounts of water to give the trees a drink as soon as possible while letting the nuts continue drying. This way they avoid a long harvest dry down period which is a huge benefit to the trees.

"That really makes a big difference to the health of the orchard," Niederholzer said.

With a healthy canopy, the trees can continue to make carbohydrates and store starch and sugars to use in the spring.

"All that stuff sets you up for next year," Niederholzer said.

"The last thing you want to do is walk away from your irrigation in the fall," he continued, but it's easy to overlook when the weather is getting cooler and the days are getting shorter.

Niederholzer suggests following ET. "That's going to drop as September rolls into October. So you don't want to irrigate them like it's July, but adequate moisture is critical to setting the trees up for next year," he said.

Fall Nutrition

Nutrition in the fall is another important postharvest consideration.

"A fall nutrition nutrient spray is a pretty solid idea, as long as tissue analysis suggest it," Niederholzer said.

"Foliar boron spray should be considered every year," he continued. "Make a decision to apply a fall boron spray based on tissue analysis results."

Boron is the one nutrient that doesn't really benefit from the leaf analysis. To determine boron levels, a hull analysis is recommended at harvest.

"Cruise across the orchard and grab hulls out of the windrow, send them into the lab and those results will help you assess the boron status of your orchard," Niederholzer said.

Zinc is another nutrient to look at in the fall. Zinc can be applied at many different times of the year, but it can be done in conjunction with a boron application in the fall. Growers using Solubor or similar sodium borate material may need to adjust the pH of the tank mix when spraying both boron and zinc. Check with your PCA/CCA about tank mixing zinc and boron.

With a record almond crop predicted this year, Niederholzer advises growers to look carefully at their summer leaf analysis numbers.

To date, there hasn't been any research showing benefits from a postharvest nitrogen fertilizer application (September/October timing) in well managed almond orchards in the Sacramento Valley, Niederholzer said. But in a record crop year with healthy trees that performed well and had plenty of nitrogen in-season, growers still might look hard at their summer leaf analysis and decide if a small application of nitrogen is warranted.

"My experience is that a fall nitrogen application to the soil is probably not going to make any difference to next year's crop," Niederholzer said.

Research results didn't show any improvement in crop the next year by adding nitrogen in the fall, Niederholzer said, however, if the summer leaf analysis shows the trees are deficient, definitely make an application. Only a small nitrogen rate is needed if the trees are deficient, perhaps 30 pounds N/acre.

"If you have low levels of summer leaf N, then an orchard could be short on overwintering reserves, and adding a little bit of N is a good idea," Niederholzer said.

Niederholzer reminded growers there are many other things that impact crop load next spring other than nitrogen application in the fall.

"In most orchards, the money you spend on that boron spray is going to make more difference to your crop load than a nitrogen application you make, as long as you've got adequate nitrogen

Continued on Page 6

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LEARN MORE ON PAGE 51

Winter sanitation in almond orchard.

Continued from Page 4

in the orchard."

Adding potassium is also a consideration, but potassium is expensive, so growers with solid summer leaf K numbers should consult with their PCA/CCA about a K program for 2021 that keeps adequate K in the trees, but doesn't break the bank.

"This is a year where you want to pick out the critical things, and make sure you get those right. From my standpoint those are the biggies," Niederholzer said in terms of nutrient applications.

Nut Samples at Harvest

Taking nut samples at harvest is a good idea, Niederholzer said. Take samples—not from the nut cart—but from the orchard floor before the sweeper builds the windrows ahead of pick up.

Kernels damaged by ants or navel orangeworm are often lost in the harvest and hulling/cracking processes, Niederholzer said. There are companies that will do harvest nut samples for a modest fee, he added.

Obtaining harvest samples and taking the time to crack out and identify the sources of damage is well worth the investment. It's important to know if the damage came from ants, navel orangeworm, peach twig borer, etc.

When reviewing reject sheets, assume there is at least twice as much damage as the sheets show, Niederholzer said.

"If you have 1% damage on your reject sheets, you probably had at least had 2% damage in the field."

It's important to know what is damaging the nuts, whether it's PTB, Oriental Fruit moth, NOW, ants, etc. as this information can assist growers in making decisions for their spray program for the following year, Niederholzer said.

Ants, for instance, can eat almost all of the kernel, so all that's left is the skin, and that damage is hard to find after field blowers and air legs at the huller.

"Ants are pretty easy to control inexpensively, but they can do a lot of damage, and if you don't realize it's happening you don't know to take corrective action. Without the harvest sample results, you wouldn't know to make a special effort to control ants at the next harvest and possibly keep losing crop and money," Niederholzer said.

"If you see some PTB leaking through, there's different ways of getting after that. Taking this harvest sample will really give you good information on where the damage is coming from," Niederholzer said.

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"This is a year where you want to pick out the critical things, and make sure you get those right. From my standpoint those are the biggies," –Franz Niederholzer, UCCE

Winter Sanitation

Winter sanitation is an important postharvest management practice.

"Sanitation is critical. It's the foundation of your navel orangeworm management program," Niederholzer said. It could be really important for the 2021 crop if a light return bloom in some regions leads to larger nuts and poorer shell seals, along with a higher risk of NOW damage.

Some growers will try to shake early and send a machine through the Nonpareils while they're harvesting the pollinizers, Niederholzer said. Other growers will wait for rain or fog, something that will get some moisture on the dried mummies to give them some weight and help them shake off easier during the dormant season.

The problem with waiting to remove the mummies is it can be difficult to get into the orchards after it rains, but some shakers are being converted to track systems, Niederholzer said. The track system replaces the wheels on side mount shakers.

"Some farm management companies up in the Sacramento Valley are putting tracks on their machines just so they can get out there (if the ground gets too wet)," Niederholzer said, which may allow them to shake mummies deeper into the winter on heavy ground.

Past research suggests that mummy shaking once buds have begun to swell (late January or early February in many years) is feasible. While buds might be shaken from the tree at these timings, only about 25% of all the flowers on the tree need to set to make a good crop in most years, Niederholzer said. However, if return bloom is light in 2021 after this record crop, don't wait too long to start sanitation.

"If you end up shaking off 10-15% of the flowers on a tree, while you don't like to see it on the ground, it may not be a measurable impact on the crop," Niederholzer said, and that would allow growers to wait and shake later. See a recent column on late sanitation by Wes Asai at wcngg.com/2020/01/06/does-late-winter-shaking-reduce-yield-potential-in-almonds/.

Scale

Niederholzer recommended one last thing—taking a spur sample to determine the San Jose and soft scale populations in an orchard. Scale doesn't have to be treated every year, but keeping an eye on it, especially if there is an aggressive NOW spray program, one including pyrethroid insecticides, is something to consider. The spray program could be harming the beneficials that keep scale under control.

"A dormant spur sample is a good idea, every year," Niederholzer said.

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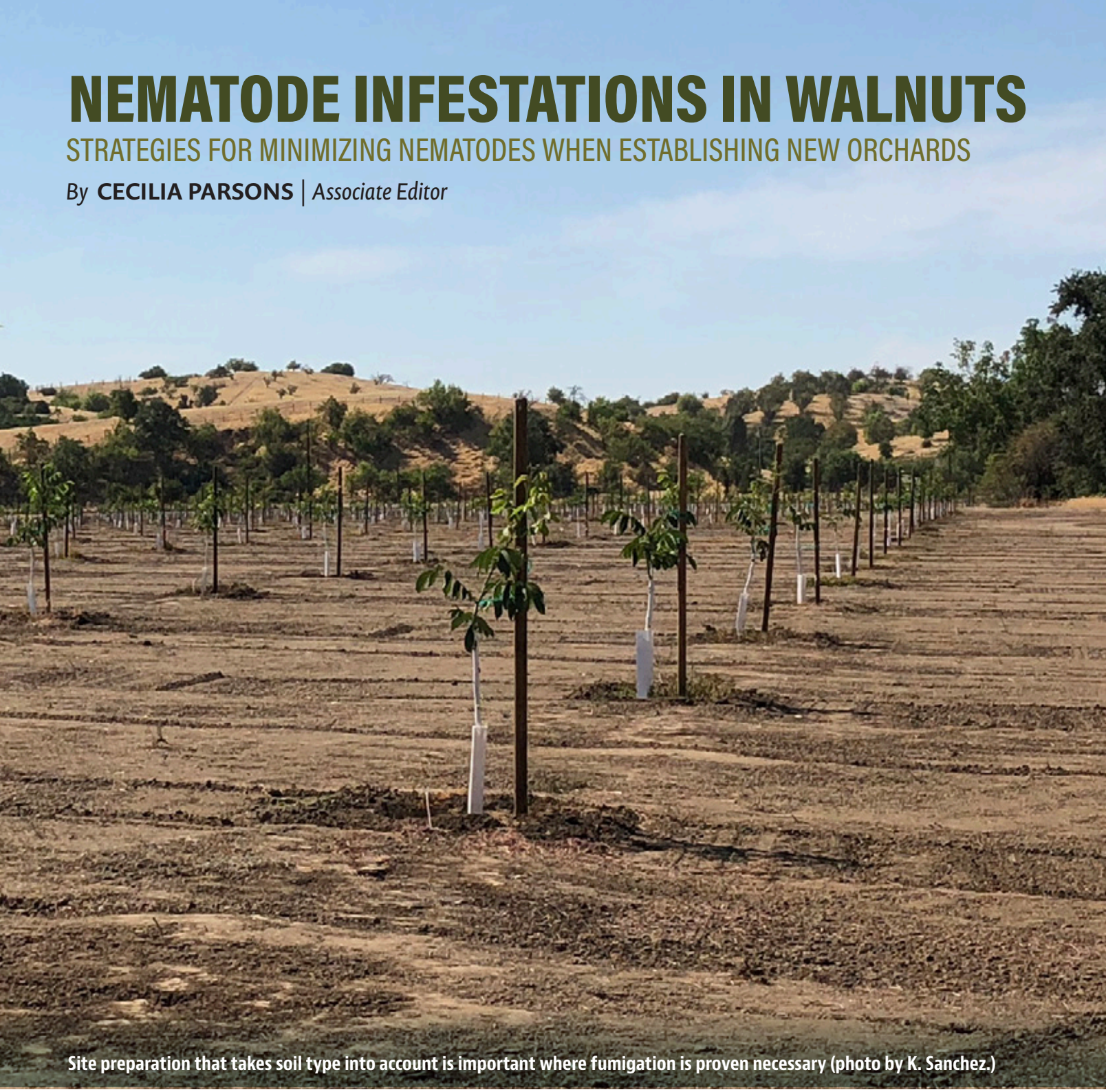
NEMATODE INFESTATIONS IN WALNUTS

STRATEGIES FOR MINIMIZING NEMATODES WHEN ESTABLISHING NEW ORCHARDS

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



Site preparation that takes soil type into account is important where fumigation is proven necessary (photo by K. Sanchez.)

THE TIME FRAME FOR PLANNING A NEW WALNUT ORCHARD can span months, if not years. From ordering trees to site preparation, growers understand the importance of preplant planning to ensure optimal orchard growth.

It is important to know the site history and soil types when planning a new orchard. If the orchard is to follow an old walnut orchard, particular attention needs to be given to the tree removal process. For successful walnut production, it is the level of damaging nematode species found in the soil that must be addressed prior to setting trees in the ground.

Fumigation and Rootstock Selection

Choosing nematode resistant or tolerant rootstocks and planning fumigation operations or other controls for nematodes plays a part in the success of a new orchard. There is active work going on in a large collaborative effort of several UC campuses, including USDA-ARS and Fresno State University, to further expand the rootstocks available

Continued on Page 10

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Continued from Page 8

for walnut production. This effort is supported by federal (USDA-NIFA), state (CDFA Specialty Crop Block Grant Program) and California Walnut Board funding.

Andreas Westphal, a UC Riverside nematology specialist based at the Kearney Agricultural Research and Extension Center (KARE) in Parlier, said that approximately 85 percent of California walnut orchards are estimated to be infested with the walnut root lesion nematode (*Pratylenchus vulnus*), one of the most damaging soil pests in walnut. Mature trees are less affected by this soil pest, but even at very low numbers in the soil, root lesion nematodes can inflict severe damage to young trees, invading and compromising their smaller root mass. Trees planted in root lesion nematode-infested soils can exhibit loss of vigor, stunting and unhealthy foliage.

Other nematode species that affect young walnuts grown on certain rootstocks are ring nematode and root knot nematode.

Identifying Problem Sites

Pre-plant soil sampling, appropriate treatment and vigilance, along with proper rootstock selection, are recommended to ensure trees get the best start possible and reach their production potential.

Soil sampling, whether in an existing orchard that is scheduled to be pulled out or a fallow site, requires some planning. Timing is important. It is a good idea to sample soil for nematodes when the old orchard is still in place so probable nematode infestations can be identified near the old trees.

Before the existing orchard trees are removed, sampling sites near active roots, at the edge of the tree canopy, in the wetting zone of drip emitters or the microsprinklers will yield the most representative sample where nematodes could be detected. Westphal said nematodes are easiest found in the soil where tree roots are actively growing. With this strategy, knowing where to sample soils will yield a better representation of the nematode population. Soil sampling at a dry, long-fallowed site at the wrong time of the year may not yield any live nematodes, but that does not mean they are not present, Westphal stressed. Nematodes do need live host

Continued on Page 12

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Fumigated (left) and nonfumigated (right) trees in a walnut replant trial (photos by K. Sanchez.)

Continued from Page 10

plant roots to thrive. If there is no host present, they start to decline, unfortunately, not quick enough below damaging thresholds, but low enough that they are difficult to detect.

Take soil samples near both healthy and weak trees to compare information about the impact of existing nematodes on reducing tree growth. Sample soils in an established orchard at the 18-inch depth level. If a dry, fallow site is sampled, the soil may have to be obtained from a depth of at least 2 or 3 feet if not down to 5 feet. Nematodes tend to not be extractable from "bone-dry" soil of the top layers but may survive at greater depths where soil moisture levels are higher, and the slower drying process allows them for some adoption to the changing environment.

Once the soil samples are taken, Westphal noted that they have to be kept cool to ensure any nematodes in the sample are alive when the samples reach the laboratory. Some of the nematode extraction procedures depend on the nematodes to be alive and active. When submitting soil samples, it is very important to provide sufficient information to the diagnostic lab. General information about the field will help to choose the proper soil extraction method. Westphal said it helps to ask about the extraction method used as different species of nematodes require different extraction methods.

Control Methods

Moving forward with the results of the laboratory tests, growers can make decisions based on nematode levels, orchard soil types and rootstock selections. Fumigation or rotating in a non-host crop are options prior to replanting walnuts.

Before orchard removal, kill old tree roots as a first step toward nematode control as it speeds root breakdown. Dr.

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Mike McKenry, nematologist emeritus, developed methods on how to kill a tree before the trees are removed. Killing roots also kills many of the nematodes inside the roots, but may not impact nematode eggs within the tissue. This method reduces the overall load of nematode infestation in a field and potentially can help in the clean-up process.

If a potential walnut orchard site is confirmed to have root lesion nematode present in the soils, and a long wait time before planting is not feasible, fumigation is the next step.

Preparation of the soil prior to fumigation will help with efficacy. Hardpan, poor percolation, high salts and herbicide residues need to be mitigated.

There are theoretical options to forego

Continued on Page 14

Kristi Sanchez, nematology specialist with TriCal Diagnostics, pulls soil samples from a walnut orchard (photo by Olegario Fernandez, PCA, TriCal Diagnostics.)

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16 Years in Walnuts | 30 Years of Sorting in the Field

Multiyear trials are comparing fumigation options in Sacramento and Yolo counties (photo by K. Sanchez.)

Continued from Page 13

fumigation and replant walnuts. These are time-consuming and require multiple years of non-walnut cropping. If root lesion nematodes are present, rotating to another crop, such as alfalfa, can reduce levels. Other crops that do not host walnut root lesion nematode are tomatoes, sweet corn and cucurbits. If ring nematodes are present, a year or two of sudan or a sorghum-sudan hybrid can reduce levels. Where both ring and root lesion nematodes are a problem, the alfalfa can be followed with a sudan crop.

Chemical fumigation is advised for orchard sites where high nematode counts have been found. Kristi Sanchez, nematology specialist with TriCal Diagnostics, said field preparation for fumigation is essential to the success of the operation.

Soil types will dictate the site preparation. Sanchez said heavier soils that hold moisture pose problems because if the soil moisture is too high the fumigation will not be as effective.

"This is a big factor; the soil moisture needs to be below 12%," Sanchez said.

Preparing an orchard site also calls for deep ripping to remove all old roots from the previous orchard as they can be a source of root lesion nematode re-infection. This soil loosening to 5 or 6 feet will also increase the easily accessible soil volume for root exploration. There should be very little plant residue on the soil surface after preparation is complete.

Soil type also plays a role in the final field preparation before fumigation. Heavy soils are more likely to form clods during the tilling process and they will hold moisture and harbor root lesion nematodes. It takes extra effort to break

up the clods, Sanchez said, but it will allow the fumigant to penetrate the soil. The two best options for orchards, she added, are 1,3-dichloropropene (1,3-D) in Telone II or Chloropicrin or a combination of the two.

Current Research

Westphal and UCCE advisors Katherine Jarvis-Shean, Elizabeth Fichtner and Luke Milliron are continuing research in pre- and post-plant remedies for nematode infestations in walnut orchards. The team is conducting trials in several walnut growing regions.

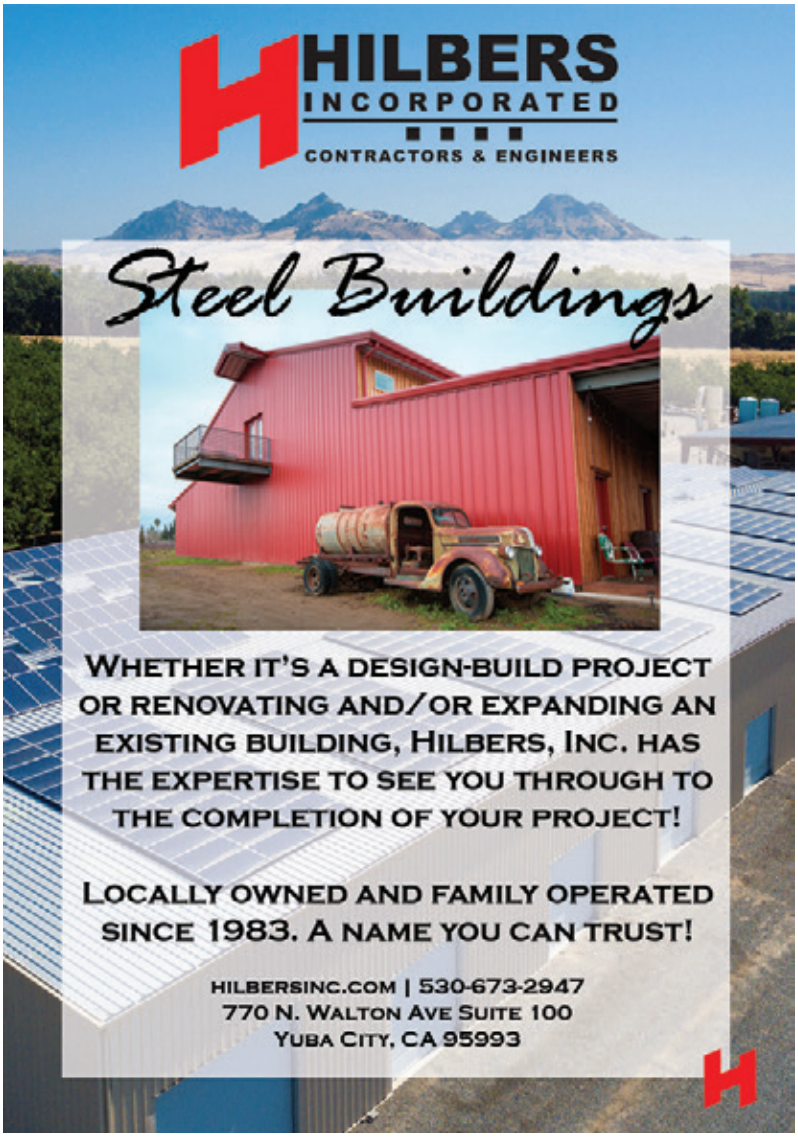
Westphal said that several newer nematicidal materials have shown promise in annual crop production and require implementation work in walnuts. In this California Walnut Board-supported project, a re-evaluation of current threshold levels for damage by *P. vulnus* is being done by exposing three rootstock genotypes to increasing population densities of nematodes in microplots. In detailed studies at KARE, three preplant treatment materials are tested and applied as soil drenches with large amounts of irrigation water. Two low-volume materials, Salibro and VelumOne, were applied in open plots through a drip irrigation system and one high-volume material was tarped during the process. These studies are currently expanded to different production areas with the help of grower collaborators.

Preliminary studies showed the materials reduced nematode population densities to the required soil depths. There is still a lot to learn about how best to use these tools. Westphal said in his research report that treatment effects were more likely to be significant after repeated growth periods that permit conversion of stress relief from nematode infection. Several growing periods of improved root growth and resulting in improved energy status of the trees have the potential to improve crop productivity.

In summary, infestations with walnut root lesion nematode require vigilance in soil testing and mitigation. Currently, emphasis is placed on the use of soil fumigants, but additional tools are in various stages of development. It is critical to be aware of potential nematode infestations before establishing an orchard. Mitigation strategies after establishment are much more challenging; so, planning and preparation is key to sustain highly productive walnut orchards.

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

> **IF A POTENTIAL WALNUT ORCHARD SITE IS CONFIRMED TO HAVE ROOT LESION NEMATODE PRESENT IN THE SOILS, AND A LONG WAIT TIME BEFORE PLANTING IS NOT FEASIBLE, FUMIGATION IS THE NEXT STEP.**



Variety and Rootstock Decisions in a Newly Planted Orchard

Consider Field History, Climate and Pest Issues Before Making Rootstock and Variety Selections

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

OF ALL THE DECISIONS TREE NUT growers make when planting a new orchard, rootstock choice has to be the most important one, said nurserymen who develop and provide the young trees for new orchard plantings. Variety choices are driven with payback in mind and are somewhat easier to make.

"Absolutely, rootstocks are the most important consideration for a new orchard. If you get it wrong, the variety doesn't matter," said Agromillora's Cliff Beumel.

According to UC Davis Fruit and Nut Research and Information, rootstocks are bred to grow in different soil types and conditions, and provide anchorage, vigor and resistance or tolerance to soil borne pests and diseases. However, no individual rootstock is tolerant of all factors that can impact production. The strengths and weaknesses of each rootstock should be considered in the context of a specific orchard location.

Match Rootstocks to Site

Matching rootstocks to the environmental conditions in an orchard site is not an exact science. The person making the decision has to factor in soil type, disease pressure and soil pests at the specific site along with climatic conditions. For example, trees planted where strong winds are common need better anchorage. The type of orchard management, conventional or organic, and how much time a grower or manager can spend 'doctoring' trees can also have an impact on the rootstock decision. There is no 'perfect' rootstock that fills every need, all nurserymen interviewed for this article agreed, but with careful consideration, sound choices are often made.

"A lot of growers come to us already knowing what rootstock they want or need, but we play a role in helping them with the decision," said Reid Robinson of Sierra Gold Nurseries.

Mark Crow of Orestimba Nursery explained that when growers have an

Continued on Page 18

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Continued from Page 16

interest in new plantings its best to collect as much information before they choose a rootstock. That information includes what has been planted at the site previously, what diseases have been diagnosed there and if there is any micro climate effect at the site. What nearby neighbors are growing may also be a consideration.

"Every piece of ground has some unique characteristics that should be recognized," Crow said. "We are able to provide our growers with data from our own test blocks of new varieties and rootstocks. As a farming family, we want to see successful orchards."

Crow is a sixth-generation grower, and hopes to pass on his knowledge to his children and their customers.

"We will always strive to find the best solution for the grower," he added.

Burchell Nursery's Ron Boone said growers either are knowledgeable about conditions at the prospective orchard site or they will ask the nursery to assess the site and make recommendations. Burchell will consider the soil texture, drainage and water table among other things to make a recommendation. The salt load in the soil and the water source for irrigation also has to be taken into account in a rootstock choice, Boone said. Since the drought, salt has built up on some ground or it may be marginal to begin with. Infiltration tests and soil mitigation may be necessary before even getting to rootstock selection. He said they also like to see results of soil tests to determine the levels of soil borne pests.

In California, Beumel said, there is a wide range of soils and growing conditions, just as there is a wide range of choices in rootstocks. Some have limitations, but there is a place suited for each one.

Nurseries should provide growers with good, solid scientific information about rootstocks and show real-world examples of their success, he added.

University of California Walnut Improvement Program has information on walnut rootstocks and varieties. Information on almond and pistachio rootstock and variety trials is also available.

Variety Decisions

Scion varieties are chosen for many reasons, including rootstock compatibility, pollination timing, harvest timing, accommodations to harvest equipment availability, weather conditions and finally, advice from the processor. Many of these decisions will also have financial implications.

Like walnut and pistachio rootstocks, the scion varieties chosen with them will have long lives. Almonds have a shorter turnover, but can be affected more by environmental conditions. There are limited choices in pistachio varieties, but the earlier maturing varieties have gained in popularity to space out harvest.

Factors to consider when selecting a walnut variety include climate and insect pest pressure. Walnuts require a period of winter chill to break dormancy and initiate leaf and flower. Pistachio varieties also have a chill requirement.

In addition to considering how a potential scion cultivar would fare in local climate and pest conditions, growers should consider other characteristics of each cultivar including leaf and bloom date, timing of harvest, nut quality and bearing habit.

Boone said that in a growing region with early rains, nuts from a later harvesting variety might end up being laid down on wet ground. That risk can be mitigated with an earlier variety.

The size of the block to be planted can also come into play. In almonds, Boone said they would recommend a grower with a smaller block use a

self-fertile variety. It will be easier to get a harvest operator to come once rather than two or three times to get different varieties. If the new block is planned near an existing variety, it is often practical to plant the same variety.

Location, Location, Location

"An astute grower will make this decision based on location and attributes," Beumel said. While prices and yields are important, they won't necessarily reach their potential if the growing conditions for a variety are not optimal.

Almond variety trials conducted by UCCE advisors are a source for information on new varieties (for detailed almond trial information, see article in September 2020 *West Coast Nut*.) These trials can provide information on time of bloom, bloom weather, bud failure, hull split and harvest maturity as well as productivity, yield data and nut quality. Much like rootstocks, UC advisors note there is "no perfect variety."

First choose the main variety, then the pollinator, they advise.

Jereme Fromm of Dave Wilson Nursery brings with him experience as a field rep with Blue Diamond. Fromm said he spends time discussing needs and specifics of potential orchard sites with growers, but also encourages them to seek some input from their processor when choosing a variety.

"Ask them what sells; that needs to be part of the conversation," he said.

Growers should also think about what varieties are already in their portfolio and if it makes sense to diversify or have a more homogenous operation. Management costs and harvest efficiency should be considered, Fromm added.

Harvest timing or spreading out harvest are often cited as drivers of growers' variety choices. Beumel said more growers are thinking about spacing out their harvests so that not all orchards are ready at the same time and may have to wait for equipment availability. Insect damage or an untimely weather event could affect crop value in those instances.

Robinson said there are a lot of regional components to choosing a variety and it is often a business decision. Growers should do a lot of homework and speak with other growers who already have the variety they are considering in the ground.

"We can provide information and perspective for specific rootstocks and varieties."

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WINTER SANITATION IN PISTACHIOS

Even with Two Shakes, Growers Should Focus on Sanitation

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

All photos courtesy J. Siegel

ONE BENEFIT THAT PISTACHIO GROWERS ARE REAPING from an increased adoption of double shaking is improved winter sanitation. But viewing an extra shake as a replacement for winter sanitation is a mistake, according to navel orangeworm experts.

The second shake, now widely employed in California pistachio production, can do wonders for removing navel orangeworm (NOW), but additional sanitation is needed, according to Joel Siegel, an ARS entomologist based in Parlier, Calif. And, Siegel said, the best thing a grower can do to minimize NOW populations during the dormant season is get nuts on the ground.

Let Nature Work for You

"The number one thing you can do is to get the mummies off the tree and on to the ground, because then we have these natural processes that can work in your favor," Siegel said. "The sooner they are on the ground, the greater the opportunity for the nuts to get wet and rot."

Particularly in the southern Central Valley, where a year's worth of rainfall can fall in a six-week period spanning December through January, getting nuts on the ground quickly is critical, Siegel said.

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"You are trying to get them on the ground as soon as you can to take advantage of the rains coming through," he said. Vegetation on orchard floors can help capture moisture and humidity and facilitate rot, Siegel said. And nuts on the ground are more likely to germinate than nuts in a tree, taking them out of play as a winter food source for NOW.

"About 80 or 90% [of NOW] mortality happens over that six-week period (in early to mid-December to mid- to late-January)," Siegel said. "That is why it is so critical to get the nuts on the ground as soon as possible."

Two Shakes Reduce NOW Pressures

With the widespread adoption of double shaking—Siegel estimates it is performed on 70% of California pistachio acreage today—NOW populations going into the dormant

USDA ARS entomologist Joel Siegel said knocking mummies out of trees and onto the orchard floor, where the rotting process is hastened, is critical to a successful winter-sanitation program.

season are significantly reduced from days past, Siegel said.

"One of the greatest pest-control activities a grower can do is to shake," Siegel said. "You have all of those eggs that are laid on the hull that haven't hatched yet. They are pulled out of your orchards. Any infested nuts are getting pulled out, and you also are getting your sound nuts out.

"You are removing several different life stages of the navel orangeworm," Siegel said, "including the newly laid eggs and the navel orangeworm that are in infested nuts. So, you are putting a tremendous hit on that population.

"At the same time, what people are doing is they are doing an extra spray between shakes to protect the nuts on the tree before they do that second shake," Siegel said. "So, you are getting the benefits of the insecticide and you are coming in and removing infested nuts."

Some growers, after calculating potential yield benefits versus harvest costs, have started doing a third shake. Often, however, quality issues come into play when considering a third shake, Siegel said.

"The longer the nuts are out there, the greater the opportunity they have to get contaminated with *Aspergillus*

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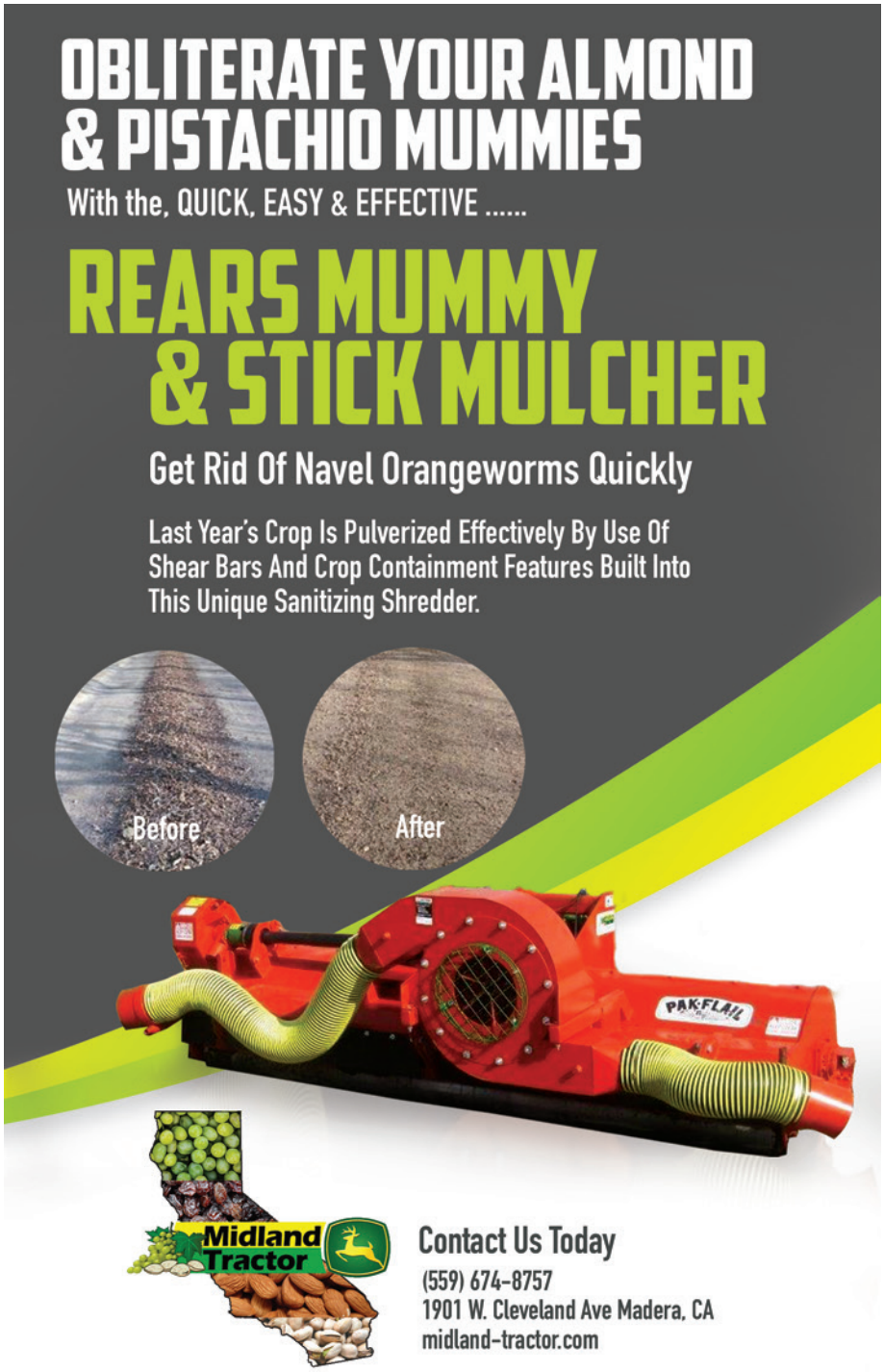

Pistachio mummies are an ideal food source for the navel orangeworm during the dormant season.

Continued from Page 21

fungi (which causes aflatoxin)," he said.

A third shake also carries the potential of reducing the next year's crop if shaking too vigorously.

"The downside is if you are shaking too much budwood off, you are sacrificing next year's crop," Siegel said.

Whether one, two or even three shakes, however, more nuts remain on trees after harvest, Siegel said. And, despite the fact that a certain percentage of the nuts are blanks, odds are that many are a prime food source for NOW.

"The thing with pistachios is you have to deal with the odds," Siegel said. "You have to shake everything, get it off, even though not everything is a threat."

Siegel added that his research has shown the survival rate of NOW in mummies on a tree is three times greater than in mummies on the ground.

Multipronged Approach

For pistachio producers, controlling NOW is a nearly year-round, multipronged task. But winter sanitation has long been identified as maybe the most important NOW control strategy.

"When you go to industry get-togethers, the navel orangeworm is always a part of the presentation," said James Nichols of Nichols Farm in Hanford, "and each farm advisor and PCA that talks says that orchard sanitation is the best way to combat this pest."

Nichols, who is developing a pistachio grinder that could dramatically improve winter sanitation programs (see related story in this issue of *West Coast Nut*), performs a post-harvest shake to knock nuts off trees as part of his winter sanitation program, an activity Siegel recommends for growers with access to shakers. And Nichols typically will send a hand crew through orchards with bamboo poles to knock mummies out of trees.

"If there is a high number of mummies still left in the tree, we will send a pole crew through," Nichols said.

Getting nuts out of crotches, another spot mummies will collect after harvest, is also an important winter sanitation activity, Siegel said. "They have to get swept out, removed from the crotch and onto the ground," he said. Many growers use pruning crews to remove nuts from crotches, he said.

Outside factors also can play a role in the success or failure of a winter sanitation program, Siegel said, including what is happening on your neighbor's farm, a factor increasingly pertinent with the steady increase of tree nut production in the Central Valley. And, Siegel said, there is always the chance that an almond grower will come through and destroy almonds left after harvest by mechanical means, an option not currently available for pistachio growers, and cause NOW to go look for an alternate food source.

"That has always been a fundamental difference between pistachios and almonds," Siegel said. "Pistachios are harder and smaller than almonds, and the navel orangeworm is able to hide inside what amounts to a little armored object. In almonds, though, a machine can come around and crush them, so they can't serve as potential hosts in late winter and spring when the navel orangeworm flights begin."

Nichols, who has experimented with his mummy grinder for the past two years, noted he has seen populations of NOW increase in pistachios after running the machine through almonds.

"Even though you have pulled some of the navel orangeworm out of your orchard," Siegel said, "you are also dependent on what your neighbors have done and what is going on in almonds, because these things can fly five or ten miles if they want to."

It's one more reason, Siegel said, to hasten the rotting process by getting pistachios on the ground and out of trees as soon as possible after harvest.

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Getting pistachio mummies onto the orchard floor is a critical step in a successful winter sanitation program. Research has shown the survival rates of the navel orangeworm in mummies on trees is three times greater than in mummies on an orchard floor.

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Pistachio Mummy Grinder Targets Overwintering NOW

Nichols Farms Tests New "Worminator" for Improved Winter Sanitation

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

Nichols Farms is developing the mummy grinder, or Worminator, for both its pistachio and almond orchards to pick up mummies, collect them in a hopper, grind them and drop them back on the orchard floor in fine pieces (all photos courtesy Nichols Farms.)

OVERWINTERING NOW IN PISTACHIOS ARE RELIABLY DIFFICULT to deal with in comparison to almonds. But growers are looking at novel ways to destroy those downed mummies. By the fall of 2021, California pistachio growers may be able to custom-order a mummy grinder that could dramatically improve winter sanitation.

The grinder is the brainchild of two farmers and a metal fabricator who have gone outside the box to develop a solution to a problem that has plagued pistachio growers for decades: namely, how to destroy mummies, a major food source for the navel orangeworm (NOW).

After two years of testing, the mummy grinder is providing results that are surprising even the growers.

"We take biweekly trap counts in our orchards," said James Nichols of Nichols Farms. "And in both the orchards that have mating disruption and those without mating disruption, we've seen a pretty drastic difference between the orchards that we ran this on."

Nichols, whose family also operates a processing plant in Hanford, Calif., said he was getting trap counts in the 60s, 70s and 80s this past spring in orchards where he didn't run the grinder. Where he ran the grinder, he was finding between zero and one moth per trap.

"It is certainly not the only tool in the toolbox, but from a nonchemical treatment standpoint, we are really excited about the fact that we've seen a lot of pressure reduction in our traps, and I think it is attributed to the lack of food source for the navel orangeworm," Nichols said.

The Nichols mummy grinder, which they are calling a "Worminator," has its origins in a conversation between Nichols and his shop manager, Richard Brock, after the farm suffered poor performances in 2016 and 2017 due to navel orangeworm.

Nichols said he remembers standing in an orchard with Brock looking at mummies on the orchard floor.

"I remember having a meeting out in one of the orchards, and we were looking at the leftover nuts from the previous harvest, and we were asking, 'How can we get rid of these,'" he said.

"Jimmy (Nichols) said to me, 'We need to come up with a different way of doing things,'" Brock said. "With our normal practice, we are probably getting 15-40% of the mum-

Continued on Page 26

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Continued from Page 24

mies. And he said, 'Richard, I want to get 90-99% of them.' So that is when we started looking at different alternatives to achieve that goal."

The mummy grinder is a retrofitted almond conditioner, with a grinder configured at the end to shred mummy nuts.

The High Cost of NOW

High navel orangeworm pressure in the 2016 and 2017 seasons cost Nichols Farms in three ways.

"It affected us at the grower level in that we weren't receiving the premiums that we would have received if we sent in low-insect crop," Nichols said. "It was slowing down the plant operations because it was requiring a lot more hand sorting. And it was asking a lot more from customer service, because we had quite a few complaints about finding navel orangeworm in our product."

Nichols and Brock started their journey by realizing their best bet would be to gather the nuts in the center of rows with an almond sweeper and somehow remove them. Pistachios are innately difficult to dispose of in large part because of the hardness of their shell, so Brock's first thought was to use a wood chipper to grind them. "But then we realized that wouldn't grind the nuts fine enough," Brock said.

The two eventually brought in Terry Kwast of Sawtelle & Rosprim in Corcoran, Calif., a fabricator who had worked with Brock's father in the past.

Kwast suggested using an industrial grinder to grind the nuts, similar to one used in municipal sewage and waste systems to grind everything from agricultural byproducts and wooden pallets to surplus compact discs.

"When Richard came and asked me if I could help on this, one of the first thoughts that came to my mind was we needed a good, high-quality industrial shredder," Kwast said. "And that is where we started. The rest of it is a matter of the mechanics of getting the power to it and getting it to work."

Nichols Farms began testing the grinder in the 2018-19 winter. "There were some struggles," Brock said.

After the first year, the designers increased the hydraulic power on the input side of the grinder and boosted the system's pressure so it could deliver more torque, and they sped up the grinder before bringing it back last winter to improved results.

"We covered quite a bit of ground with it this year," Nichols said. "I would say we ran it on 40-50% of our orchards on the east side (where the farm typically has high NOW pressure)."

The farm tested the grinder in orchards with and without cover crops, and it performed equally well in both.

The system requires some prep work on orchard floors, and it requires an almond harvester to windrow pistachio mummies and condition an orchard floor before bringing the grinder in. The Worminator then comes through and picks up the mummies, collects them in an enclosed hopper, shreds them and drops them back on the floor in fine pieces that no longer provide a food source for the navel orangeworm. Nichols said he ran the grinder at 4 miles-per-hour with good results this past winter.

The grinder also works in almonds.

Pays for Itself

As for the economics of purchasing

a grinder, Nichols said he believes the system will pay for itself in premiums alone many times over.

"One of the things that was driving me to look at the idea was economics," Nichols said. "On pistachios, there is a very high premium for low-insect inshell product – on the order of 25 cents a pound for most processors. So, if you have a payable 3,000-pound inshell crop that comes in at 2% insect damage, you are missing out on roughly 750 dollars an acre, which is pretty substantial, plus the missed revenue opportunity of the nuts that were infested."

Added together, the missed revenue in the example comes to $900 an acre when adding $150 an acre in missed revenue for the crop itself.

Nichols said the farm didn't initially intend to make the grinder commercially available. "This is something we originally thought we could have for our own operation. But going through this process and seeing what it is able to do in the field, we took a position that we think this might be of commercial viability," Nichols said.

Asked when growers may be able to purchase the grinder, Kwast said probably a year to a year and half.

"Things are going to have to be worked out," Kwast said. "For example, how somebody wants to drive them: do they want something that is self-powered or do they want something they can drive with their tractor? There are a lot of different options here.

"For the first several years, you are probably looking at custom building one for each customer," he said.

Asked how Nichols, Brock and Kwast may have come up with a solution to a problem that has dogged pistachio growers for decades, Kwast said it involved looking outside the box.

"I think we just looked at the problem a little differently than it was looked at in the past," Kwast said. "The people that have tried to address it in the past have tried to address it with traditional agricultural practices, such as disking and flail mowers and such, and we kind of took a different approach.

"We kind of looked at it like, let's collect the nuts in a hopper in an enclosed system with a grinder that is capable of grinding that product," Kwast said. "I think it is just a different thought from the starting point of how to attack the problem."

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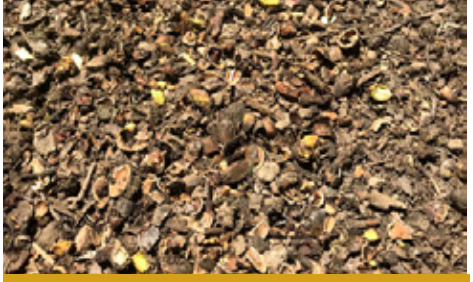

The Nichols Farms' mummy grinder grinds pistachio mummies into fine pieces, eliminating them as a food source for the navel orangeworm. The grinder also works in almonds (all photos courtesy Nichols Farms.)

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Current and Future Applications of Unmanned Aircraft Systems in Precision Agriculture

By **GREGORY KRIEHN** | *Ph.D., CSU Fresno*

UNMANNED AIRCRAFT SYSTEMS (UAS) are increasingly being utilized in farming applications throughout California's Central Valley. The Federal Aviation Administration (FAA) anticipates that the adoption of UAS technology will continue to dramatically increase over the next several years.

In 2019, there were 900,000 registered UAS drones in the United States, with about 17% being utilized for agriculture, meaning there are more than 153,000 drones currently in use for farming applications. As California farms produce roughly 13% of US farm dollars in the United States, it can be estimated that there are about 20,000 agriculture drones in California today. Additionally, the 2017 census noted that there were 124,405 farmers and 70,521 principle operators in California, meaning roughly 1 in 10 California farmers and 1 in 5 principle farm operators currently utilize UAS technology as part of their farming operations. It is important to note that these estimates have doubled over the past couple of years and, if the trend continues, it is anticipated that the majority of farmers will utilize drone technology to some degree over the next decade.

Integrated Technology

Although aerial imaging has been previously used within agriculture for over 50 years to monitor crop conditions (including pest, weed, disease monitoring, damage observations due to drought and flooding, and growth differences due to soil chemical and physical problems), it is the integration of imaging systems with global positioning systems (GPS), recent advancements in UAS autonomous flight capabilities, and the miniaturization of flight technology enhanced with micro-electromechanical systems (MEMS) that has allowed the UAS industry to take off.

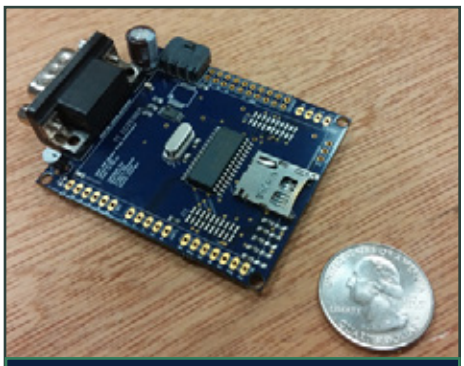
Over time, the focus has shifted from the development of basic flight technologies (electrical motors, battery technology, GPS, magnetometers, gyroscopes, accelerometers, etc.), to low-cost imagers and multi-spectral devices for imaging and photogrammetry, toward autonomous flight and automated data collection, and finally, to integrated systems that have the potential to provide actionable intelligence and prescription maps to the farming community.

Most imaging capabilities utilized by drones currently include taking photographs measuring the reflectance off of a canopy in the Red, Green and Blue (RGB) color bands (400–700 nm) to produce visible RGB images, in addition to near-infrared (NIR) wavelengths (800–850 nm) where strong scattering starts to occur due to the leaf's internal structure, and the so-called red edge spectral bands (the wavelengths between 700–800 nm, where chlorophyll absorption stops.) The reflectance values within each color band are normalized between 0 (no reflectance) and 1 (complete reflectance), and are combined using sums and differences to produce vegetation indices that attempt to correlate the spectral information against the

Continued on Page 30

Tree nut growers are becoming increasingly interested in UAS technologies due to their ability to analyze a number of different growth factors within an orchard (photo courtesy Cary Edmondson, CSU Fresno.)

Dr. Kriehn inspects a UAS drone built at Fresno State (photo courtesy Cary Edmondson, CSU Fresno.)



Embedded sensor developed by Dr. Kriehn's research group at Fresno State for automated data collection of temperature, humidity and soil moisture data by a UAS platform (photo courtesy Fresno State Unmanned Systems Research Team, led by G. Kriehn.)

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Continued from Page 28

Crop Water Stress Index (CWSI) to determine how much stress a plant or tree is currently experiencing.

A variety of vegetation indices have been developed over the years, including the Normalized Difference Vegetation Index (NDVI), Green NDVI and Normalized Difference Red Edge Index (NDRE), all of which examine the degree to which chlorophyll absorption is occurring within the visible spectrum and compare the result against expected higher reflectance in the NIR or Red Edge (RE) band(s). In a healthy canopy, there is a strong difference between the visible and infrared reflectance (producing an index closer to 1.) When a plant or tree experiences stress, the indices generally trend closer toward 0.

Additionally, when many pictures are taken over a large field, sophisticated digital imaging software can then "stitch" the images together to produce an orthomosaic map in which the aerial photograph is geometrically corrected (orthorectified) to keep the scale uniform across the entire set of images as they are stitched together. The goal is to produce a high-resolution vegetative image over a much larger area that has been corrected for camera tilt, lens distortion and topographic relief so that true distances can be measured and accurate decisions be made within the field.

Remote Sensing

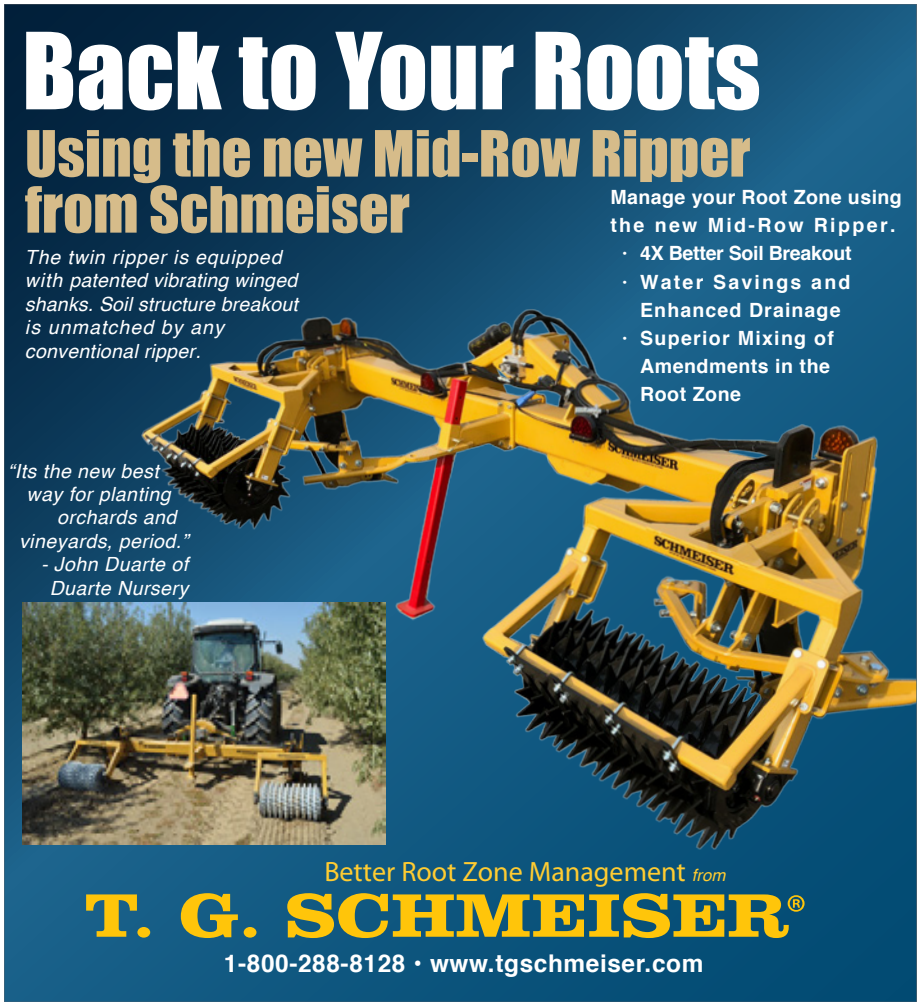
When properly used, the integration of UAS technology with remote sensing and imaging has the potential to readily produce prescription maps that can then be uploaded to variable rate spreaders capable of using real-time GPS sensor information for precision agriculture. A recent case study by AeroVironment demonstrated that a walnut grower in Modesto, Calif. was able to increase his yields by 21% in a 40-acre field by altering irrigation and nitrogen applications in the northern part of his field based upon the NDVI images that were taken over a two-year period using drone imaging.

However, there are several other things to keep in mind when considering this technology:

Accurate NDVI, NDRE or other vegetative indices are highly dependent upon obtaining accurate reflectance values. Since reflectance measurements can change significantly over the course of the day and under different weather conditions and seasons, it is important to operate such imagers under the same conditions each time data is collected. This is especially important for tree-based crops (i.e. almonds or walnuts), since tree canopies are much more variable and more loosely correlated against stem-water potential and water stress when using remote imaging.

Vegetative indices produce relative measurements that must be properly calibrated to produce actionable data. In years past, a calibration target had to be placed in the field so that the images could be calibrated against the known reflectance of the target pad. Today, most imagers should contain a secondary sensor that points toward the sun (such as the MicaSense RedEdge) that serves to properly calibrate the measured reflectance values. Regardless, the imaging device must have its reflectance values properly calibrated every time it is utilized to produce accurate data.

Orthomosaic vegetative maps still need to be calibrated against "boots on the ground" to provide a baseline understanding of what is happening within the



Fresno State students code internal data into UAS drones in Dr. Kriehn's UAS laboratory (photo courtesy Cary Edmondson, CSU Fresno.)

field. The vegetative index maps that are created by these imagers are still relative – it is up to the farmer to determine at what values between 0 and 1 is true stress occurring. Toward that end, differential NDVI or NDRE maps are recommended, in which multiple sets of vegetative maps are created over several days and/or weeks so that changing trends within the field can be determined. Several case studies have demonstrated farmers have been able to identify localized stress (such as disease) down to the tree level in almond orchards when using differential NDVI and NDRE images.

Additionally, UAS technology provides more tools for precision agriculture than just imaging. Within areas of rough terrain, drones have been used to collect data from remote sensors. This technology can readily be applied within large agricultural fields, reducing the need for transmitters, repeaters, and the associated wiring and infrastructure.

Wireless sensors and sensor networks have evolved from requiring custom manufacturing limited by large power consumption and short duration (hours to days,) heavy weight (kilograms) and large footprints to commercial companies providing embedded solutions that can be powered by standard batteries (AA, 9V, etc.) with significantly reduced weight (grams or lower) and size (tens of centimeters down to sub millimeters.)

Continued on Page 32

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Continued from Page 31

Potential for UAS Technology

This combined reduction of power, cost and size has provided a unique opportunity to provide cost-effective solutions for farm operations to employ smart technology with fields containing significant variability in moisture content, salinity, pH, etc. to optimize the application of fertilizer, water and pesticides for precision farming.

Under Dr. Kriehn, Fresno State University has been investigating the advantages of wireless remote sensing in conjunction with UAS technology to transmit data from soil probes and other sensors in the field for automated data collection that is correlated against spatial GPS coordinates in the field and orthomosaic images. Between 2013-2019, Fresno State developed a low-power, embedded sensor platform that integrated temperature, humidity and moisture sensors with a Texas Instruments microcontroller to create an automated data collection system for almond orchards. The embedded platform stored sensor data on an integrated SD card until wirelessly transferring the data to a small UAS platform via a 2.4 GHz wireless radio.

A MEMS sensor was utilized to collect temperature and humidity data, and a Watermark 900 Soil Moisture monitor and sensors were used to collect soil moisture data which was then communicated to the microcontroller using standard electronic communication protocols. A GPS receiver was also used to date, time and location-stamp the data. After data was collected at specific (and re-configurable) time intervals, the microcontroller was placed in a sleep state to minimize energy consumption of the sensor platform. When data was ready to be transferred to the UAS drone, the microcontroller woke from the sleep state, read data from the SD card, and transmitted the information to the UAS platform using the wireless radio.

Additionally, Fresno State developed and refined necessary networking and communication protocols to ensure the ground sensor nodes could communicate effectively with the central "mother" node on the UAS platform for smoother automated data collection. Multiple field tests were conducted to test and validate the system, which lead to refining software protocols including GPS and a real-time clock for long-term data synchronization. Statistical delays were also added to the ground sensor nodes to avoid data collisions or data loss when multiple nodes received a wake-up chirp for data transfer and attempted to communicate with the UAS simultaneously.

The first field prototypes were successfully demonstrated during educational drone field days at farms in Riverdale, Calif. and near Los Banos, Calif. under the support of a UC-ANR grant in conjunction with UC Merced and the UC-ANR Cooperative Extension.

It is therefore anticipated that the continued integration of embedded sensor technology, advanced multi-spectral imagers, autonomous flight and data collection, next-generation UAS platforms with beyond line-of-sight navigation and collision avoidance systems, and sophisticated data analysis tools will increasingly allow farmers to optimize their yields while allowing for sustainable farming practices due to increased pressure on the world's natural resources.

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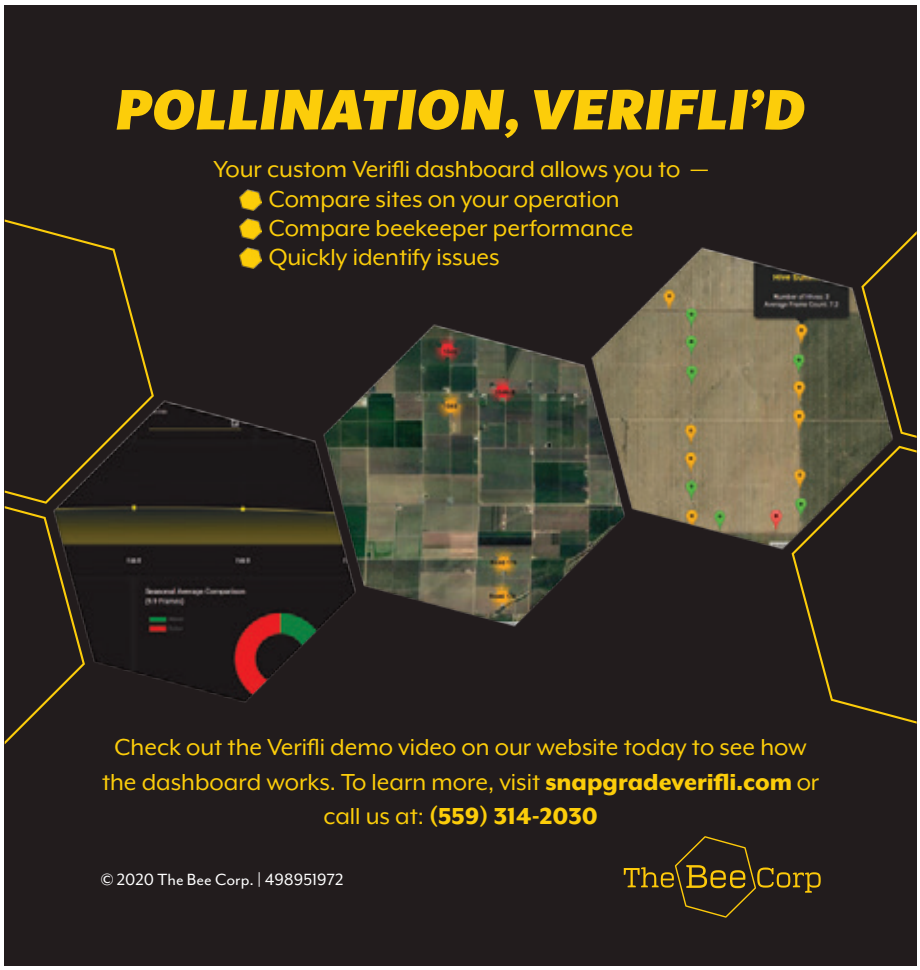

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ADVANCING CROP NUTRITION TECHNOLOGIES

for Increasing Nutrient Efficiency

By **SETH HANSEN** | *CCA Contributing Writer*

Bountiful uses multiple data sources for the machine learning model to forecast yield by field (photo courtesy Bountiful Agriculture.)

AS THE 2020 SEASON DRAWS TO A CLOSE, HOPEFULLY you and your agronomist have a chance to review the season and plan for 2021. It has certainly been a challenging season with a wet and cool Spring, COVID-19 disruptions and late, intense heat waves. Although it would be nice to put a difficult season behind us and start fresh, we must remember that for the crop, next year's start is dependent on how this season ends.

This is definitely true of crop nutrition as both nutrients and carbohydrates will be stored for utilization next spring. Early- and mid-season tissue samples as well as Fall soil samples, visual observations and yield numbers are integral to the evaluation process. With this valuable data in hand, post-harvest applications can be planned to help your orchard recover from harvest, store nutrients for the coming season and address soil deficiencies or imbalances.

It is also a great time to identify opportunities for improving your nutritional program next season. Perhaps you observed a great nut set this spring and determined your nitrogen rates based on projections for a heavy crop. In many areas, it appears that kernel weights are down, and therefore your application rates may have overshot crop demand. This ultimately resulted in a lower nitrogen use efficiency and wasted money on fertilizer. What can you do to determine the crop demand with greater accuracy next season? Maybe you applied an insufficient nitrogen or potassium rate since fertilizer rigs were unable to enter wet fields once March and April rains started. How can you prepare to be more timely with your applications next season?

Technology exists today that will help you dial in your crop nutrition program to maximize use efficiency, ease of application and ultimately hit those target yields.

Yield: The Moving Target

As an experienced grower, you know your fields and you know what yield numbers you should be able to achieve. You also have a good sense for what looks to be a "light" or "heavy" crop, and probably a good memory of previous production. But how accurate are your estimates? If you are accustomed to measuring yield by the number of truckloads from the field, what if weights are down? If you miss your estimate by 20-30%, you may have also missed your nitrogen rate by 20-30%.

It is not surprising that yield can be an elusive target. First, yield is not easy to measure.

Second, field conditions are constantly changing, and factors such as frost, pollination, pest damage and irrigation can impact yield during the season. To become more precise in meeting the nutritional demands of the crop, it is important to forecast the yield accurately and adjust fertilizer applications accordingly.

One company working to assist growers with this challenge is Bountiful Agriculture. Megan Nunes, Bountiful's founder and CEO, explained that starting in 2015, they began using data science to forecast with greater accuracy by processing location, weather, imagery and historical production data.

"We basically give you the yield potential range with the median point of what our model is estimating yield in a given field is going to be, and the

Continued on Page 36

> "Regularly inspecting and maintaining the irrigation system, carefully scheduling fertigation events and monitoring crop irrigation demand will pay dividends in your nutritional program."

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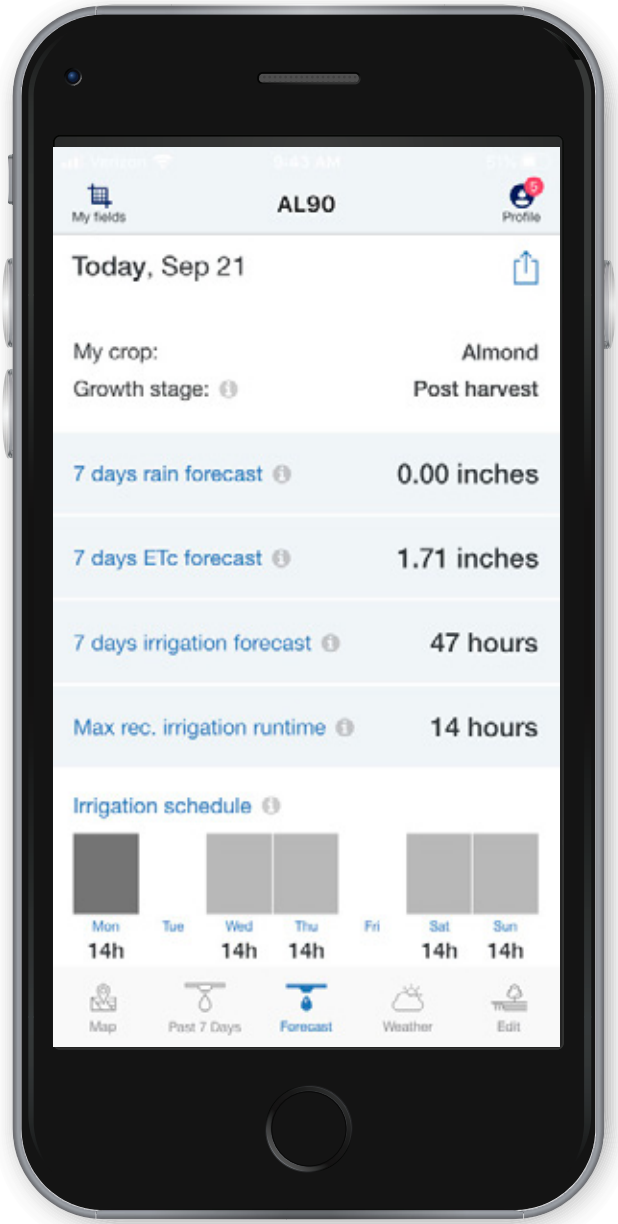
Continued from Page 35

spread of 90% probability where yield is going to end up," Nunes said. "So, when you are visualizing things in the field, you can contextualize that with a number based off of a robust machine learning assessment of yield."

Their team provides these forecasts at four points during the season in almonds, with walnut and pistachio support coming soon. There is still much work to be done, including relaying the information to different people on a farm management team.

"You're trying to figure out how to build something that works for multiple people, but each of those people making decisions want to see the information from a different viewpoint because they are going to use it a little differently," Nunes said.

If growers can get better yield forecasts, disseminate the data in a usable format to their team and respond to changes in season, there is the potential to make gains on nutrient efficiency.



Farm Water Advisor provides localized Crop Evapotranspiration at your fingertips (photo by S. Hansen.)

Water is Key

Research has clearly demonstrated the importance of irrigation management in relation to crop nutrition. For nitrogen particularly, poor irrigation management can result in poor use efficiency and nutrient losses from the field. Therefore, it is extremely important that growers focus efforts not only on fertilizer application rates, but also on application timing and method.

Scott Warr, Commercial Manager for Digital Farming at Yara North America, found this to be an area where better digital tools could help. Working closely with growers and advisers, Warr found that they recognized the importance of irrigation management, but they acknowledged there was still a need to improve their management. Yara, a fertilizer company, responded to this need by developing an irrigation scheduling app called Farm Water Advisor.

"What we've done is provided a very precise crop evapotranspiration calculation based on a specific field, crop type, soil type, tree size and hyper-local weather data to determine crop demand," Warr said. "We're using this crop water demand, specific to the field, to generate an irrigation schedule to maximize water utilization."

By maximizing water utilization, growers have a better chance of also maximizing nutrient utilization.

Warr is quick to note that the tool is not a replacement for other in-field observation tools like manual probing or soil moisture sensors, but it does give a very localized, baseline estimate of crop

demand and a schedule based on the irrigation system specifications. He hopes that Farm Water Advisor's ease of use and precision will allow many growers to make improvements to their irrigation management, and see the beneficial impact that has on their crop nutrition program as well.

Fertigation's Capabilities and Limitations

With many nut growers operating or converting to drip irrigation systems, a significant percentage of nutrient applications are being made through those drip systems. The use of fertigation systems has grown dramatically over the last 10 to 15 years, and advanced automation equipment is available to schedule, control and monitor those systems.

Phil Bartel, President of Streamline Irrigation in Kingsburg, Calif., emphasizes the importance of tailoring systems to the grower's needs. He states, "The first thing to address is what your goals are. If you want to schedule an injection every 10 days or 2 weeks, we can set up a simple system that is scheduled through the online platform or controlled manually, and build in failsafes to protect the system from issues like a pump failure, for example."

In more complex systems, it is possible to inject multiple products more frequently, or automatically inject proportional to the flow of water. Bartel also stressed that by avoiding overly complicated systems, growers can save money and reduce the risk of equipment breakdowns.

However, just because a field has a fertigation system installed, it does not mean that optimal nutrient applications are being made. Growers need to diligently maintain their irrigation systems as performance issues that affect irrigation uniformity and efficiency will also affect nutrient use efficiency. Imagine a situation where all of a field's nitrogen is fertigated during a season. If the distribution uniformity falls to 70%, that means your fertilizer application uniformity is at most 70%. The use efficiency could be much lower. Regularly inspecting and maintaining the irrigation system, carefully scheduling fertigation events and monitoring crop irrigation demand will pay dividends in your nutritional program.

Putting It All Together

More accurately determining your crop yield and water demand, paired with a properly designed and maintained fertigation system, can make huge improvements in your nutritional programs. Combined with periodic soil and tissue samples to verify nutrient levels, you can achieve a high level of confidence you are supplying what your crop needs to maximize yields.

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

PRESSURE CHAMBER GAUGES TREE WATER STRESS, HELPING FINE-TUNE ORCHARD IRRIGATION

By **VICKY BOYD** | *Contributing Writer*

Running the Pressure Bomb Express program on a tablet (photo courtesy Pressure Bomb Express.)

Testing the stem water potential of an almond leaf using the pressure chamber, also known as the pressure bomb (photo courtesy Pressure Bomb Express.)

UC Davis Plant Sciences Professor Ken Shackel, who has spent much of his career working with the pressure chamber, thinks of the device as measuring the "blood pressure" of plants. Unlike blood pressure, which is taken when a person is resting, pressure chamber readings are taken during midday when the tree is most active in pulling moisture through the xylem into its leaves.

Although Shackel has been a staunch promoter of the device since the early 1990s, he said the industry has been slow to catch on. A recent survey by the California Department of Food and Agriculture's Fertilizer Research and Education Program noted about 16% pressure chamber use in perennials.

"I've been saying, 'This is a really good tool,' but it's really taken a lot of time to catch on," he said. "The main resistance to it is people regard it as a scientific instrument and say it's too detailed. There tends to be a little bit of bias against a monitoring tool that requires hand labor."

The device's utility wasn't lost on second-generation nut grower Ryan Kaplan, who saw the pressure chamber put to use about eight years ago in a Butte County walnut orchard. The trees were suffering from Phytophthora and other health issues.

UCCE Farm Advisor Bill Olson, who has since retired, pulled leaf samples to analyze with the pressure chamber and found they were at -2 or -3 bars on a hot day – a sign of over-watering.

Kaplan said they had been using evapotranspiration and soil moisture probes to time the irrigations, but subsequently added pressure bomb readings.

"The pressure bomb tells you exactly how the tree is doing based on many scientific studies done by UC," he said.

The following year, the orchard was much improved. During the next few years, yields climbed to 8,000 pounds per acre from 5,000 pounds per acre.

"At that point, I was sold on the benefits and started using it on all of our crops," said Kaplan, whose family also grows almonds, pistachios and prunes. "But I was held back by the amount of time and effort it took to calculate and interpret all of the collected data for each orchard."

To that end, he and a team developed the Pressure Bomb Express app that helps manage the information and produces an easy-to-use report.

Continued on Page 40

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Continued from Page 38

A Complementary Tool

Allan Fulton, a UCCE Farm Advisor emeritus in Tehama County, has worked with Shackel and his research group on pressure chambers for more than two decades to expand their applications. Like many other tools in agriculture, Fulton said he doesn't see it necessarily as a stand-alone, but instead as a complement to ET values and soil moisture sensor readings.

In addition, growers and orchard managers need to weigh their own experience irrigating specific blocks with pressure chamber results when deciding when to irrigate, he said.

Outside factors, such as forecast ET rates and well output, also may play into irrigation scheduling.

"You have to make some judgment calls on what's going on, and that's where there's some art," Fulton said. "With one year under your belt, you should start to figure out where the boundaries are."

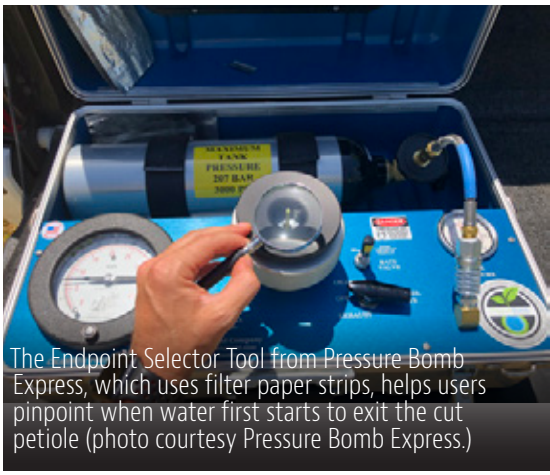
During this tenure, Fulton has seen increased use of pressure chambers, especially since the 2015 drought. Since 2000, UC studies that validated additional pressure chamber applications also aided adoption.

Wait to Irrigate

Take walnuts, for example. UCCE Integrated Orchard Management Walnut and Almond Specialist Bruce Lampinen and Shackel found many growers were irrigating too early in the spring, reducing the development of deep roots needed to mine water later in the season. As a result, trees had shallower root systems, and many that had yellow leaves were diseased.

By waiting to irrigate until the trees were mildly stressed based on pressure chamber results, typically mid- to late-June, the trees were healthier.

"I remember the first walnut meeting where we told growers we were waiting over a month to start (irrigation), and nothing happened to the trees," Shackel said. "What's been surprising in walnuts is the amount of time you can wait and actually let the soil dry out. In fact, it tends to have beneficial effects. It's not even much stress early in the season. All we did was wait until we were showing just a little bit of stress – just -1 to -2 below baseline."



The Endpoint Selector Tool from Pressure Bomb Express, which uses filter paper strips, helps users pinpoint when water first starts to exit the cut petiole (photo courtesy Pressure Bomb Express.)

Pressure chambers aren't used as much in pistachios because a latex-like sap complicates determining when the water just begins to appear at the cut edge of the petiole. But UCCE Orchard Systems Specialist Giulia Marino, who's based at the Kearney Agricultural and Research Extension Center, is developing an easy fix to the issue.

What is a Pressure Bomb/Chamber?

A pressure chamber, also known as a pressure bomb, works by applying air pressure to a leaf inside the chamber. Only a small part of the leaf stem or petiole is outside the seal. The amount of pressure it takes to cause water to begin to appear at the cut edge of the petiole tells you how much water tension the leaf is experiencing.

The more pressure it takes, the higher the tension value and the higher the water stress. The readings are expressed as negative values, which can also be thought of as a water deficit. Researchers refer to this as the "stem water potential" or SWP when the leaf has been covered and prevented from losing water for at least 10 minutes before sampling.

A handful of companies manufacture pressure chambers, and they come in two basic models. The hand-pump relies on the user to manually increase the pressure within the chamber. Although it is cheaper to purchase, using it to sample multiple orchards may be too slow and not enable enough sampling, Fulton said.

As a result, most users favor pressure chambers that rely on a tank of welding-grade nitrogen to create the needed pressure.

Pressure Chamber Use in a Nutshell

Based on years of research, UC recommends sampling between noon and 4 p.m. when the tree is experiencing the greatest stress. Solar radiation, air temperature and relative humidity are also the most stable during this period.

Select trees that are representative of the orchard. They should be healthy, the same variety, the same size, have undergone the same pruning regimen and be planted on the same soil type as other trees. These same trees, which can be flagged, marked with paint or GPS-tagged, should be sampled throughout the growing season.

How often to sample depends on a number factors, including labor availability, orchard acreage and other cultural practices. Ideally, UC recommends sampling just before irrigation and then one to two days afterward to gauge how the trees have recovered. In almonds, select leaves that are in the interior shaded portion of the canopy. In walnuts, use leaves from the lower interior shaded portion of the tree.

Small Mylar or plastic bags are placed over the selected leaves while still on the tree for at least 10 minutes to allow for equilibration. Carefully cut the stem using a razor, knife or other sharp object. Place the stem end into the pressure chamber cap with ideally 1/8 to 1/4 inch sticking out. Then put the bagged leaf portion into the pressure chamber canister and tighten it into place.

As pressure is applied, watch the stem end for water just


A grower tests an almond leaf for SWP (photo by Marni Katz.)

beginning to glisten on the cut end of the petiole. Shackel recommends using a hand lens with 7x magnification to help pinpoint when this occurs. The results are reported as negative bars.

SWP levels ranging from -4 to -8 in walnuts typically indicate low to moderate tree stress conditions. Low to mild SWP levels in almonds range from -10 to -14, while readings of -14 to -18 indicate moderate stress used during hull split to reduce hull rot and improve nut removal.

Continued on Page 42

Continued from Page 41

Environmental conditions, such as temperature and relative humidity, also affect what normal or "baseline" pressure chamber values would be in a fully irrigated orchard. UC has tables for download (https://bit.ly/3b1C9KF) that calculate baselines based on temperature and humidity. A website is also available (https://bit.ly/3iefQTT) that provides these values for the last six days for any of the CIMIS weather station locations.

The growth stage during the season also will influence the amount of stress desired, particularly in almonds when moderate stress shortly before hull split reduces hull rot and promotes more even nut removal.

There's an App for That

If these calculations seem confusing, you're not alone. Kaplan, the second-generation nut producer, was in a similar boat when he expanded use of pressure bombs in their orchards more than four years ago.

He tried compiling pressure bomb results with baseline information, temperature, relative humidity and other factors in an Excel spreadsheet, only to find out it didn't simplify matters.

"If it's really hot and humid or really cool, the baseline will be different," he said. "If you don't figure in the baseline each time you take readings, the numbers that come out can really throw you off."

The Pressure Bomb Express app he helped develop can be run on a smartphone or tablet. Users enter the temperature, relative humidity and pressure bomb result as they take a reading.

Drawing from years of UC pressure chamber research, the app then builds a report showing the level of tree stress and recommendations with the baseline and crop specific seasonal growth stages already factored in.

The Endpoint Selector Tool from Pressure Bomb Express, which uses filter paper strips, helps users pinpoint when water first starts to exit the cut petiole (photo courtesy Pressure Bomb Express.)

"You can see which ones are stressed, which ones are in the sweet spot and adjust your irrigation instantly," Kaplan said. "It totally streamlines the process."

The app is available through a subscription, which includes updates and training. It runs about $1 per acre. For more information on Pressure Bomb Express, visit pressurebombexpress.com.

For more information on using pressure chambers, also known as pressure bombs, download https://ucanr.edu/datastoreFiles/391-761.pdf.

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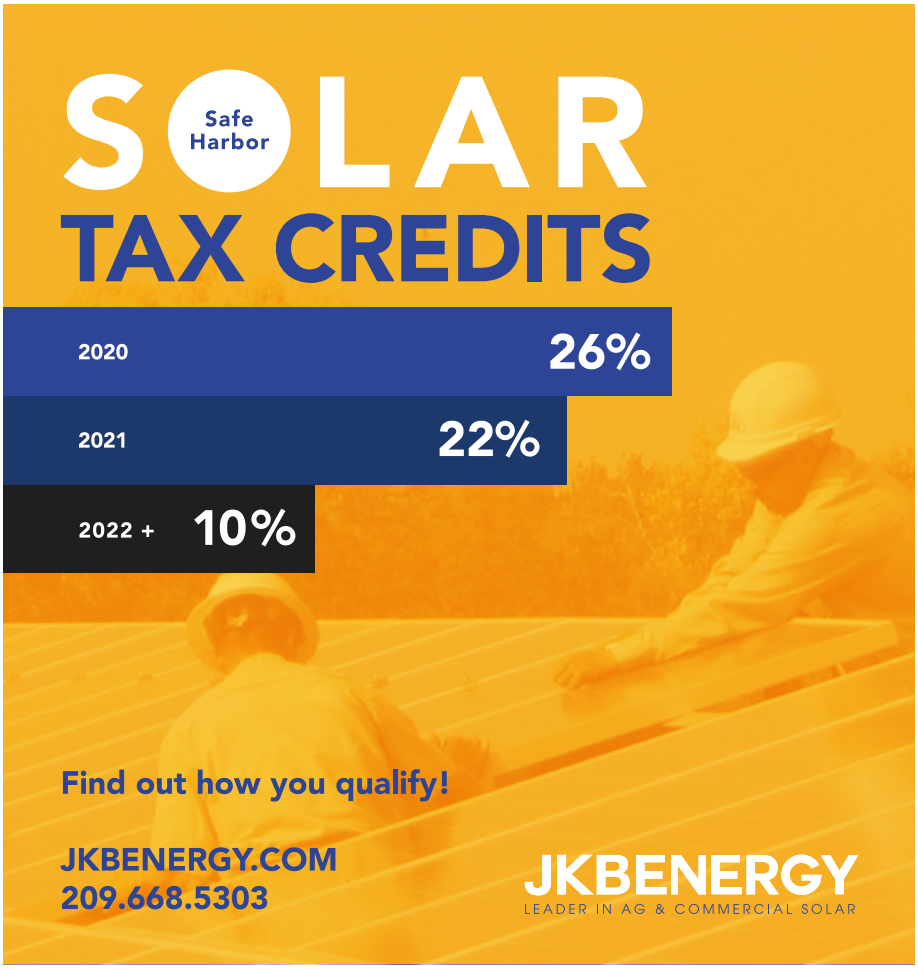

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The Role of Irrigation Technology in Your Future Orchard

Drought and regulations continue to put pressure on almond growers to achieve more crop per drop (photo courtesy Almond Board.)

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

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With the sting of California's latest drought still in memory and the state beginning to clamp down on groundwater use, maximizing every "crop per drop" of water has never been more important. This reality, in fact, helped propel the almond industry to announce its Almond Orchard 2025 Goals – one of which is to reduce the amount of water needed to grow a pound of almonds by an additional 20%.

To achieve that goal and continue improving water use efficiency for years to come, industry members throughout the state will increasingly look to advanced irrigation technology to help adequately address trees' needs and ensure optimal productivity.

In fact, it's likely that growers will rely as much on artificial intelligence as they do their own experience. In-field data on soil moisture and texture, spatial variability, and weather information collected by remote sensors or pressure chambers could be combined with aerial imagery that captures plant vigor or water stress to provide real-time analytics on an orchard. Similarly, computer algorithms could help growers make scientifically informed decisions about how much, at what frequency and where to apply water across the orchard. Many of those components

Continued on Page 46

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Continued from Page 44

are already accessible and being used today in orchards up and down the Central Valley.

Glimpse into the Future

Almond Board of California (ABC) is looking to support the industry in its efforts to implement more advanced technology by helping growers understand how new technology can lead to solutions among other strategies. At the heart of finding and honing in on irrigation solutions are two key factors: the rapid advancement of commercial precision farming technology and an understanding of almond tree growth and what drives yield.

"Smart irrigation management will consist of a combination of hardware and software that will allow almond growers to make precision irrigation decisions," said Sebastian Saa, Associate Director of Agricultural Research for ABC.

Within the next decade, Saa and ABC's Senior Manager of Field Outreach and Education Tom Devol foresee growers adopting the following advanced practices and technologies:

Measuring actual evapotranspiration (ETa) – the amount of water a tree actually uses – to more effectively calibrate irrigation needs.

Fine-tuning yield forecasts to create more precise irrigation plans that determine how much water is needed to maximize production.

Applying different volumes of water to be applied in different parts of the same orchard via improved technology.

Implementing additional improvements in water use efficiency due to Sustainable Groundwater Management Act (SGMA) factors.

Devol said that while many growers already use some form of today's irrigation technology, enhancements in software and standardization of certain metrics will make it easier to aggregate and analyze the data to better support an orchard's needs.

"There are pieces of the larger irrigation improvement puzzle being implemented now in different forms," he said. "For instance, remote imagery is becoming more common. There are a number of companies that provide that service – they send satellite images to growers every couple of weeks."

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The Role of Research

For nearly 50 years, ABC has been investing in irrigation-related research, recognizing the role growers must play in sustainably managing water resources in California. In the last five years alone, ABC devoted almost $4 million to irrigation research, encompassing 21 projects (eight of which are ongoing.)

"We seek to play a catalytic role in how irrigation in the orchard of the future evolves, connecting the expertise we have supported through public sector research with the growing arena of commercial technology innovation," Saa said. "We expect this to result in the development of better instruments, software and hardware that provide a more reliable and user-friendly experience by really understanding the almond ecosystem."

Saa said grower-related data on irrigation techniques

In the last five years alone, ABC devoted almost $4 million to irrigation research, which has helped growers implement water saving technologies (photo courtesy Almond Board.)

and water use provided through ABC's California Almond Sustainability Program (CASP) is critical for researchers as well as the companies who make irrigation equipment as it provides insight into what practices growers are conducting and what tools they're using to do so.

The data also influenced multiple discussions among ABC's Irrigation, Nutrients and Soil Health Workgroup members, who identified several factors that must occur in order for the orchard of the future to take shape. Elements that are outlined in ABC's Strategic Plan on Irrigation:

Growers must be less confined by water district schedules that influence when and how much water is available, as these schedules limit the flexibility of scheduling and can affect the feasibility of variable fertility application.

Utility companies compel growers to schedule irrigation around off-peak times for economic reasons. This can strain the ability to meet water demands during the hottest time of year, when the trees have higher water requirements than other times of the year.

Growers would benefit from having better recommendations on when to start irrigating (in early spring) and when to stop irrigating (by the end of

Continued on Page 48

Continued from Page 47

the growing season).

The industry's low adoption of pressure chamber use demonstrates the need for more user-friendly devices that provide data on plant water status.

ABC's Irrigation, Nutrients and Soil Health Workgroup members charted a research path that focuses on ETa, the continued development and application of remote sensing technology, and improved methods to measure spatial variability.

"We're also interested in finding the breaking point between tree water demand and the tree energy needed to support predicted yield early in the season," Saa said. "We envision that the results in this area will provide the means to make decisions on how much to irrigate given a certain crop load and thus translate into water-saving capabilities."

Growers interested to learn more about the work of ABC's Irrigation, Nutrients and Soil Health Workgroup are invited to attend an upcoming meeting. Visit Almonds.com/Events for meeting information.

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1) University of California, 2010. Food and Agriculture Organization of the United Nations, 2012. Almond Board of California, 1990-94, 2000-14.

2) 2019 California Almond Sustainability Program (CASP) data.

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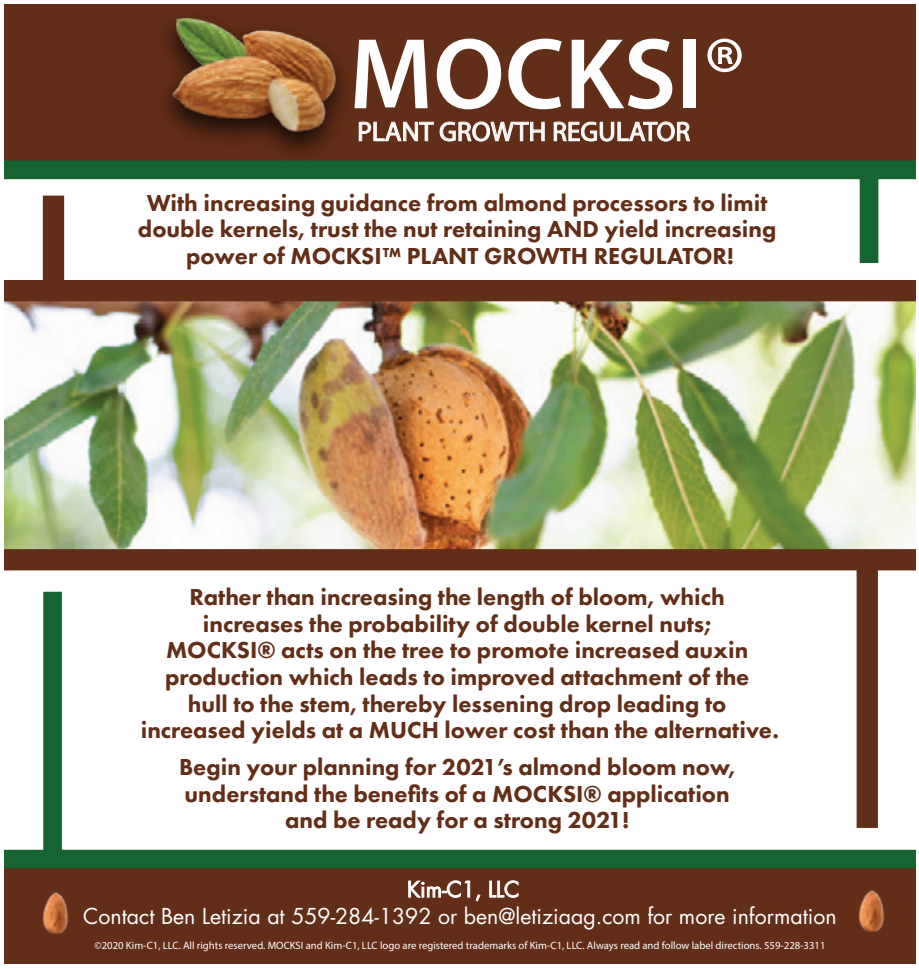

Fulton's Career Helping Growers Achieve 'More Crop Per Drop'

DURING HIS 32-YEAR career in California agriculture, retired UCCE farm advisor Allan Fulton played a pivotal role in helping growers, particularly those in the almond industry, better understand how to effectively manage water to ensure maximum yield while achieving "more crop per drop."

Fulton was on the cutting edge of important research that led to measurable improvements in irrigation efficiency and overall knowledge of trees' water needs, including research that led ABC to create the Almond Irrigation Improvement Continuum, a 149-page comprehensive manual packed with information on irrigation management and scheduling practices for growers.

ABC and West Coast Nut magazine would like to recognize and thank Fulton for his many years of service to the industry, and wishes him all the best in the next stage of his journey.

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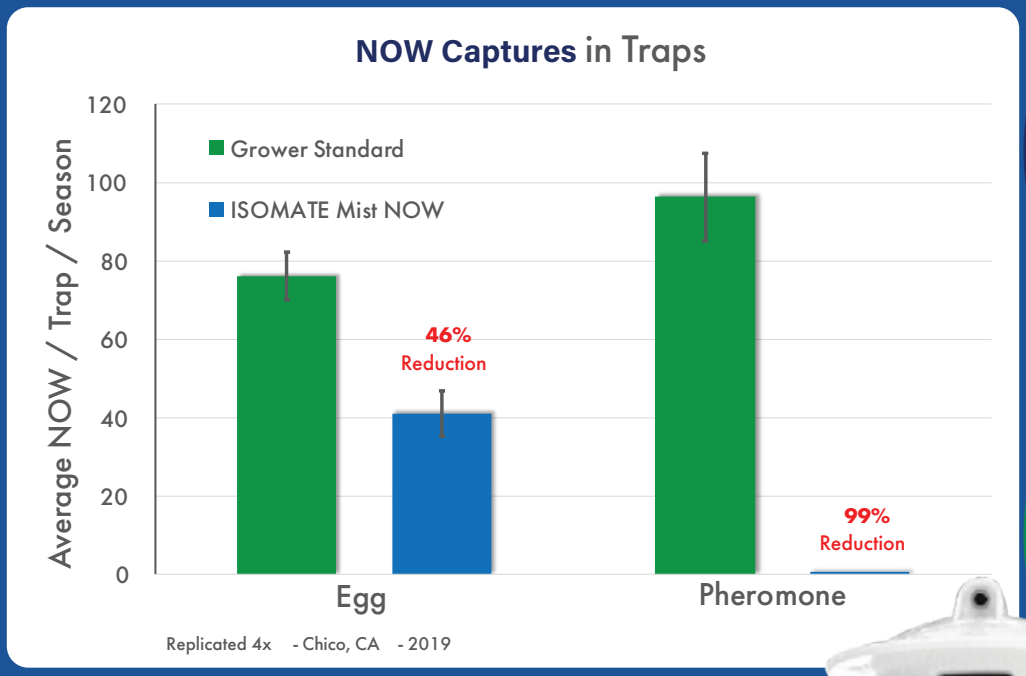

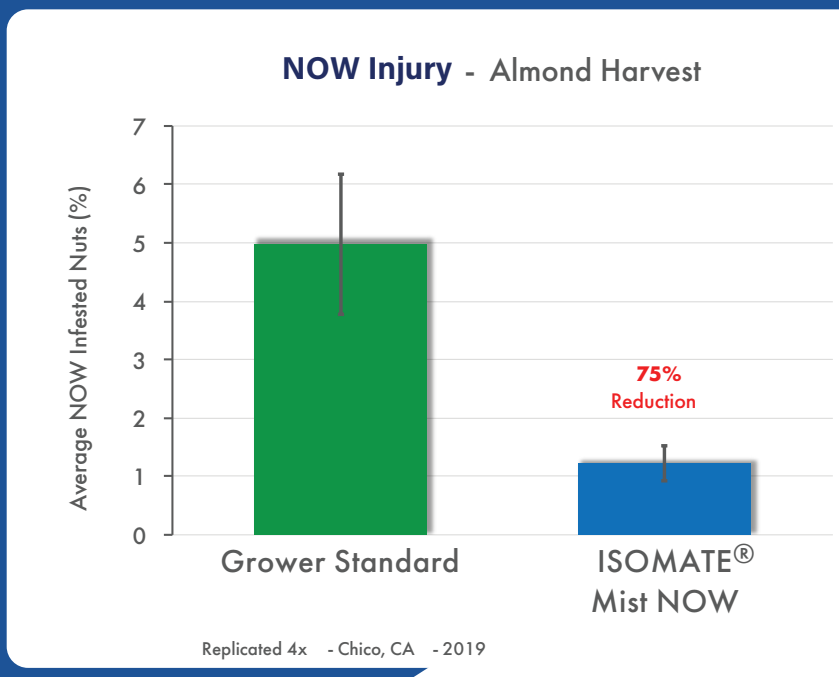

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DIAMOND OF CALIFORNIA TAPS INTO THE UNDERDEVELOPED MARKET FOR SNACK WALNUTS

By **CRAIG TOKUSATO** | *Chief Marketing Officer, Diamond Foods*
Contributing Writer

Growing increasingly popular as a snack food, walnuts are the only nut significantly high in Alpha-Linolenic Acid (ALA) Omega-3. (all photos courtesy Diamond of California.)

DIAMOND OF CALIFORNIA IS PAVING the way to help energize the ready-to-eat (RTE) snack nuts category in walnuts with its latest product: Diamond of California Snack Walnuts. The product's tagline, "walnuts made for snacking," sounds simple and familiar, but no major national snack or nut brand has solely featured the superfood nut, let alone debuted with eight flavors and distribution on a national scale.

Targeting Snack and Wellness Trends

The 108-year-old Diamond of California is uniquely poised to help grow this underdeveloped market due to the company's strong agricultural foundations, rich culinary history and brand expertise. As a century-old company exclusively offering culinary nut and ready-to-use pie crust products, Diamond of California initially discovered that many of its consumers were buying culinary nuts and eating them as snacks on their own. With this insight in mind, we decided to learn more about this quickly growing and ever-evolving market.

In March 2018, *The Keynote Report on Snacking* evaluated the snack market at $150 billion, with projected growth of an additional $30 billion by 2022. Just two years later in 2020, the Kelton Global Snacking Survey reported that nearly all Americans (98%) eat snacks, with 70% of consumers snacking at least twice a day. In current times, about one in two Americans (49%) admit they

Continued on Page 52

Walnuts at Diamond of California are laser sorted (above) and later glazed for flavor and texture enhancement (below).

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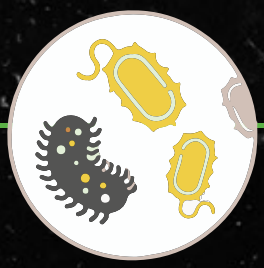

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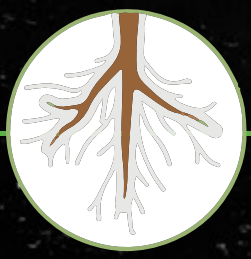

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Continued from Page 50

are snacking more now than before the COVID-19 pandemic began. These recent statistics made it clear that the demand for snacks will continue to grow, making it a viable market for brands to roll out new snack options for consumers.

Diamond of California's primary objective when developing its snack line was to uncover the types of snacks consumers are looking for. We learned 66% of consumers are looking for healthier snack options, but only 30% of consumers say the majority of snacks they eat are healthy[1]. This same report revealed that 54% of consumers want snacks that contain vitamins and minerals, 48% want high-fiber snacks and 47% want low-sugar snacks.

Taking all these facts into consideration, Diamond of California recognized a natural fit to create a product that would cater to consumer demand for nutritious, accessibly priced snacks that could be enjoyed on-the-go or as a meal replacement, a.k.a. snack walnuts.

California-grown walnuts are rich in protein, fiber, antioxidants, and are the *only* nut significantly high in Alpha-Linolenic Acid (ALA) Omega-3. Omega-3 fatty acids are necessary for health, but cannot be made by the body. They play vital roles in many bodily processes including inflammation, heart health and brain function. Walnuts have also been researched for their potential role in a variety of health outcomes, including cognitive function, heart health, cancer, diabetes, weight, gut health and reproductive health[2].

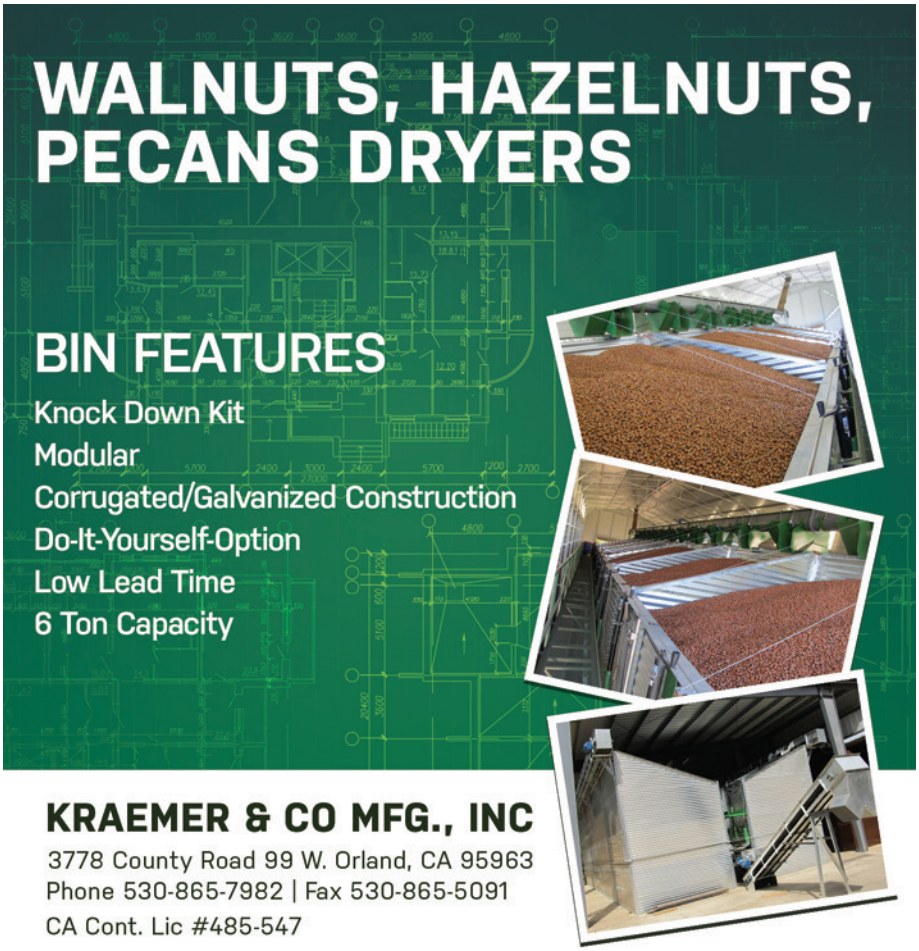
A California Walnuts Attitude & Usage Study in April 2019 found there is consumer loyalty to walnuts, as evidenced by the fact that "40% of households bought walnuts within the last year and 73% of consumers indicate they would buy walnuts and/or products containing walnuts today if they were available at an acceptable price. Consumers who do use walnuts eat them often, with roughly half eating them at least once a week."

The same study revealed that walnuts are most commonly eaten as snacks, followed by use in baking applications. Yet, the current leading snack nut brands primarily feature almonds, pistachios, cashews and peanuts. Specially commissioned market research for Diamond of California also indicates snack walnuts could serve as an incremental purchase to the RTE snack nut category for many consumers rather than just replacing their other brand snack nut usage. The success of future categories can also be studied with existing products. Snack almond sales by volume are five times that of unflavored culinary almonds, indicating the significant untapped long-term potential for flavored snack walnuts given the sizable existing market for unflavored culinary walnuts[3].

Improving Snack Quality

Walnuts are known for their rich and buttery taste, but also for their at-times more bitter notes, which some people may find disagreeable. Thus, Diamond of California pioneered a simple process to remove naturally occurring surface oils and tannins that contribute to bitterness. The walnuts are then roasted or glazed with real ingredients often found in home kitchen pantries using spices, seasonings and a range of natural sweeteners including cane sugar, maple syrup, coconut palm sugar and honey powder. The roasting or glazing processes serve the purpose of bringing out nutty flavor notes and enhancing the naturally crisp texture of walnuts. The nuts are then cooled and packaged in RTE resealable bags available at the affordable suggested retail price of $3.99 for a 4-ounce bag.

Many snack nut options might have higher than desirable levels of sodium, sugars and other ingredients, so when it came to the new snack walnuts, Diamond of California created a line that respects the goodness of nuts. The flavors are inspired by modern kitchen pantry ingredients and crafted using real ingredients that are mindful of sugar and sodium while complementing the natural flavor of walnuts. Americans are mostly torn when it comes to the perfect flavor profile of their snacks—the preference for sweet snacks (57%) currently edges out salty (43%)[4] — so we made sure to



The Diamond of California snack line will initially target domestic consumers.

A variety of flavor types allow for consumers to choose between salty and sweet snack cravings.

offer both sweet and savory options that are delicious and still nutritious.

Since 59% of adults prefer snacking to meals[5], our variety of flavors were designed to satisfy hunger and cravings at any time of day. The Cinnamon Churro, Diamond's twist on a cinnamon pastry stick, and Sweet Maple are better-for-you and energizing with a touch of sweetness for the mornings. The Himalayan Pink Salt, Teriyaki and Wasabi, Chile Lime, Hickory Smoked Bacon and Hot Honey are filling and savory/spicy afternoon options. For the evening, consumers can satisfy their cravings for sweet, comforting dessert profiles with Salted Dark Chocolate, Sweet Maple and Cinnamon Churro options.

Diamond of California is currently in the process of a strategic nationwide rollout of our Snack Walnuts. We began with select locations of major retailers such as Walmart, Kroger, Albertsons, Cub, Bartell Drug, Lidl, Big Y, HyVee, and also recently launched on Amazon. Snack Walnuts are slated to become available at additional national and regional retailers going into the holiday season.

While Diamond of California does sell its culinary walnuts and pecans internationally, we are currently focusing our efforts on the Snack Walnut line on the U.S. domestic retail market. With hopes for great success for the product on a national level, we can only hope for future opportunities to answer the unmet needs of more snack shoppers in the future.

Sources

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2. California Walnut Commission, 2020
3. IRI, MULO Dollar Sales for 52 Weeks Ending May 2019
4. Kelton Global Snacking Survey, 2020
5. Study cited by Fooddive.com, November 2019

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ARE YOU PREPARED FOR A CAL/OSHA COVID INSPECTION?

By **AMY WOLFE** | *MPPA, CFRE, President and CEO Emerita, AgSafe*

Cal/OSHA has identified agriculture as a priority for their strategic enforcement of COVID-19-related inspections.

EARLIER THIS SUMMER, CAL/OSHA began conducting enforcement inspections in earnest specifically focused on COVID-19. On Sept. 4, the agency announced the first group of agricultural employers to be cited and the proposed penalties, ranging from $2,025 to $51,190. Cal/OSHA considers agriculture a priority for their strategic enforcement. According to Cal/OSHA Chief Doug Park, "these are industries where workers have been disproportionately affected, and these citations are the first of many to be issued in the coming weeks and months." It is critical that agricultural employers understand and are prepared for what can transpire during a Cal/OSHA COVID inspection.

Elements of an Investigation

The practical reality is that a visit from Cal/OSHA specific to COVID should look and feel like any other agency investigation, with the exception being that the enforcement staff are specifically focused on the steps being taken to mitigate the risk associated with COVID. It is also critical to remember that while they are there to evaluate the business' COVID-focused efforts, it is within their jurisdiction to request details on any programs specific to worker safety and health. That being said, developing an Inspection Protocol Checklist covering the following areas will be the most effective way of ensuring all staff are prepared and respond appropriately:

- Visitor Arrival
- The Walk-Around
- Employee Interviews
- The Document Request
- The Departure Discussion
- After the Departure Discussion

Visitor Arrival

Whomever from the company that is responsible for greetings guests at the office or entrance to your business should politely welcome the investigator and then ask to see their official ID card and a supporting business card. All supervisors, foremen, crew leaders and other managerial staff should be instructed to look for visitors on the property in any location (office, shop, packing shed, supply building, fields, vineyards, orchards, etc.) If they encounter a visitor, the same first request should be made to see official identification, a business card and, in the case of individuals not at the office, ask that they travel to that location for further assistance.

The guest should then be asked about their purpose, including why they are there and what they would like to see. The designated organizational contact should be then be contacted and informed of the investigator's presence and stated purpose. It is reasonable to ask the individual to wait while the management designee arrives, and they should be seated in a communal, public area that is visible to others. Based on the purpose of the visit, the management designee may contact the company's legal counsel to inform them of the visit and, in turn, any directives provided by the lawyer should be followed. Additionally, ensure a request is made of the investigator to follow your company's COVID safety protocol, including wearing the appropriate PPEs and face mask covering, temperature check, complete a health screening questionnaire and washing or sanitizing their hands.

The Walk-Around

Once it is determined who will accompany the investigator, it is critical to consider the path that will be taken for them to visit all areas of the site that have been requested. Think clearly before departing where you and they will walk and drive, being mindful of the work currently being conducted. The agency team will be made up of any of the following: One or more inspectors; Measurement tools; Cameras; Union representatives (if applicable); and Employee(s).

The company team should be comprised of the following: The designated management representative(s) each with a notebook; Your Safety and/or Human Resources Manager, if that individual is not the designated management representative; An additional staff member to serve as photographer and note taker; and Your Shop Manager/Mechanic/individual capable to speaking to equipment-specific inquiries.

Understand that the investigator will want to have a clear understanding of how your business operates and in the context of COVID, how and where workers are taking breaks, washing hands, using hand sanitizer, and the types of barriers being used that allow for proper social distancing. Remembering these areas of focus are critical prior to the investigation taking place so you can provide proper evidence of the steps being taken.

Employee Interviews

An integral part of the investigation process is employee interviews. This allows the Cal/OSHA team to attempt to ascertain what the culture of the business is like versus what is described by management or laid out in written documents. As with the walk-around, thought needs to be given in advance to where interviews would be conducted, allowing for privacy from other employees. You may request to sit in on the interview, but prepared to be told no.

If you are allowed in the interview, remember the following:

- Take notes of what is discussed by both the Cal/OSHA team member and your employee
- Keep any comments you provide short
- Do not allow yourself to become part of the interview, in turn being perceived as guiding, influencing or even pressuring your employee
- Do not offer additional information outside of what is requested by the investigator, in turn assisting them in their duties unnecessarily

If you are not allowed in the interview, keep these details in mind:

- Make a note to talk with your employee later but not so long afterward that they may not remember details: What were they asked? What did you say? What was the investigator interested in learning?
- Remember that our workforce tends to be leery of any government official that is questioning them, which leads to mischaracterizations or misstatements. It is important to remember not to retaliate against any employee for the information provided during an investigation of any type, Cal/OSHA or otherwise.

The Document Request

Cal/OSHA may contact you prior to their onsite visit, requesting a wide variety of occupational safety and health related documents. Alternatively, they may make that request when arriving to your operation. In either case, consult with your legal counsel prior to turning over any documents. In the case of the COVID investigation, be prepared to provide these documents:

- Injury and Illness Prevention Program (IIPP)

Continued on Page 56

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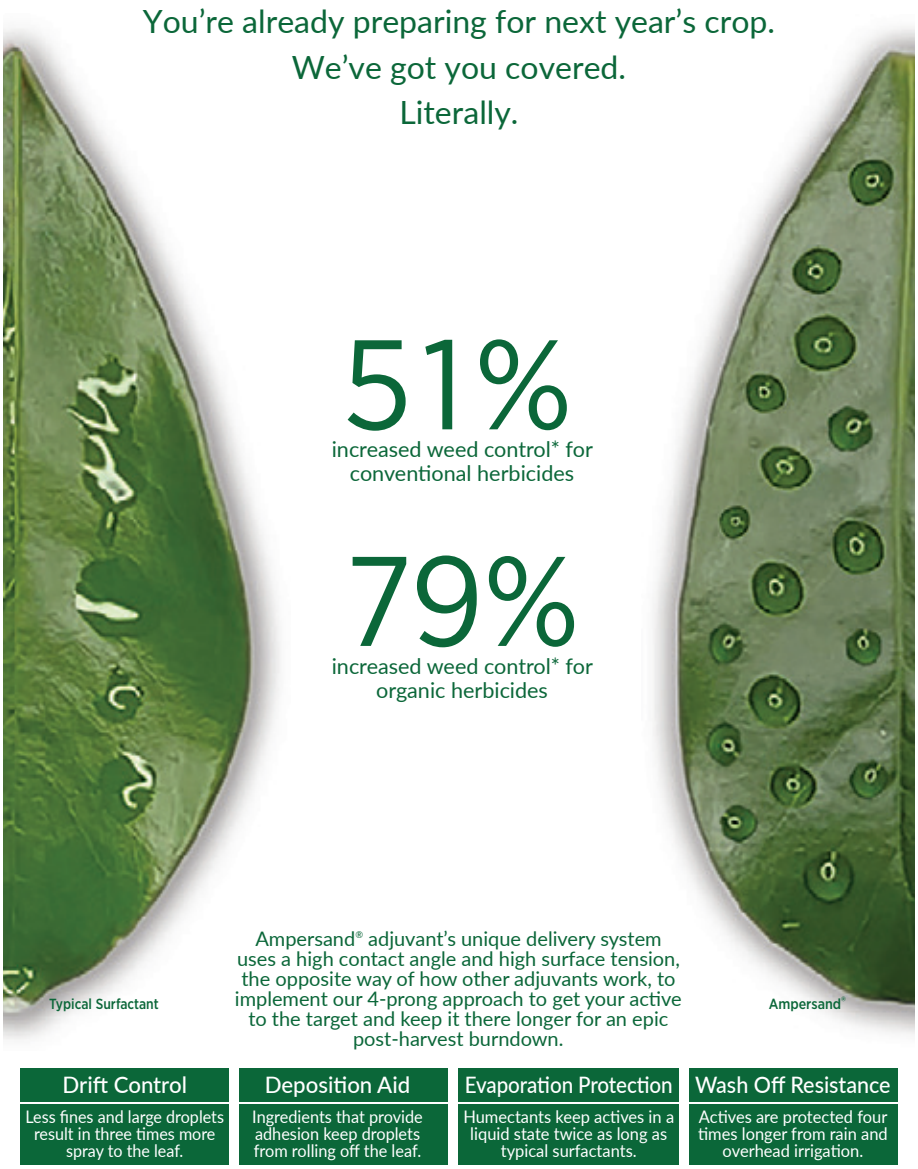
- COVID-19 IIPP Addendum
- Log 300
- Employee and supervisor safety training records, specifically COVID-safety training documentation

Remember, while they agency is there specific to reviewing COVID, they may also inquire about any and all other worker safety programs. Do not be surprised if they ask to see the Heat Illness Prevention Program and accompanying worker training documentation, equipment safety training records and field sanitation documentation, amongst others. Ensure that you are clear on who should receive those documents and the deadline for when documents must be provided.



The Departure Discussion

Ideally, the management designee and other staff have maintained a professional, courteous demeanor throughout the Cal/OSHA visit. As their onsite work comes to a close, use that opportunity to ask questions and thoughtfully listen. Inquire about what was found, the citations being considered, the regulations specifically being referenced and any other details they can provide. Do not interject with explanations, defending your position or offering to fix issues on the spot. The investigators are required to follow a process and, as such, any efforts made to take corrective action should come after you have been notified of their official decisions.

After the Departure Discussion

It is essential to immediately act following the investigator's departure. First, assemble all staff impacted by the investigation. Conduct a team assessment of how things went, including capturing a list of all the questions asked of various team members, the answers they provided and the areas of concern raised by the inspectors. Then have each staff person document their interaction with the investigator.

After discussing with legal counsel, begin assembling all the requested documentation and providing records in a timely fashion. In addition, ensure that all photos of the process are downloaded and stored securely. Keep all notes, statements and other pertinent details in one secure location for access throughout the process. Ultimately, developing a plan to ensure you are prepared is the most critical step to be taken. Discuss what this could look like with your key staff and ensure the team knows how to respond. With the agricultural industry as a stated target of Cal/OSHA, this is time and energy well-spent.

For more information about worker safety, human resources, labor relations, pesticide safety or food safety issues, please visit www.agsafe.org, call (209) 526-4400 or email safeinfo@agsafe.org.

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Improper soil nutrition will lead to loss of nuts as seen in this almond bunch (all photos by R. Kreps.)

No "One Size Fits All" for Soil Nutrition

Consultants and Growers Must Work Together to Find a Tailored Solution

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

ONE OF THE GREATEST MARKETING TAG LINES OF ALL TIME IS "One size fits all!" That sure makes it easy to shop. Unfortunately, when you're a mountain of a man like me at 5'7" and 160 pounds, a typical trucker's hat is going to have to be cinched up like a 10-year-old wearing grandpa's belt to keep it from falling over my ears. Farmers keep looking for the silver bullet of one-size-fits-all as well.

One of my favorite questions from my clients this time of year is, "What do you do post-harvest?" Once a detailed prescription is calculated, the diagnosis is inevitably followed by a statement like, "Well, John does this and he consistently makes 300 pounds more per acre than me." I wish at that point I could just say, "Well then, do what John does and you don't need me." But of course, as consultants, we all have too much invested in our clients and their perceptions of us to just walk away and let them fend for themselves.

No Silver Bullets

There is a lot of information out there these days. Unfortunately, there are also a lot of companies trying to provide that one-size-fits-all approach to farming. Many companies have a specific product they sell and have done ample research on how it specifically works. "Three tons of this and you're golden!" Then the rep shows up from another company that has a different nutrient or amendment they sell saying, "Ten gallons of this and you won't believe the growth!" I will tell you as farmers, most consultants have the best intentions at heart and base their convictions on their personal experience and specific product marketing material.

Early in my career, I was guilty of this as well. I had seen products work beautifully at one farm, become immersed in my convictions that this was the silver bullet, only to have mediocre results at the neighbor's place. It took a few years to understand you had to have more pieces of the puzzle to solve most problems. Just making recommendations based on past experiences on other farms was like playing solitaire with a deck of 51 and wondering why you can't win.

The point is, most farmers have so much on their plate (labor, machinery, accounting, irrigation, logistics, etc.) that they don't have the time or energy to devote additional effort to nutrition. That's where they look to consultants to craft a program. So, how do we get the most out of our programs? Follow Reagans motto, "Trust but verify." The trust part is the hardest.

Start with Good Information

Putting on my consultant hat, we will dig in your ground to get a soil sample. We should pull tissues at different stages of the season and see what is getting into the trees. We need to know what is coming out of your water, both well and surface deliveries if you're lucky enough to have them. We need to adjust the nutrition with the size of the developing crop but keep it in line with the stage of growth. We need to follow the nutrient demand curves. However, we need more.

Wearing my farmer hat, we need to share with our consultants the last three (or more) years of yield data. How

Taking soil samples on client land for nutrient analyzation.

much did we make? What was the size and quality? How long were the irrigation sets? When did we start them? Did we adjust for ET? Do we have soil moisture probes? What did the orchard look like? Which products produced the desired responses? And most importantly, did we achieve our goals? I have had relatively new farmers be disappointed at the end of a season if yields didn't improve over the last year, only to find out they were way above the industry standard for that particular season. Remember, Mother Nature has more to do with our crops than we do. Even when we think we have done everything perfectly, some years are going to be a bit off if "Momma" isn't happy. But orchard health doesn't have to suffer if the crop does.

Trust but Verify

There is abundant research available on most nutritional products in the market today. Have your consultants show you instead of just tell you? Again, trust but verify. Then, ask why. What will this product do with, or to the other nutrients you have already applied? Have we over or underapplied other products that will affect this application? Are you missing anything in your program that the current consultant doesn't provide? Do you foliar or soil apply this nutrient? There are many calculations a consultant can make to get to an "ideal" soil constitution for your CEC. There are also many products that can help you get to that level. A good consultant will have no problem recommending other products they may not represent if it's the right thing to do.

Farming is hard. Don't make it harder trying to figure it all out by yourself. Trust in a good consultant. You need to know if they will go the extra mile for you even if they don't have the answers right now. Work together with them. Withholding information can lead to yields below expectations. You need a team to help you. The extra yield will more than make up for it. Even in tough years like this one, an extra 300 pounds of almonds per acre can pay for the majority of a fertility program. And 300 pounds extra per year for 25 years at even $1.75/pound is an extra $13,000 per acre. Don't leave that out in the field. You work too hard.

Share more information with your consultants to help them make you more successful. Don't just take a recommendation as the gospel because your neighbor does it. Trust but verify. Build your team to help you. One size won't fit all, but make sure the one you are trying on will meet your expectations and capitalize on your efforts.

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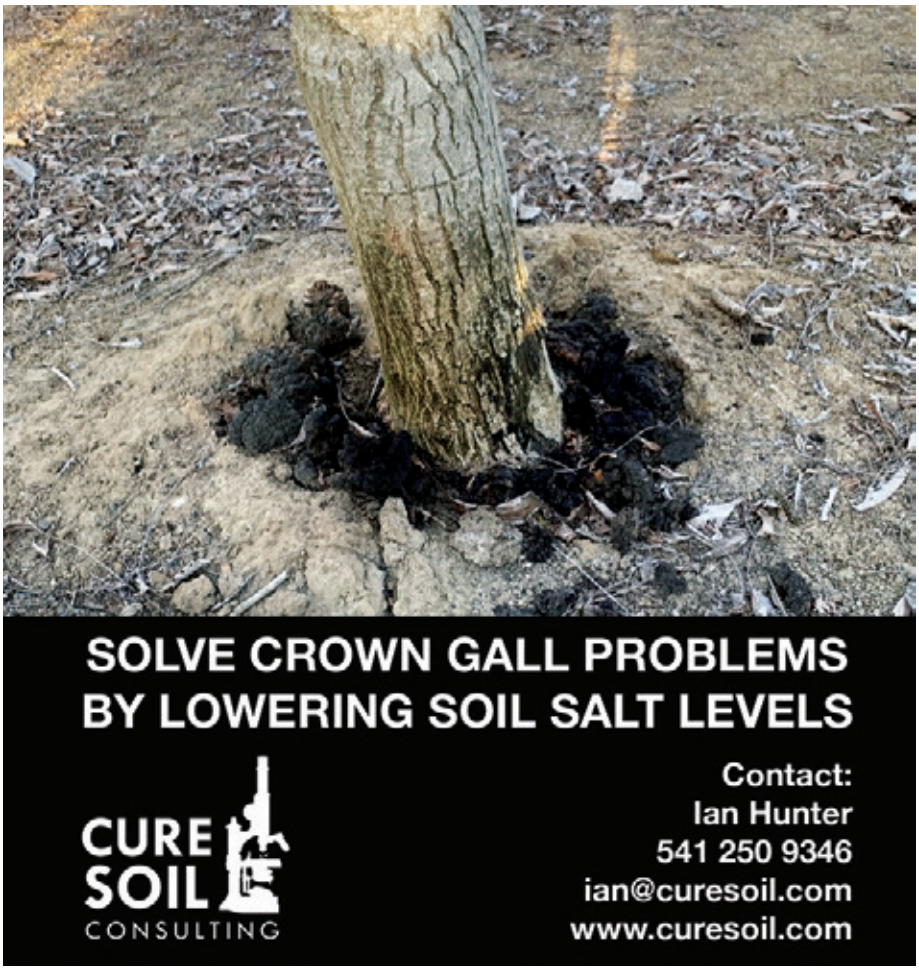


FARM ADVISOR PROFILE

KURT HEMBREE

WEED MANAGEMENT FARM ADVISOR

By **CRYSTAL NAY** | *Contributing Writer*

Kurt Hembree was one of the few remaining weed scientists left in UC Cooperative Extension before he retired in July 2020 (photo courtesy K. Hembree.)

GROWING UP IN SONOMA COUNTY, Kurt Hembree, M.S., weed management farm advisor with UCCE Fresno County, was surrounded by berries, apples, plums and other stone fruit. Though his father had grown up on a farm in Illinois, he moved out to California to leave the farm life and pursue a career in civil engineering, where he dealt with large wells and developed systems in both rural and urban settings.

But Hembree grew up to be interested in tree farming.

"We didn't have any annual crops. Just all trees, and not even vines at the time," said Hembree.

Though his initial intrigue was for animal science rather than plant science, Hembree made the switch and ventured south from Sonoma County to California State University, Fresno, where he received a bachelor's degree in plant science, and then his master's in plant protection. It was in one of his earliest courses that he studied with weed scientist Dr. Gary L. Ritenour and found himself on a path that would shape his career in research and agriculture.

"I was super excited about it. It was something completely different that I'd never been exposed to," recalled Hembree.

Shifts in Industry

It's been nearly 35 years since Hembree began as a staff research associate for the Fresno County extension, and over 25 years since he became a farm advisor for the same county. He's had a hand in developing new herbicide registrations and helped discover California's glyphosate-resistant horseweed and hairy fleabane. It has been over the last 20 years of his career that Hembree has seen some dramatic shifts in the industry.

The biggest change for him is the move from annual cropping systems to trees and vineyards.

"Geographically, when you look at it, you don't even see the same structures because it's all trees," said Hembree. "I could drive across from Fresno all the way to the west side, and once you got out of the [areas with vines], all of a sudden it was all open agronomic ground and vegetables. It's not like that anymore."

The changes in how crops are grown is a close second, followed by the staggering number of increased tree nut acreage every year.

As the growing environments change, Hembree has noticed growers and PCAs have become more progressive in their thinking, setting the bar much higher for everyone else.

"We've got some of the top-notch people, probably in the world," said Hembree. "It's very rare that we get simple questions anymore. I think it's awesome."

Retirement Leaves a Hole

Hembree—one of the few remaining weed scientists in Cooperative Extension—retired in July 2020. State budget cuts have left the future of Hembree's farm advisor position in limbo with the very real possibility of the position going permanently unfilled. Over the last few months, Hembree and others have been working to put together a position proposal that could support a regional person covering the whole of the southern San Joaquin Valley.

> "TALKING TO INDUSTRY FOLKS, PARTICULARLY IN THE NUT CROP BUSINESS, THEY REALLY NEED SOMEBODY THAT'S A (FULL-TIME WEED FARM ADVISOR) POSITION, SO WE'RE GOING TO PUSH FOR THAT. WE'VE GOT A LOT OF INDUSTRY SUPPORT TO HELP US."
>
> —KURT HEMBREE, RETIRED UCCE WEED MANAGEMENT FARM ADVISOR

For now, whom should growers contact regarding weed management?

"That's something we're trying to work out now," said Hembree. "Hopefully, some of our orchard and nut crop advisors will move in that direction a bit. I've been working with them closely, so at least they can address some of the basic issues."

While the UC system contains a healthy number of entomologists and plant pathologists, it's the opposite for weed scientists. This is problematic because—particularly for nut crops—there are still some majorly resistant weed species, such as fleabanes, that need to be more consistently controlled. Weed scientists receive a lot of calls, and there is still a lot of work to be done in this area of orchard management.

Without farm advisors specializing in weed management, growers will either be knocking down the last weed scientist's door, or resources will move into the private sector. The former is less than ideal, as that plate is full with other research and extension obligations. But having research move into the private sector can leave space for potential conflicts of interest.

"[These things] are why I think it's really critical that this is a must-fill position from my perspective," said Hembree. "Talking to industry folks, particularly in the nut crop business, they really need somebody that's a (full-time weed farm advisor) position, so we're going to push for that. We've got a lot of industry support to help us."

Many companies have field stations and conduct their own research. County agricultural commissioners also conduct educational outreach. This trend is expected to grow, and it ultimately comes down to whether or not growers will turn to the companies from whom they purchase products for the information needed on the best ways to manage their orchards.

"We've always been unbiased and tried to represent that. But this," said Hembree about research moving into the private sector, "might change that a little bit. [Growers] just have to have confidence that the results and efforts they're putting forth are straightforward."

Hembree may have retired, but he is hanging around the field for a little bit. The pandemic forced him to delay some of his plans, so he will likely be available for a couple of months following retirement to address any questions. This may even include encouraging growers to take a closer look at their weed management practices.

Over the last 10 to 15 years, Hembree has encountered many situations involving spraying modifications, particularly with ground spray equipment, which can create problems. He suggested growers should have equipment dedicated to weed sprays, along with applicators that are well-trained and well-versed in why it's important to have herbicides properly applied. It cuts down on potential losses, problems, litigations and other less-than-favorable outcomes.

"The more we can be on the same page with that, it really does make everybody happier," he said.

As Hembree wraps up his decades with UCCE, he's in the process of looking for his new home out of state and closer to family. With some acreage already awaiting his arrival, Hembree has some ideas for what comes next in retirement.

"I might buy myself a tractor and some equipment and just do some small farming or something. You just never know."

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

"PLAN BEFORE YOU PLANT" TO MAINTAIN SAFE SPACES BETWEEN POWER LINES AND TREES

By **JOHN BOLLING** | *Orchard Vegetation Program Manager, PG&E*

AS A NUT GROWER, EVERY TREE YOU plant is an act of faith and a considerable investment in your future. You toil endlessly in your orchard, arm yourself with the latest information and carefully plan to protect your crop and secure your livelihood.

Before you plant new trees, you'll eliminate the risk of tree removal by a utility crew and probably rest easier at night, too, by planning before you plant to avoid conflicts with high voltage power lines. PG&E works with growers to prevent hazards that lead to property loss and perhaps loss of life.

As a utility provider, our most important responsibility is ensuring public safety and a reliable supply of power by maintaining safety clearances between trees (and other vegetation) and our high-voltage power lines.

Each year, PG&E is required to inspect all transmission lines carrying 200 kilovolts (kV) and above. Our inspections are audited, and we will be fined if we fall short of complying with required standards for vegetation clearance.

Vigilant Monitoring

For all of those reasons, we vigilantly monitor our transmission lines for potential hazards using ground patrols as well as aerial remote sensing.

We continue to ask orchard growers to plan before planting and to contact us early. Working together, we can prevent potential injuries and tree removal by maintaining safe distances between trees and high-voltage power lines.

We'll respond to your request quickly. Within a few days, we'll pull the land rights, generate property maps and mark any incompatible planting regions in your orchard with pin flags. That frees you to plant, and plan, with confidence for the long haul.

PG&E also offers a Mature Orchard Incentive Program for Transmission Lines, which encourages orchard growers to remove their own nut-bearing trees under transmission lines. Growers can use the incentive to replant crops that are compatible with electric transmission lines or reinvest the funds according to their needs.

Planning Prevents Problems

Now that the current growing season is winding down, you may be considering new plantings for next season. Whether you're thinking of making an orchard exchange or replacing mature trees with new ones, now is the ideal time to get the go-ahead from PG&E early in the planning process. You may even learn that you can safely plant your entire parcel.

Your call or email could save you thousands of dollars in lost revenues by preventing tree removal down the line. Not only that, it could save lives and prevent widespread power outages that disrupt businesses and essential medical and emergency operations in your community or far beyond.

In 2003, for example, sagging power lines contacted untrimmed trees in Ohio and caused a massive cascading outage, costing the states millions and leaving entire cities without power throughout parts of the Northeastern and Midwestern United States, and the Canadian province of Ontario.

A few years later, in a California orchard, a fast-growing walnut tree grounded to a high-voltage power line, causing power loss on a slightly smaller scale. And there are many similar scenarios – most of them preventable.

While we're constantly working to get our "plan before you plant" message out, it continues to go unheeded by some. That's especially disheartening when it leads to needless injuries and fatalities to workers, owners and their families. Even a child passing by can shake a tree and cause contact with power wires.

Growers have different reasons for not contacting PG&E. Some are independent-minded business owners who are fundamentally opposed to outside interference, no matter their potential personal risk or the benefit to others.

Some growers question that their young trees could ever interfere with power lines that soar 40 or 50 feet, especially when their tree varieties are designed to top out at 20 or 25 feet. But plantings routinely exceed their expected growth rate and height. In fact, we've seen trees that grew 12 feet in a single growing season.

Others who fail to notify us genuinely misunderstand the nature of our easement on their property. They may believe the electric easement right-of-way for vegetation applies only to our wires in the air, when it actually extends across a grower's physical property.

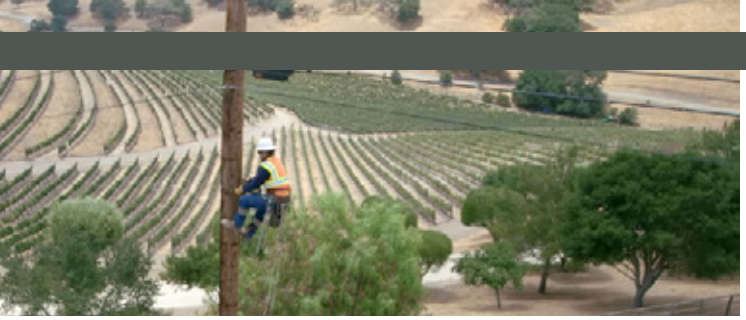
It's also human nature to hope for the best or to think "it can't happen to me." In fact, one of the state's largest nut producers learned through trial and error that power lines and orchard trees don't mix. Today, he contacts us regularly before planting.

Trees and High-voltage Lines

Trees can interfere with safe and reliable service in many ways. Most tree issues are caused by tall-growing varieties planted too closely to power lines or directly under them. As branches grow, they often extend beyond clearance limits, too.

Keep in mind that power lines are also dynamic and affected by the elements. Extreme heat and cold or severe weather events can create a variety of problems.

Metal transmission conductors ex-



Plantings near high-voltage power lines pose fire and electrical hazards to people on the ground (all photos courtesy PG&E.)

Planning before planting orchards can minimize losses due to removals later on and also avoid safety and fire hazards.

pand in hot conditions, causing wires to sag. Wind and ice storms can also wreak havoc, loosening normally taut wires and causing branches or trees to fall into electrical lines.

It's vital to remember that the electrical voltage flowing through our transmission lines is many times more powerful than that carried by the usual neighborhood power lines. And its unintended effects are that much more dangerous and unpredictable.

Plantings near high-voltage power lines pose fire and electrical hazards to people on the ground, whether they're touching the power line or simply standing near the tree. For example, lightning strikes can create a voltage surge, causing an electrical arc that travels to nearby objects like trees, vegetation and people.

When a tree does come into actual contact with a power line, or when a worker or child climbs or shakes that tree, the potential risk to lives and property is very real. And the results are often unimaginable.

Every orchard is vital to the economic health of our state. And we understand that growers need to maximize yields and plant every possible acre. But no grower wants to think that their time and investment was wasted because their tree was located too close to the power line.

Contact PG&E at 1-800-743-5000 or email us at planbeforeplanting@pge.com early in your orchard planning process. We'll help you identify power-line friendly planting locations that avoid transmission lines – and prevent unwanted tree removal. And that's a good thing for all of us.

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

Make sure your investment has room to grow.

Get the most from your orchard by avoiding areas where transmission lines may interfere with trees.

Whether you're planting a new orchard or replacing one that has matured, it's important to contact PG&E early in the planning process to understand how you can maintain required distances between new trees and high-voltage transmission power lines.

Be safe. Save money. Call 1-800-743-5000 or visit pge.com/PlanBeforePlanting

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Trailer drying at West Valley Hulling Inc. is a promising and simple solution for in-hull almond drying (photo courtesy Almond Board of California.)

Prune dehydrator at Campos Bros. (photo courtesy Almond Board of California.)

Stadium dryer at Emerald Farms (photo courtesy Almond Board of California.)

A NEW LOOK AT DRYING HARVESTED ALMONDS AND WALNUTS

EMERGING INFRARED TECHNOLOGY COULD ADDRESS AIR QUALITY CONCERNS OF CURRENT METHODS

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

WHEN CONSIDERING OFF-GROUND harvest, how to remove moisture from almonds becomes a major challenge, and an expense, for growers and processor. While this evolving method of harvest may help the industry meet dust reduction goals, it could also add the need for energy to dry the nuts.

Almond Board of California and USDA Agriculture Research Service are both addressing the mechanical drying issue and have considered options including use of infrared drying technology.

Guangwei Huang, associate director of food research and technology research and innovation at the Almond Board, said off-ground harvesting is one of the alternatives to reduce dust during harvest, and this change would also necessitate mechanical drying. The board's technology-economic analysis has indicated that off-ground harvest followed by mechanical drying on orchard windrow, rented open ground or hot air dryer, is a value proposition for growers.

The board's research efforts are also focused on building drying capacity for freshly harvested in-hull almonds, developing drying protocol and assessing drying capacity of existing dryer facilities in California, including those used in walnut, prunes and rice, as those drying facilities could be available for almond drying during early harvest season. Drying trailers, like drying wagons used for peanut drying, have shown to be a very feasible and economical choice for in-hull almond drying from a preliminary study.

Off-Ground Harvest Research

The current harvest method with natural drying on the orchard floor has the drawbacks of insect infestation, microbial infection and dust generation. The most critical challenge, Huang said, is to dry the almonds rapidly and efficiently in order to handle large volumes of almonds in the short harvest season and to ensure kernel quality.

ABC funded two research projects to determine if off-ground harvest would have significant impact beyond dust reduction. Huang shared that the research showed off-ground harvested almond crops were cleaner with less foreign material included in the loads. Insect damage was also significantly reduced compared to conventionally harvested almonds. Percentage of insect-damaged almonds was 0.8-3.3% in off-ground harvest and 2.0-10% in almonds dried on the ground. Time spent on the ground contributed to the higher insect damage, Huang said, and the results of the study showed that off-ground harvest reduced insect damage by 57 to 67%.

When it comes to drying, Huang said that tests with hot air with temperatures up to 60 degrees C had no adverse effects on the quality characteristics of the almonds, including cavity,

> **"The new drying method could be implemented in the existing facility without the need to build a new drying facility."** - Dr. Zhongli Pan, USDA-ARS

Stockpile drying photo at Nickels Soil Lab orchard (photo courtesy Almond Board of California.)

kernel color, concealed damage and oil quality. The high temperatures can achieve high drying rate and capacity. Huang believes that the drying temperature can go even higher since wet almond hulls are more heat tolerant and absorb most of the heat.

Infrared as a Drying Method

The California walnut industry has been supporting walnut drying research by Dr. Zhongli Pan, USDA-ARS researcher at the Albany facility. The Walnut Commission voiced its support of California Department of Food and Agriculture's Specialty Crop Block Grant Program for Pan's proposal to develop new walnut drying methods for reduced drying time and energy usage.

Pan has been working on a drying method using infrared technology to reduce energy use in the drying process and improve nut quality. In walnuts, the standard hot air drying process takes more than 24 hours with the use of natural gas and electricity. Infrared, a form of intense light that is felt but not seen, is a type of electromagnetic radiation much like radio waves, ultraviolet light and microwaves. In walnuts, with a broad range of moisture at harvest, there is a problem with overdrying and underdrying.

Using infrared heating as a pre-drying method quickly removes the entire moisture on the surface of the shell. The pre-drying step takes less than three minutes. The pre-dried walnuts are then sent to the regular hot air drying to finish, reading the optimum 8% moisture level for safe storage. In research station experiments, the infrared technology saved up to 25% of the natural gas and electricity used to dry walnuts. By removing moisture from the surface of walnuts, the drying

Continued on Page 66

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Dr. Zhongli Pan, USDA-ARS researcher who has been working on lower costs and lower-energy drying solutions for the walnut and almond industries (photo courtesy USDA-ARS.)

Continued from Page 65

time was reduced by 35%.

The new drying method could be implemented in the existing facility without the need to build a new drying facility, Pan said. A commercial-scale pre-drying unit using this technology was successfully demonstrated during the 2016 walnut harvest season at Emerald Farms.

Pan said for this season, more research is going to test variable temperature drying by using 80 degrees C and 90 degrees C to heat almonds to 60 degrees C, then followed by holding and hot air drying. The high-temperature drying can achieve simultaneous disinfection and disinfestation for almonds, resulting in improved product quality and food safety. It was also found that almost 60% of drying energy was used for drying hull. Therefore, when in-hull almonds, in-shell almonds and loose hull were separated based on their dimension and terminal velocities, the in-hull and in-shell almonds were able to be dried more efficiently and uniformly with reduced drying cost. The patent of the new sorting and drying technology of UC Davis is pending. Pan said the new technology should provide a needed solution for the almond industry for reducing insect damage, increasing economic benefits, ensuring food product safety and improving sustainability.

There are many factors involved in mechanical drying of almonds, whether it be hot air drying or infrared technology, said Roger Isom, president of Western Agricultural Processors Association.

If the infrared technology proves to be feasible in almond processing, Isom said, it would address one of the most pressing challenges facing the almond industry—air quality. Currently, hullers and dehydrators are looking at double the cost for new California Air Resources Board compliant drying machinery that has the capacity to handle large volumes of nuts.

Moving to off-ground harvest would mean cleaner loads would be delivered to hullers, Isom said, but the mechanical drying side will have to be addressed. Infrared is part of the conversation and would add some benefits for the industry, he added.

"If it works, it would eliminate the air quality issues, and there is potential, but the technology isn't here yet."

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Why California Agriculture Needs to Rally Against PROP 15

IF PASSED, NEW LAW WOULD ELIMINATE CURRENT CAP ON PROPERTY TAXES AND TRIGGER ANNUAL REASSESSMENTS

By **ROGER A. ISOM** | *President/CEO, Western Agricultural Processors Association*

FOR TREE NUT FARMERS, HULLERS AND processors, the November election may be one of the most important elections in decades. And I'm not talking about the Presidential election.

For Californians, Proposition 15 is on the ballot and, if passed, would create $12.5 billion in new taxes, the largest tax hike in our state's history. It would do so by eliminating the 1% cap on property taxes for businesses throughout the state, including agricultural processing facilities such as tree nut hullers and processors. In addition, it would trigger annual reassessments for agricultural fixtures such as irrigation systems, solar installations on farms and processors, barns and even permanent crop trees including almond, walnut, pecan and pistachio trees. It would do all this in a state where businesses already pay the highest taxes, not to mention highest regulatory fees.

Historically, the cap was created in 1978 with the passage of Proposition 13. At that time, families, seniors and small businesses were faced with the possibility of losing their properties because they couldn't afford 50-100% increases in their property taxes every year. Unpredictable property tax bills skyrocketed, often beyond owners' ability to pay. As a result, many families were forced from their homes and small businesses were left with no choice but to raise prices on consumers. California voters overwhelmingly passed Prop 13 in 1978 to bring certainty to residents and businesses, allowing them to afford their property tax bills in the future. Specifically, Prop 13:

- Limits general property taxes for residential and business properties to no more than 1% of their purchase price.
- Caps annual increases in general property taxes at 2% per year, which prevents sharp increases in property taxes, especially when property values rise quickly.

If passed in November, Proposition 15 would eliminate those protections. Fresno County Tax Assessor Paul Dictos was recently quoted as saying "Prop 15 will not help. It will make things worse. It will remove Prop 13's protections for California farmers, triggering annual reassessments at market value for agriculture-related fixtures, irrigation systems and improvements,

including barns, dairies, processing plants, wineries, producing fruit trees, nut trees and vineyards. California's cost of living is already among the nation's highest. We should not make it even more expensive to live here. Prop 15 will make it more difficult for Californians living paycheck-to-paycheck."

The higher taxes, in many cases, would be passed on to the tenants of those commercial and industrial property owners. In short, it's a tax on businesses, often small businesses, at a time when they can least afford it. To help offset some of the impact, Prop 15 would reduce a separate tax on businesses by reducing the taxable value of each firm's equipment by $500,000 starting in 2024. Nevertheless, the measure would increase the total property taxes collected statewide by an estimated $8 billion to $12.5 billion annually by 2025. Indeed, backers of Prop 15 are pitching the measure as a way to raise more money for schools, even though schools would receive only about 40% of the new money available after administrative costs. The rest would go to cities, counties and special districts.

In a year like 2020, it is difficult to fathom we are facing something like Proposition 15. For tree nut farmers, hullers and processors, the time to take a stand is right now. There are three groups you can contribute to help the effort to defeat the ballot measure:

- NO on Prop 15 Coalition – www.noonprop15.org
- Alliance of California's Farmers and Ranchers – www.noonprop15.ag
- Family Farmers Against Prop 15 – www.cafarmersagainstprop15.com

No matter which group you contribute to, be sure to vote NO on Proposition 15 and make sure friends, family members and neighbors understand the consequences if the largest property tax hike in California history passes.

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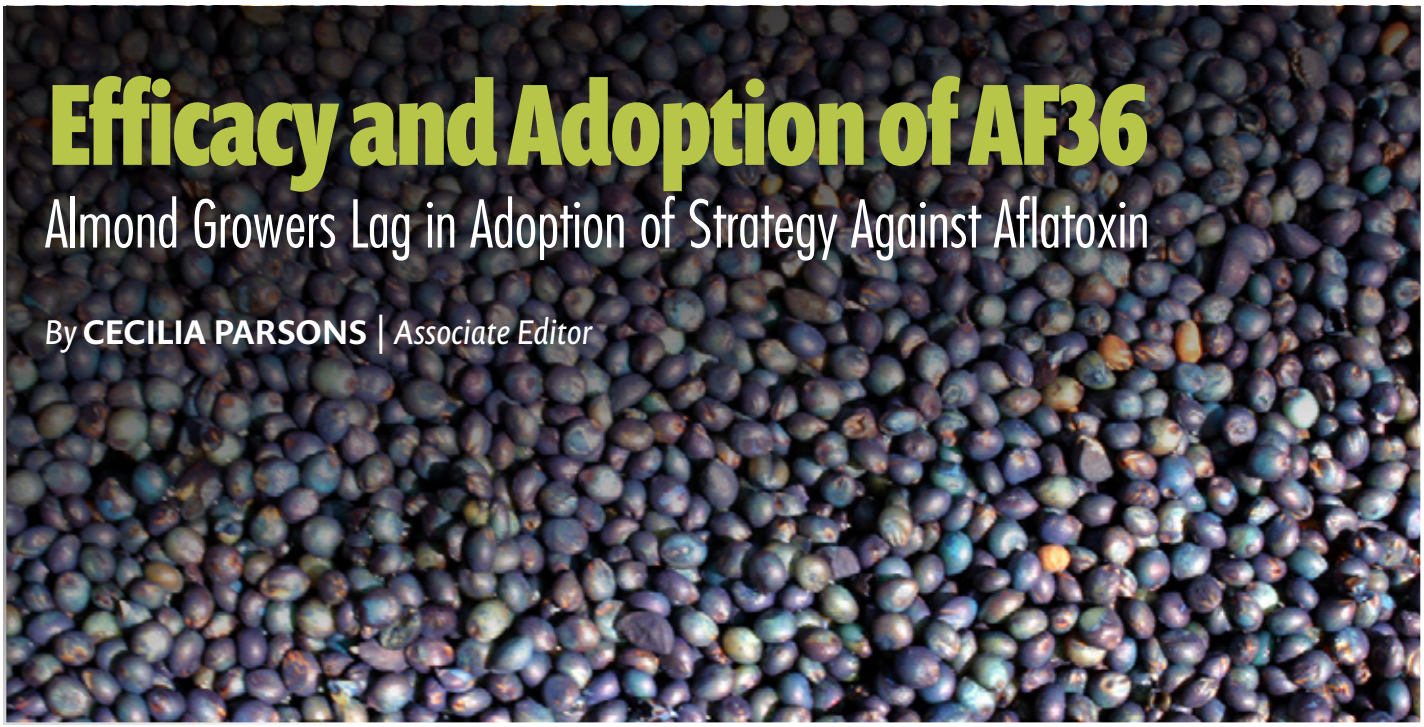
Efficacy and Adoption of AF36

Almond Growers Lag in Adoption of Strategy Against Aflatoxin

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



Sterilized, devitalized sorghum seeds are treated with a commercial coating technique to hold the fungus spores (all photos courtesy T. Michailides.)

REDUCING NAVEL ORANGEWORM damage in almond and pistachio orchards is one way of preventing aflatoxin contamination in the harvested crops.

Another component that is widely used in pistachio orchards and is gaining traction in the almond industry is the use of AF36, a sterilized sorghum product that carries spores of an atoxigenic strain of the fungus *Aspergillus flavus*. This fungus species occurs naturally in orchard soils and has both toxigenic and atoxigenic strains. The atoxigenic AF36, spread on orchard floors, displaces the toxigenic strains that can cause formation of aflatoxin when the nuts are damaged by navel orangeworm.

Since use of AF36 was approved by FDA in almonds in 2017, more almond growers are now applying this product in their orchards to reduce chances of aflatoxin contamination. The product has been available to pistachio growers since 2012 and nearly all pistachio acres are treated annually.

The reduction of aflatoxin is important to pistachio and almond growers because domestic and export markets will reject shipments if they exceed the tolerance level for aflatoxin. EU rejects at 10 parts per billion (ppb) and the U.S. rejection level is 15 ppb. Rejected shipments incur costs for resorting and testing, and in some cases may also be destroyed.

Encouraging Adoption

Themis Michailides, UCCE plant pathologist at the UC Kearney Agricultural Research and Extension Center and a lead researcher on the efficacy of AF36, has been conducting research on AF36 for the past eight years. Field studies in both pistachios and almonds achieved aflatoxin reduction of up to 45% in crop samples. Displacement rates in the soil reached 90 to 95%.

In his research, Michailides said effectiveness of AF36 is measured by the displacement of the toxigenic strains and also by the lower frequency of rejected loads in export markets.

In pistachios, application of AF36 in orchards is recommended every year, usually mid-July to mid-August. In almonds, Michailides' research showed that the first year it is applied in an orchard, the biocontrol strain reaches very high levels and can survive for a second year in high levels. Research suggests AF36 is more effective when used every year as it helps build up the population in the soil. Michailides said if applications ceased, it is likely that the competitive effect would diminish. Nearly all California pistachio acres are treated annually with AF36, said Bob Klein, manager of the California Pistachio Research Board, due to subsidies from processors.

Michailides is continuing several research projects, partially funded by the Almond Board, to further establish the efficacy of AF36.

"My ultimate goal is for almond growers to adopt this method of aflatoxin control as well as the pistachio growers have," he said.

ABC's Associate Director of Food Research & Technology, Guangwei

Spreading AF36 in a pistachio orchard.

Huang, confirmed adoption of AF36 by almond growers is increasing. He is working on improving the efficiency of the product as well as an incentive program to promote use.

AF36 is marketed under the trade name "AF36 Prevail". It is produced by the Arizona Cotton Research and Protection Council, a non-profit state agency that was originally formed to develop the product for cotton growers.

Leighton Liesner, executive director of the agency said other commodities, including walnuts, have sought to be included on the AF36 label. Liesner said he has been in contact with the California Walnut Board about adding a registration. The Environmental Protection Agency chooses to label AF36 as a biopesticide, Liesner said, and compliance with Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) is necessary.

How it Works

To make the product, sterilized sorghum seeds are treated with a commercial coating technique to hold the fungus spores. The spores are from genetically isolated sterilized cultures. Liesner said that soil sampling to show growers the levels of the atoxigenic strains in their orchard soils is done for free to producer cooperators including American Pistachio Growers Association.

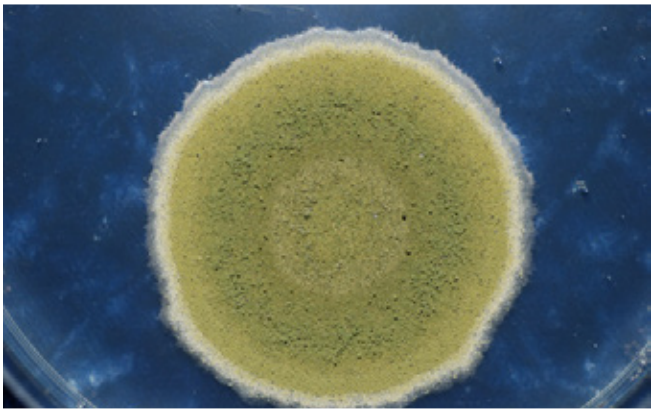
Jeff Chedester of Western Milling, a distributor for AF36 in California, said retail prices for the product can vary; a ballpark figure is less than $10 an acre plus application costs.

In 2017, the first year AF36 was available for use in almonds, US EPA approval came too late in the season to apply the product. Last year, more almond growers became aware of AF36 and began applications. Liesner said growers are realizing that an area-wide approach to displacing toxic strains will be more effective in the long run.

Michailides' research has also focused on optimum application methods for AF36. In almonds, the best time to apply is about two weeks before hull split, usually in mid-July, to ensure maximum sporulation of the atoxigenic A. flavus strain. It should be applied on the wet zone of the orchard floor at the rate of 10 pounds per acre. Growers report using an ant bait spreader or a pair of spreaders at each side pulled by an ATV or a tractor works well. After application, irrigation is necessary to encourage sporulation. AF36 should only be spread where water can reach it. In some instances, growers pre-irrigate to have a moist soil before application of AF36.

If orchard conditions are optimal for sporulation, the spores of the biocontrol strain will disperse throughout the orchard and into tree canopies. This dispersal increases the potential to displace the toxigenic strains and decreases the potential for aflatoxin contamination. Michailides noted that his future research would focus on application strategies to deliver AF36 to the orchard environment in a timely manner even when conditions for sporulation are less than optimal. New formulations and timing of application will also be researched.

Although AF36 Prevail® is the only AF36 product currently registered by the EPA, another biological control currently on the market for aflatoxin control is Afla-Guard GR, created by



Aspergillus flavus on a microscope slide.

Syngenta. This product uses barley instead of sorghum (as is used by AF36 Prevail®) as the sterile seed carrier for a different atoxigenic fungal strain and appears to sporulate better under drier and cooler conditions. It has been registered for use with peanuts and corn, and Michailides and researcher Dr. Ramon Jaime expect it could be approved for use on almonds, figs and pistachios by 2021.

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

Building a Robust Soil Ecosystem

By **TERRY BRASE** | *Farm of the Future Director, West Hills College Coalinga*

MENTION "SOIL HEALTH" TO A grower and they may recognize its value but may not understand exactly what it is or how to get there. Mention soil health to a soil scientist and you'll likely get an hour lecture on how it needs to be done. Soil health, or regenerative agriculture, is a growing priority, and its central tenet is a soil that is robust, resilient and capable of performing desired ecosystem functions such as nutrient cycling and sustaining plant health. The components of a healthy soil include biota, organic matter, porosity and aeration, and a balanced chemistry.

Soil 101 says that soil is composed of inorganic minerals in the form of sand, silt and clay. It also includes microorganisms and organic materials in the form of humus and decomposing matter. The combination of these components creates the soil structure. In addition, soil pore space comprises half of the total soil volume through which water and air move into and out of the soil. The fraction of pore space is a critical factor regulating soil health. The soil pore network governs the rate of water infiltration and air exchanges with the atmosphere.

Components of Soil Health

The percentage of each of these components within a soil is what determines the type, texture, productivity, and many of the characteristics of soil health. A healthy soil has a pH between 6 to 7.5, adequate cation exchange capacity with a proper balance of basic cations (e.g., calcium, potassium, magnesium), relatively low salinity, an appropriate balance of plant nutrients in both organic and inorganic forms, a pore distribution that ensures adequate infiltration rates and water retention for crop production, and organic matter and associated microbial communities that buffer and sustain plant nutrient requirements.

West Hills College Coalinga (WHCC) Farm of the Future (FoF) has made healthy soils a focus because of its importance to productivity and soil and water conservation. Fundamental concepts are taught in several courses: Introduction to Soil Science, Soil Amendments, Orchard Production and Plant Science. To support this instruction, FoF is looking for partners to demonstrate to our students, products or practices that improve soil health using demonstration research projects. These projects teach students about research methods and new technology. WHCC is in an excellent position, as a college known for hands-on learning, to serve as an unbiased third party for evaluating new products and the practical side of research.

Recently, WHCC had the opportunity to test a new soil amendment product that is promoted to enhance nutrient and water use efficiencies. Field trials suggest the product duplicates the effect that organic matter has on soil structure, water retention and supporting soil microorganisms. It can be described as a nano-granule polymer that is inoculated with Mycorrhizae and has a CEC value five times greater than peat moss. The product, called Zytonic, is produced by a company called Zydex. Zydex was interested in demonstrating the impact Zytonic can have on soil health to students and approached WHCC about doing a demonstration project.

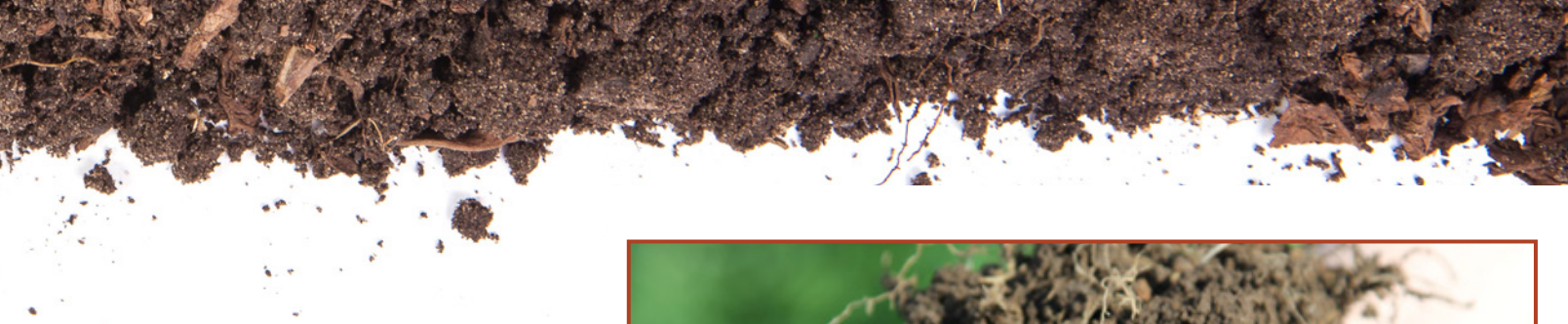
Organic Matter

Organic matter as a carbon-based material has the ability to bind soil particles together to create aggregates, altering the soil structure and soil pore networks. As a result, soils with higher organic matter feel "fluffy" or "softer".

One problem with maintaining healthy soils in the California Central Valley is maintaining organic matter. In the Midwest, summer rains, cooler temperatures and higher humidity are conducive to maintaining organic matter. When land in the Midwest is fallowed, cover crops grow naturally. In the Central Valley, cover crops require irrigation and higher levels of management. Fallowed land typically is managed as bare ground by regular disking to control weeds; the net effect burns away any organic matter that is present. To reverse this trend, fallow practices that provide organic residues and sustain moisture levels are required. With water restrictions, such practices are especially challenging in annual crops while perhaps more feasible in permanent cropping systems.

Organic matter impacts other soil components, and its loss results in a cyclic pattern. Application of inorganic fertilizers reduces the ability of a plant to absorb organic sources of nutrients which results in mineralizing organic matter. The loss of organic matter on the top layer of soil reduces cohesiveness which increases wind and water erosion and compaction. Compaction reduces the ability of microorganisms to grow, which in turn reduces the ability to decompose fresh organic matter. This lowers the nutrients available and requires an increase in use of inorganic fertilizer.

Inorganic soil particles impact the cohesion of water molecules to soil particles. Water Holding Capacity (WHC) is an indicator for retention of water (high WHC) or infiltration (low WHC). A soil that has an extremely high WHC due to soil texture not only retains water in the soil, but may retain it so "tight" that it is unavailable to the plant. In soil with low WHC, water infiltrates or flows through



the soil, taking nutrients with it (leaching). This also leaves less water available for the plant, resulting in roots "fighting" soil particles for the water. The goal is to have a soil structure that retains water not only for the plant roots but also for the microorganisms within the soil.

In our Zytonic test, a one-acre plot was laid out by WHCC students into six rectangular blocks, each of which were divided in half. For each of the six blocks, halves were randomly assigned to a treatment or control plot. Students from Introduction to Plant Science hand-plant-

Continued on Page 74

West Hills College Coalinga (WHCC) Farm of the Future (FoF) has made healthy soils a focus because of its importance to productivity and soil and water conservation.

Continued from Page 73

ed 3000 broccoli plants in the field. Students assigned to the project, assisted by Dr. Tim Ellsworth, applied pre-emergent herbicide and manually weeded the plots. Soil Amendments and Fertilizers students mixed and applied the Zytonic to the treatment plots in a water solution. Plants were watered using the FoF sprinkler system uniformly over all blocks and plots.

Row Crop Production students assisted in the plot, though the COVID-19 pandemic developed during the study. By the time the broccoli was ready for harvest, the home sheltering directive was in place and staff completed the harvest and data collection.

For this initial research demonstration, the weight of the product was the key indicator. Sixty random sample plants were pulled with roots from each block plot and weighed for an aggregate. Thirty random plants were then selected for individual weights for each plot. Nick Trujillo, FoF Research Analyst, helped to complete harvest, data collection and analysis of the data.

ORGANIC MATTER AS A CARBON-BASED MATERIAL HAS THE ABILITY TO BIND SOIL PARTICLES TOGETHER TO CREATE AGGREGATES, ALTERING THE SOIL STRUCTURE AND SOIL PORE NETWORKS.

The most meaningful advanced statistic would be a t-test, which shows if there is a significant statistical difference. A Welch t-test p-value of 0.028, which is below the 0.05 value, means there is a statistically significant difference between the weights in descriptive stats above and that the Zytonic broccoli weighed more.

An unexpected outcome was the growth of root hairs. Though it was not a part of this study, as staff were pulling the broccoli from the ground, it was consistently more difficult pulling them from the treatment plots. On investigation, the amount of root hairs from the treatment group was much more developed than the broccoli from control plots. It was theorized that the pore space allows for the advanced growth of root hairs in the row crop and may translate to lateral roots in permanent crops.

Though this demonstration was completed on a row crop, the next demonstration project being discussed is applying the Zytonic through the drip system on the FoF Pistachio Orchard. Orchard Production, a new course on the schedule for the first time in Spring 2021, will likely use Zytonic in the establishment procedure for pistachios or almonds that will be planted as part of class lab exercises to determine long-term effects.

The results from this one demonstration doesn't prove that the use of polymer-based nano-granules help with increased growth, but fundamental concepts of soil science support it. Having a soil that has a higher percent of pore space and availability of water will likely absorb water and nutrients at a higher rate. Looking toward the next demonstration with Zydex, it will likely focus on extended availability of water due to higher retention with Zytonic. In other words, testing to see if water applied in an 8-hour set will stay in the root zone for a longer period of time, allowing trees to get the water they need with less total water applied in lesser numbers of sets.

No final conclusions on the effectiveness of Zytonic can be made from this one small demonstration, but from an educational point of view, it was extremely valuable for WHCC FoF students.

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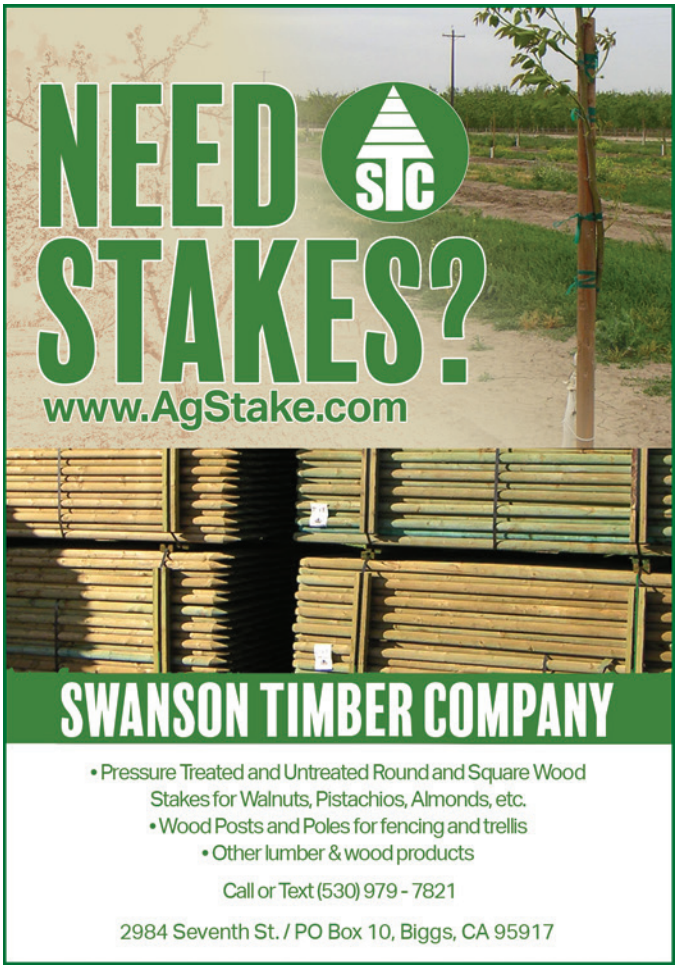

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