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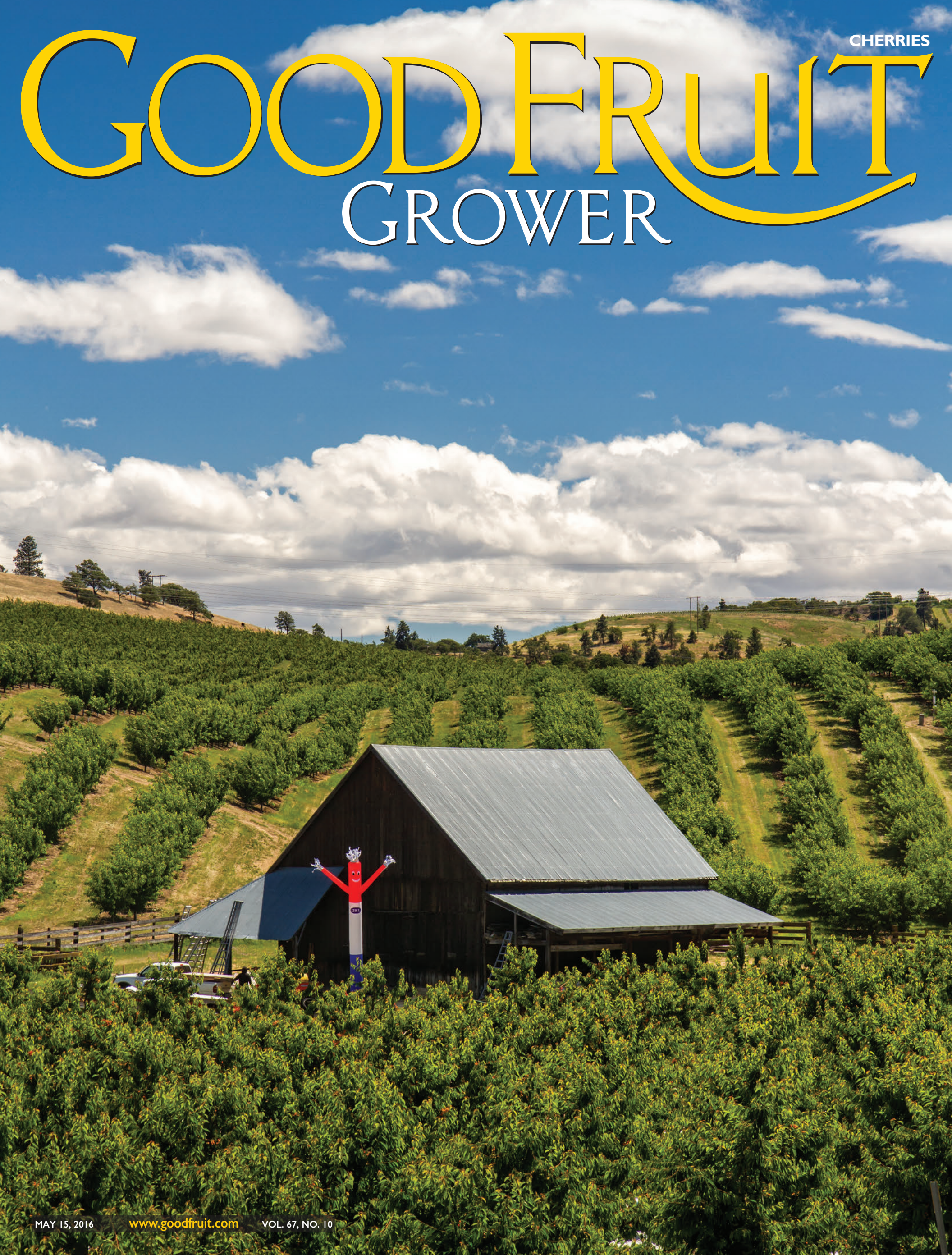

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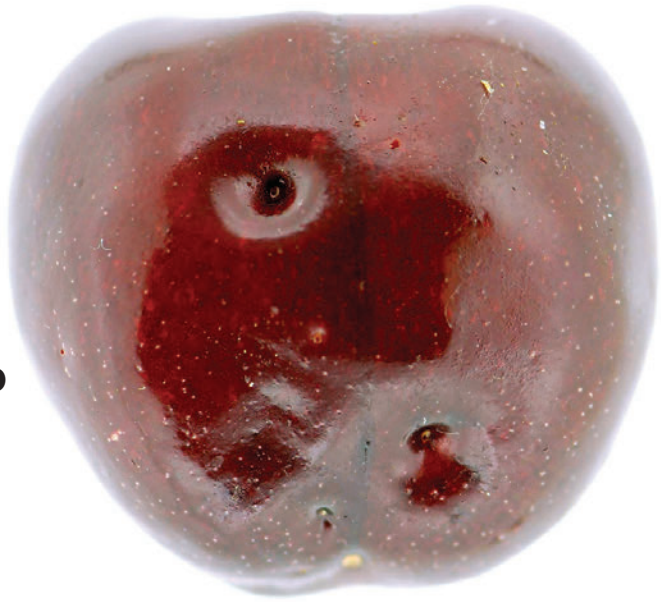
These trees are in one of the southernmost commercial cherry orchards in California, which is managed by Bruce Frost, southeast of Arvin. Despite the ongoing drought, California cherry growers and packers remain optimistic. Read their story on page 32.

Centerpiece

Good Point

Cherries

Special Report: Spotted Wing Drosophila



Good Grape Grower

Good to Know

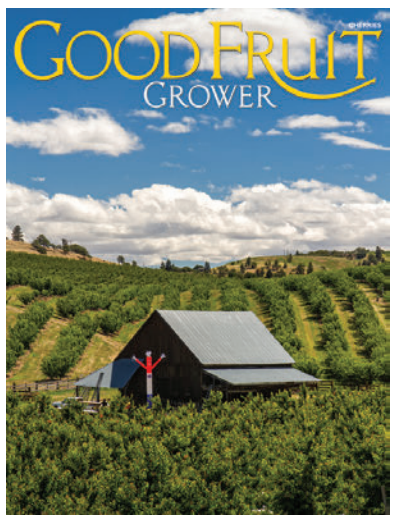
Also in this issue

Departments

On the cover

A cherry orchard in Dry Hollow near The Dalles, Oregon.

BY PHIL HULL, YAKIMA, WASHINGTON



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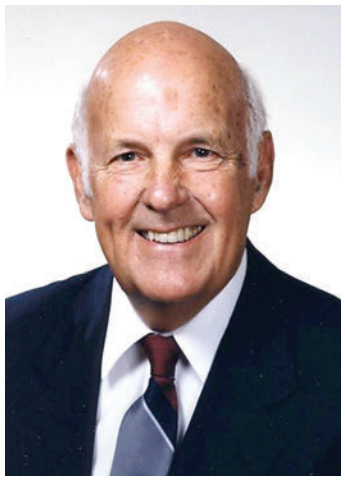
Gordon Guyer: 1926-2016

Dr. Gordon Guyer, Michigan State University's 18th president and longtime head of MSU Extension, died March 30. He was 89 years old.

Guyer attempted to retire twice in his career — the first time, immediately after his tenure as director of MSU Extension (1973-85) in 1986. Michigan Gov. Jim Blanchard had other ideas and immediately appointed him director of the Michigan Department of Natural Resources.



Gordon Guyer

After two years at the DNR, MSU brought him back as a legislative consultant. In 1990, he was named vice president of governmental affairs. He retired from that position in 1992, but again MSU called him back to serve first as interim president and then as MSU's president (1992-93).

Known for his extensive experience in Michigan's political arena, Guyer followed his time at MSU with a three-year stint as director of the Michigan Department of Agriculture.

Educated at MSU, he earned his bachelor's, master's and doctorate in entomology. In 1953, he joined the Entomology Department as an instructor and later as an assistant professor. Guyer authored more than 70 research publications on such varied subjects as aquatic ecology, integrated pest management, vegetable pests, public policy and international agriculture.

In 1975, Guyer led one of the first American scientific teams allowed to visit China. He also received MSU's Distinguished Faculty Award in 1965.

Guyer is survived by his wife, Mary Gettel Guyer, and his children, Dawn, Gregory Todd and Daniel. His first wife, Norma Lake Guyer, died in 2001.

—Dave Weinstock

Good Point

B.J. Thurlby, **Northwest Cherries**

Hot for cherries

TJ MULLINAX/GOOD FRUIT GROWER

SweetHeart cherries are harvested last July in Selah, Washington. The 2015 harvest was challenging for Northwest growers because of record temperatures and a compressed season.

After record-setting heat in 2015, cherry growers look to new year.

Another Northwest cherry season is around the corner, and at this point, there is no reason not to expect another 20 million box crop of amazing sweet cherries!

Our cherry growing cohorts in California are reporting the best chilling hours and best southern district bloom and set that they have seen in five years. The California crop is running ahead of normal by four or five days, and experts suggest that a crop of 6 to 7 million 18-pound equivalent boxes is a realistic estimate at this point. The Californians are predicting enough cherries for Memorial Day promotions and very limited crossover into June. The Northwest, meanwhile, is planning for large Fourth of July promotions and hoping that the entire country has "summer weather" during that holiday weekend.

Being in the sweet cherry business, we all know that no season ever seems to play out the same. Every season is about high hopes for a unique and truly outstanding product. But every season seems to have different nuances and issues that come into play. From the orchard to the market, we work hard to cultivate opportunity for success. Likewise, everyone in the Northwest hopes that 2016 will be the season where everything goes right from start to finish.

The 2015 season came and went like a whirlwind. Shipments started in late May and were all but done by the first week of August. The quick and compressed season constitutes the earliest finish for the Northwest in over 20 years. It appears that the total Northwest fresh crop came in at 19.4 million 20-pound equivalent boxes. The 2015 crop started early (on May 23) and compressed to 18.5 million boxes being shipped over just 60 days. Likewise, the Round 1 crop estimate that was distributed to the industry on May 4, 2015, came in at 19.6 million boxes; that means that by season's end, the industry estimate was accurate within 1.5 percent.

In the preseason, the industry saw a clearly defined

Being in the sweet cherry business, we all know that no season ever seems to play out the same. Every season is about high hopes for a truly unique and outstanding product. But every season seems to have different nuances and issues that come into play.

separation between the end of the Bing crop and the beginning of the Skeena and Lapin harvest. The hottest June in history pushed the late crop forward and the gap our industry sales organizations expected to have between Bings and the Canadian varieties never developed, causing some panic across the industry. Likewise, it is important to note that during the week of June 26, the estimate lagged behind actual shipments by over 1 million boxes (and incoming receipts were much, much higher). Why? In a word: heat.

June was a record-setting month. The industry shipped an all-time record 11.8 million boxes in June and 14 million by July 4. As every cherry grower knows, we also saw the hottest June on record. In the words of Nic Lloyd at Washington State University's AgWeatherNet, "June 2015 here in the Northwest is in a class of its own in terms of temperatures." Statistically speaking, Lloyd said, June was at least a one in 400-year event.

Those conditions were challenging both in the orchard and in the market. We saw unprecedented demand for our fruit from the beginning of the season through July 4.

The two weeks following July 4 saw the industry struggle to move fruit as quickly as the compressed harvest demanded. For the first time, we saw Bings, Rainiers, Lapins, Skeena, Regina and Sweethearts being harvested at the same elevations all at the same time. Here is a quick look at the 2015 season by the numbers:

—May fresh shipments were just over 400,000 boxes, a Northwest record.

—The industry shipped for 77 days in 2015 — averaging 266,000 boxes per day — compared to 84 days in 2014, 81 days in 2013 and 92 days in 2012.

—The industry shipped over 400,000 boxes per day for 23 days in 2015, and over 500,000 boxes per day for 11 days.

—The largest shipment day was June 25 at 594,744 boxes.

—The Rainier cherry pack was 1.7 million 15-pound equivalent boxes vs. 2.1 million 15-pound equivalent boxes in 2014.

—Seventy percent of the crop went to the domestic market, and 30 percent to exports.

—California finished shipping on June 8 and shipped 5.9 million 18-pound equivalent boxes.

I know that this information does not offer any magic remedies, but I hope it at least gives our growers some further insight. I do not think the late season is doomed over the long haul; it has been on the short end of unstable market dynamics the past two years. Growers are adamant that weather trends are cyclic, and the current cycle has been harder on the late growers and on our late varieties. While I believe the entire industry is better off with an early start that allows for ample shelf space for the July 4 holiday, the sustained heat of over 100 degrees changes the playing field for growers, sales organizations and domestic and export markets. ●

B.J. Thurlby is the president of Northwest Cherries.

Piece-rate pay guidelines

Officials working to provide practical advice following last year's Washington state Supreme Court ruling.

by Ross Courtney

Washington state authorities and grower groups are working out practical guidelines for paying piece-rate workers during rest breaks in the wake of last year's state Supreme Court decision against a berry grower.

With input from grower groups, labor associations and attorneys that represent both employers and workers, the state Department of Labor and Industries has drafted an update to its employment standards manual, answering several questions regarding rest breaks.

"The guidance is not yet final, but if it is adopted, this is going to catch people off guard," said Sarah Wixson, an attorney with Stokes, Lawrence, Velikanje, Moore & Shore. Wixson and her Yakima, Washington, firm have a history representing grower employers in labor issues.

In July 2015, the state Supreme Court unanimously ruled in favor of piece-rate workers, demanding that Sakuma Brothers Farms in Skagit County pay them separately for their rest breaks at a rate calculated based on their productivity for the week. In the past, growers had usually just included the wages for state-mandated rest breaks in the overall rate paid for bin filled, box picked or tree pruned. Workers then took a break if and when they wanted one.

"Those who see the changes coming are going to be in a much better position than those who are caught totally unaware. We're trying to keep farmers from getting sued."
—Sarah Wixson

To help growers comply with the ruling, the Labor and Industries Department has so far come up with several guidelines and is attempting to draft more.

Here are a few examples:

—Growers wanting to pay by the hour but offer a bonus for certain productivity levels must include the bonus amount when determining the rest-break rate.

—Workers and employers may not agree to a piece-rate contract that would pay rest-breaks rates lower than their productivity.

—Workers shifting between hourly rate and piece-rate chores must receive rest break pay at the rate of what they were doing when they took the break.

Other questions, such as how bonuses to salaried employees — for example, yield bonuses for an irrigation manager — would affect rest break pay, remained unanswered at *Good Fruit Grower*'s press deadline.

Many of the guidelines will deal with the difference between discretionary and non-discretionary bonuses and how each affects rest break pay.

A discretionary bonus is essentially a gift, given at the discretion of the employer independent of any contract, incentive or promise and therefore does not have to be included in rest break pay.

A nondiscretionary bonus is one granted in exchange for production levels or longevity and must be reflected in the rate paid for rest breaks. For example, if a grower promises a bonus to workers who stay through the end of the season, that grower must retroactively pay extra for all the rest breaks that season adding the bonus into the calculations.

"Most bonuses are an outright promise," Wixson said. "You don't get people to stay if you say, 'Well, stay until the end of the season, and I might just give you a bonus.'"

Wixson suggests growers pay attention to the guidelines and make sure to follow them, even as they are under development.

"Those who see the changes coming are going to be in a much better position than those who are caught totally unaware," she said. "We're trying to keep farmers from getting sued."

The Labor and Industries Department does not plan to make the guidelines part of the Washington Administrative Code, said Alison Drake, management analyst for the fraud prevention and labor standards division of the department.

It's unclear when the guidelines will be complete. "We know that is definitely an outstanding concern for everyone in this industry," Drake said. ●

ONLINE
Read all the "Unanswered Questions" document at bit.ly/PieceRateQuestions

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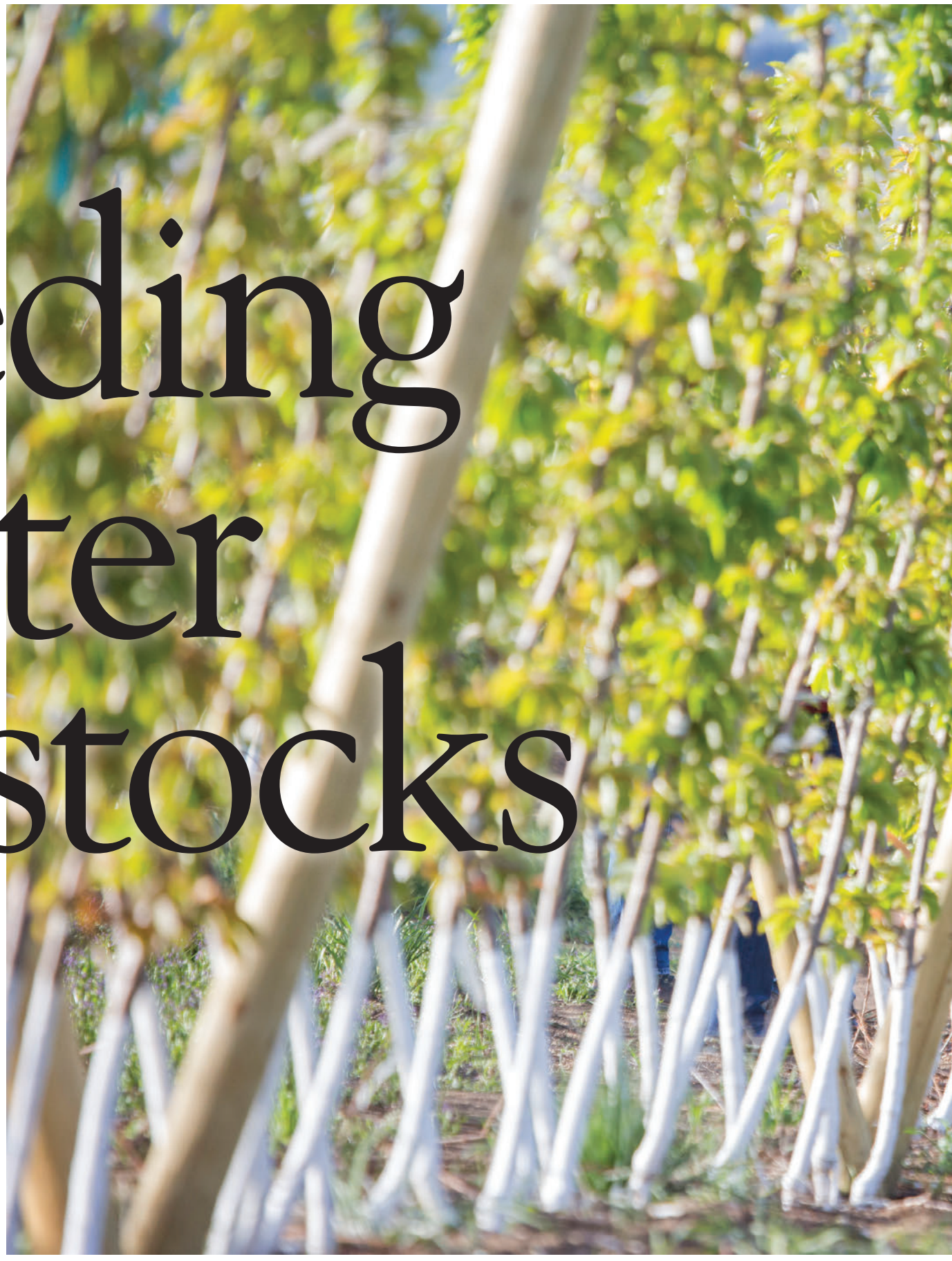
Breeding better rootstocks



Michigan State pursues patents for improved cherry rootstocks using plantings in the Pacific Northwest.

by Shannon Dininny

When it comes to dwarfing and precocious rootstocks, the greatest impact on commercial production has come in the apple industry, with research to develop new cultivars going back nearly 40 years in the United States. For sweet cherries, interest — and current cultivars like Gisela and Krymsk — came later, though growers continue to seek rootstocks that will produce high volumes of high-quality fruit on labor-friendly dwarfing trees.

Michigan State University's cherry rootstock program has been working to improve efficiency and reliability of such finished tree propagation, while aiming to improve virus sensitivity, among other things. The project is seeing some results, and it's growing in planted plots and data, with additional plantings planned in the Pacific Northwest.

MSU is pursuing patents for these cherry rootstocks, as several West Coast nurseries have plant material ready for propagation. Meanwhile, researchers are examining how each rootstock performs with different cultivars and in different training systems, soils and growing conditions. Five rootstocks are of key interest — Crawford, Lake, Clinton, Cass and Clare, all named after Michigan counties.

"It's wonderful to see them growing with such vigor."

—Amy Iezzoni

The project, led by MSU researcher Dr. Amy Iezzoni, has the support of the Washington Tree Fruit Research Commission, the Oregon Sweet Cherry Commission and the Michigan Cherry Committee, which also has provided support to develop Armillaria resistant rootstocks as part of her work.

Iezzoni visited the Pacific Northwest in April to examine the plots in Wenatchee and Mattawa, Washington, and The Dalles, Oregon, and gather data with cooperating researchers. Following a six-year trial at Washington State University in Prosser, Washington, additional trials were planted in 2015. Four of the rootstocks are in their second leaf, with the fifth, Crawford, planned for planting next spring. Scions are Regina, Early Robin and Sweetheart. Control rootstocks, which varied by site, were Gisela 5 and 6 and Krymsk 5 and 6.

Washington sites

At McDougall and Sons' Legacy Orchard east of Wenatchee, Washington, the training system is a super slender axe in an angle canopy trellis, with 12 feet between rows. Spacing between trees varies by rootstock — 2 feet for Clinton, 1 foot for Cass, Lake and Clare — with a range of 1,800 to 3,600 trees per acre. The result is the large rootstocks are 4 feet apart under each arm of the trellis, and the more dwarfing are 2 feet apart under each arm of the trellis. The orchard has drip irrigation with fertigation.

The trees' outer bark was girdled at 10- to 12-inch intervals and some individual buds notched just above the buds by Dr. Stefano Musacchi, Washington State University pomologist. Following the gentle girdling, there were four Promalin (benzyladenine and gibberellic acid) treatments timed to precede warm weather (over 70 degrees Fahrenheit). Iezzoni noted the impressive bud breaks that were occurring as a result of the girdling and Promalin treatments.

The target was for trees to be hitting the top trellis wire, around 11 feet from ground level, by the second leaf, Musacchi said, and that was happening almost

TJ MULLINAX/GOOD FRUIT GROWER

Tom Auvil of the Washington Tree Fruit Research Commission and Michigan State University researcher and tree fruit breeder Amy Iezzoni visit a cherry dwarfing rootstock trial in central Washington in April.

TJ MULLINAX/GOOD FRUIT GROWER

SHANNON DININNY/GOOD FRUIT GROWER

The trial includes a variety of rootstocks — including Cass and Lake — at sites in Washington, left, and Oregon, right.

PHOTOS BY SHANNON DININNY/GOOD FRUIT GROWER

Workers plant dwarfing rootstocks at Mike Omeg's cherry orchard in The Dalles, Oregon, in April, as part of a trial of Michigan State University rootstocks. Below, a closeup view of a rootstock planting.

everywhere in the orchard.

At a Washington Fruit and Produce Co. orchard in Mattawa, Washington, trees were planted on a four-wire trellis, super slender axe V system, with the spacing between trees under each arm of the trellis at 3 feet for the large trees (Gisela 6, Krymsk 5), 18 inches for the dwarfs (Clare, Cass, Lake) and 2 feet for the intermediate vigor trees (Clinton, Gisela 5), with 12 feet between rows. For spacing down the row, the equivalent would be: 1.5 feet, 9 inches and 1 foot.

Key to this site is the soil, which is very sandy, but Iezzoni noted the trees' growth. "It's wonderful to see them growing with such vigor; and once again, with the girdling, they're getting all these breaks," she said. "The challenge in Mattawa is to keep that break growing in the light soils."

In the 2009 Prosser Bing trial, Clare had fewer flowers per cluster than Gisela 5 or 6. The flower clusters on Kyrmsk 5 and 6, Lake, Clare and Cass had better distribution and less bunching than the Gisela rootstocks.

The Dalles

Tim Dahle's orchard in The Dalles, Oregon, features a central leader system for Regina and a KGB system for Early Robin and Sweetheart, with 16 feet between rows and 8 feet between trees, at about 340 trees per acre. The trees are irrigated by microsprinklers.

Lynn Long, Oregon State University Extension educator, said he plans to prune a second time in this second year.

The MSU rootstocks will have to be pruned to balance crop load, and all need support by staking or trellis. The dwarf stocks should be planted in a footprint of 12 feet by 6 feet (72 square feet) or less, and Clinton could have a footprint up to 14 feet by 7 feet (100 square feet), as a larger tree will overcrop and not support the crop on a larger canopy, Auvil said.

Overall, the early results show that the target tree type can be achieved, Iezzoni said. "We just don't know yet, genetically, what's the right match."

Future sites

More growers are getting on board with the rootstock research this year — a move that aids Iezzoni's efforts to breed rootstocks suited to the soils, climate and production systems in the region. In Washington, Zirkle Fruit Co. and Stemilt Growers also are planting trials near Mattawa, as are Orchard View Farms in Dallesport, Washington, and Mike Omeg in The Dalles.

Stemilt is focusing on planting Clinton, Class, Clare and Lake rootstocks with Skeena, which is a later variety — an unusual choice for a region that ripens early, acknowledged Robin Graham, the company's manager for the Mattawa/Othello, Washington, area. But Graham said the variety fills a gap in the company's market and harvest season. And while sunburn may be common in that part of central Washington, the company could consider covers if it becomes a problem, he said.

For Omeg, the trials offer an opportunity to broaden the knowledge around production systems for cherries — both for himself and for others. "In cherries, no one has figured out the rootstock issue like they have in apples. I'm doing this to learn," he said.

Omeg is replacing a Bing block that struggles to grow big fruit, but he said he figures he has until August to decide which scion to graft onto them. ●

PHOTOS BY TJ MULLINAX/GOOD FRUIT GROWER

Michigan State's Amy Iezzoni is leading the cherry dwarfing rootstock project, which includes support of the Washington Tree Fruit Research Commission, the Oregon Sweet Cherry Commission and the Michigan Cherry Committee.

Stoking the North American cherry market

PLAY
Go to vimeo.com/nwcherrygrowers to see videos of chefs talking about recipes using cherries.

Cherry marketing: "awareness, awareness, awareness."

by O. Casey Corr

James Michael

Northwest Cherry Growers is looking at 2016 as another big crop year with marketing to consumers grounded on a concept worth repeating: "Awareness, awareness, awareness."

James Michael, vice president of marketing in North America for the five-state Northwest Cherry Growers organization and the Washington State Fruit Commission, says marketing cherries is a complex puzzle involving a host of factors, such as weather, the size of the crop and the velocity of the harvest. But the key to consumer sales is making buyers aware when cherries are in season.

Consumer awareness is activated in large part by traditional midweek print ad fliers found in newspapers or on racks at stores, supplemented by coverage in radio, TV and print and by newer tactics, such as briefing food bloggers and sharing on social media.

Based in Yakima, Washington, Northwest Cherry Growers represents 2,100 growers whose harvest value of 19.3 million boxes last year was $827 million. This year, the group projects a crop of 20 million boxes, a number that will be adjusted as the season progresses. By comparison, last year produced 19 million boxes and 2014 produced a record 23 million boxes. (About 79 percent of Northwest cherries are sold in the U.S. and Canada. For a discussion of export promotions, please see "Big export year for Northwest cherries" in the February 1, 2015, issue of *Good Fruit Grower*.)

When cherries will start to move from tree to packing house and in what numbers are critical questions for retailers who work four weeks in advance on merchandising, ad placements and shelf space. Typically, about two-thirds of the cherry harvest ships in four weeks, a compressed window to alert consumers and induce repeated purchases. Because grocery weekly circulars are so critical to sales, Michael and his team of part-time regional representatives work hard to encourage retailers to create ads for cherries, using a combination of crop data, category research and promotion programs. Timing ads for a highly perishable crop can be tricky; because of unusual heat in 2015, for example, most Northwest cherries arrived in stores two weeks earlier and finished three weeks sooner than in recent years.

For all the curveballs thrown by Mother Nature — be they rain, heat, birds, hail or all of the above — Michael and others in cherry marketing have sophisticated tools to promote fruit. Those tools start with extraordinarily detailed research on people who buy cherries and the catalytic effect cherries have on overall sales at grocery stores.

For example, research shows that 76 million people in the U.S. buy cherries, and that cherry buyers shop more often and spend more than average shoppers. Typical cherry buyers spend $28 more per grocery trip than non-cherry buyers. Put another way, cherries are the No. 1 dollars-per-square-foot item in July and fiercely compete with berries for the top spot all summer. To assist grocers with how to sell more, Northwest Cherry Growers suggests setting up secondary displays at perimeter locations, even at checkout stations because 53 percent of cherry sales are impulse buys. Grab-and-go packages are effective. Visibility and attentive merchandising are key. Michael says it's the responsibility of Northwest Cherries to conduct that type of research on behalf of growers and then turn those studies into usable statistics for retailers and cherry shippers.

Health is another driver of cherry buying. Northwest Cherry Growers promotes awareness of research showing that cherries help protect against Alzheimer's disease, reduce inflammation, combat hypertension, discourage diabetes and fight cardiovascular disease. Cherries even help people sleep better.

Michael and others spend considerable time working with writers and producers to cover cherry topics, at times talking months, even years, in advance to magazines with long lead times. The results have been impressive, generating coverage in the *New York Times*, *Good Housekeeping*, *Martha Stewart Living*, *Real Simple*, *Bon Appetit*, *O* magazine, *Family Circle* and other major outlets. The health message has driven additional coverage in *Shape* magazine, *Men's Health, Women's Health,* Yahoo! Health, the Food Network, the *Dr. Oz The Good Life* magazine and elsewhere. Media research shows the cherry health coverage generated 267 million audience impressions in 2015.

When the crop begins to ripen, Northwest Cherry Growers ships more than 2,000 pounds of fresh cherries to more than 30 influential food bloggers across the U.S. whose "buzz" is a powerful validator of cherry buying. At the same time, Northwest Cherry Growers steps up postings on its Facebook account, a platform for Michael to post articles, images and cooking tips for consumers to share. More than 11,000 people follow that account.

In June, as the cherry crop begins to emerge, Michael will be visiting senior editors at places such as Condé Nast and Hearst, owners of many magazines and websites, to educate and entice them with Northwest cherries. He will pitch ideas for print and online articles about the coming season. It isn't hard getting people to write about cherries, he says. Editors know they are a popular topic. The trick is coming up with fresh angles for the popular topics.

To further improve communications to both consumers and industry insiders, Michael is overhauling the websites *nwcherries.com* and *cherryupdate.com*.

Aimed at consumers, the updated *nwcherries.com* will go live in late May, featuring images and various articles on health and nutrition messages. For the Northwest cherry industry people, *nwcherryupdate.com* will feature frequent postings on crop data and will provide more video reports from orchards by growers.

"It's an attempt to strengthen the established trust retailers place in our representation of the overall crop," said Michael. "With the best information, everyone succeeds." ●

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Optical lines are growing

Upgrades using near-infrared technology to sort fruit are necessary to keep pace with the industry.

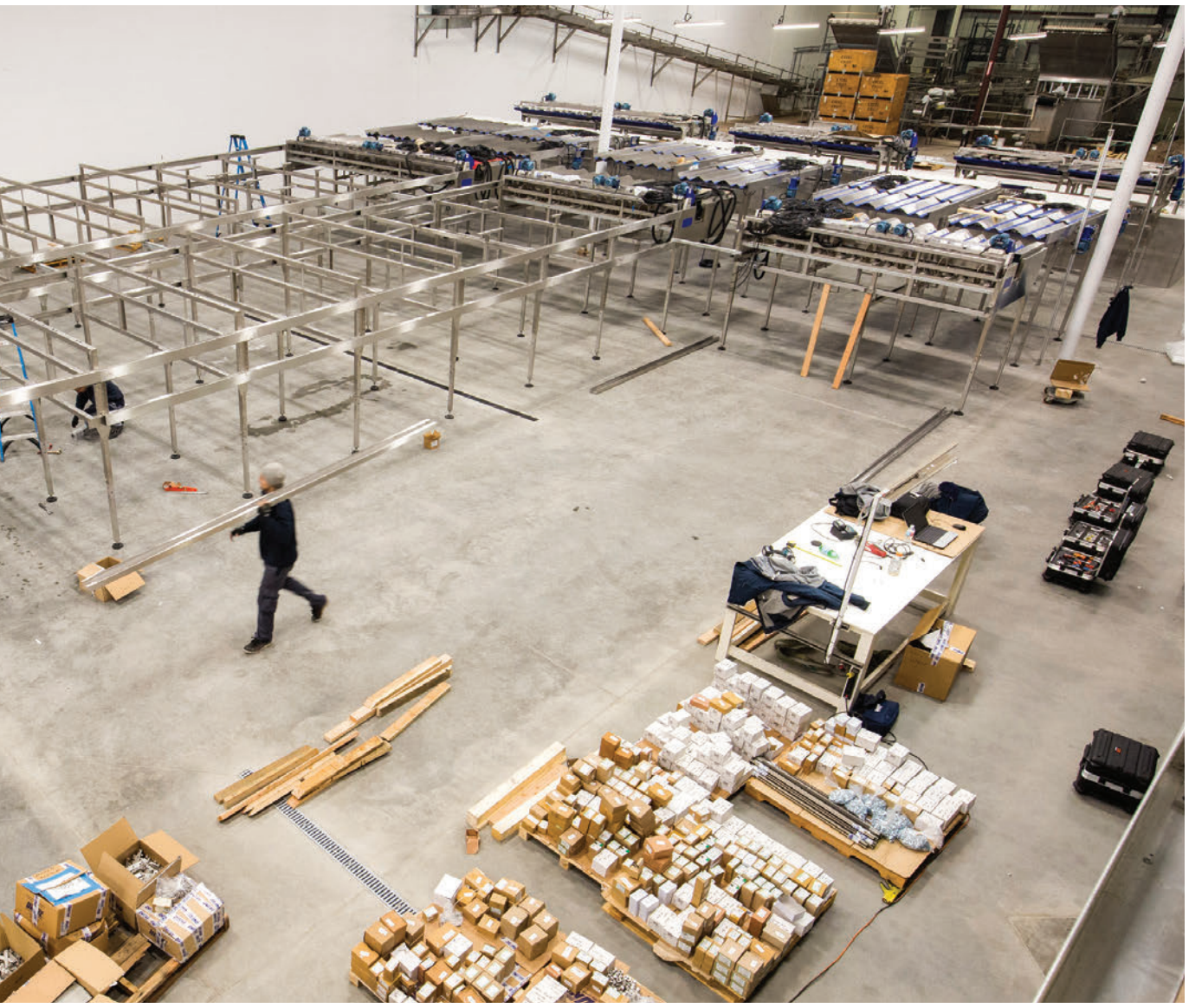
by Ross Courtney

When the first of the Columbia Gorge's sweet cherries come off the trees, Mt. Adams Orchards Corp., will begin using its new packing equipment in Dallesport, Washington.

Their neighbors across the Columbia River — Orchard View in The Dalles, Oregon — will do the same.

Both cherry companies have invested millions of dollars in 48 lanes each equipped with optical equipment that uses near-infrared technology to sort fruit by size, firmness, color and defect. The gear, once a new

Workers install a cherry processing line that will feature optical



TJ MULLINAX/GOOD FRUIT GROWER

equipment to sort fruit at The Dalles Fruit Co. in Dallesport, Washington, in January.

technology that gave a packing house an advantage, is now becoming expected by buyers.

"It's a new set of standards," said Don Gibson, president of Mt. Adams.

Other packing houses in the Northwest are using sorters from other manufacturers this year, following the lead of still other companies that made similar investments over the past four or five years, Gibson said.

The two companies are the two largest packers in the Columbia Gorge, competing with packers in and around Yakima, Washington, for fruit grown in the area. Even at full capacity, the two packers could not pack all the cherries grown in the Gorge, Gibson said, though he declined to speculate a market share.

The Dalles Fruit Co., a packing subsidiary of the Mt. Adams ownership group, has invested tens of millions of dollars over the past four years to expand the facility to a total of 64 lanes of near-infrared optical sorting, Gibson said.

Mt. Adams formed The Dalles Fruit Co. in 2008 and completed the packing house in 2009, expanding in 2010 and 2014. The 2014 expansion added 16 lanes of optical sorting. The latest round added 48 more, making the facility one of the largest to use the sorting technology in the Northwest. The additional lanes should increase the plant's capacity by 50 percent to 600 tons per day, Gibson said. At times, The Dalles Fruit Co. receives 550 tons of cherries per day.

"We have growers that have grown and we're growing with them," Gibson said.

The latest improvements are scheduled to be ready for operation in time for the 2016 cherry season.

"We have growers that have grown and we're growing with them."

—Don Gibson

Mt. Adams also packs apples and pears at its facilities in Bingen and uses the Dallesport buildings for cold storage for pears and apples.

In The Dalles, Orchard View added the equipment to create packing consistency, better packouts and higher returns for all of its varieties, said Brenda Thomas, company president.

"I believe it's going to create a more consistent quality box of cherries," she said.

The facility also includes a new water treatment system to cut down on the use of fungicides and a new post-packing rapid cooling system, she said.

"It's the largest (monetary) investment we've ever made," Thomas said.

Previously, the firm ran its Rainiers through a Red Pearl sorter and its dark sweets down a conventional, mechanical and hand-sorting line, she said.

The extra capacity also will come in handy on days when the company suddenly needs higher throughput to keep up with picking ahead of rain, she said. In the past, supervisors would have had to scramble to call in extra workers. ●

Arnulfo Valdez, left, and Vasile Gado work on the installation at

TJ MULLINAX/GOOD FRUIT GROWER

The Dalles Fruit Co. The upgrades will expand capacity to 600 tons per day.

PHOTOS COURTESY WASHINGTON STATE UNIVERSITY

In trials, using air knives to apply pressurized air to the cherries in the final section of the packing line helped reduce the moisture getting into packages with the fruit.

Controlling cherry cracking

Top: A packing line with an air knife installed. Bottom: A packing line without an air knife. Notice the water droplets below.

Reducing moisture uptake can help prevent cracking in storage.

by Geraldine Warner

Scientists at Washington State University are testing a three-prong approach to reducing splitting of fresh cherries during storage, which can be a significant problem for the industry.

Packaged cherries absorb moisture during storage. As the cherries go through physiological changes and the pressure inside the fruit increases, the skin becomes thinner and the fruit tends to crack.

Dr. Girish Ganjyal, food processing specialist at WSU, is leading a project to address the problem with these techniques:

—Applying edible coatings that serve as a barrier to prevent the cherries from absorbing moisture.

—Removing excess surface moisture from the cherries on the packing line.

—Packing cherries in desiccant-embedded polyethylene bags to absorb excess moisture inside.

Initial trials were conducted in 2014 at WSU's Pullman campus, and in 2015 three trials were conducted in packing houses.

Ganjyal and his colleagues found that using air knives to apply pressurized air to the cherries in the final section of the packing line reduced the amount of moisture going into the packages with the cherries. The type of drain belt had a significant effect on the amount of moisture removed. Drain belts with bigger holes worked best.

Lab studies, using a scanning electron microscope, showed that cherries have an uneven surface and excess moisture can pool in pores. The scientists decided to test whether an edible coating could smooth out the surface to reduce the amount of water that accumulates on the surface and is then absorbed by the cherry.

In the lab, the scientists screened 16 edible coatings and tested the four most promising in a packing plant. Cherry varieties used for the tests were Chelan, Skeena and Sweetheart. The coatings were dissolved in warm water, then cooled to room temperature before application. They were applied to the cherries either by dipping the fruit in the coating solution or by running the cherries under a waterfall applicator. Both methods worked well.

The cherries were held in cold storage at WSU for four to six weeks at a temperature of 40 to 41 degrees Fahrenheit and 86 percent relative humidity.

Gum acacia (gum Arabic) proved to be the best coating in terms of reducing fruit splitting. An added benefit was that the cherry stems stayed green longer than those of non-coated fruit.

Packaging with a desiccant and with holes decreased the amount of moisture inside and reduced cherry cracking during storage.

No significant differences were noticed in color, firmness, percentage Brix, or pH level of coated cherries versus untreated cherries, but the coatings appeared to reduce firmness loss in storage.

Girish Ganjyal

Though air drying alone reduced cracking, the coating reduced it even further and also reduced the stem browning, Ganjyal reported. This suggests that the coating seals the stems and reduces moisture loss.

In trials last season at three packing houses, air drying and the gum Arabic coating again reduced cracking during six weeks of storage. However, use of desiccant bags did not consistently reduce cracking.

Ganjyal is proposing to continue the work for three years in order to develop specific strategies for reducing cherry splitting. He plans to:

—Identify how the gum acacia film reduces cracking and explore the science behind it.

—Explore ways to enhance the strength and film-forming ability of the coating by using a superior grade of gum acacia and by adding other edible coatings and modifiers, such as agar or sodium alginate.

—Study the ability of enhanced coatings to reduce stem browning. Typically, after cherries are packed, they are cooled in super cooling tunnels with forced air that flows across the packed fruit, which is believed to dry out the stems.

—Optimize the amount of desiccant incorporated into the packaging and the number of holes punched in the bag to maintain the appropriate level of relative humidity inside the bag during storage.

In the final year, Dr. Carolyn Ross will test consumer acceptance of coated cherries at the sensory laboratory in WSU's School of Food Science.

Also collaborating in the project are Dr. Shyam Sablani, biological systems engineer at WSU, and Dr. Yan Wang, postharvest physiologist at Oregon State University.

The Washington Tree Fruit Research Commission has provided funding. ●

Cherry line with waterfall application of a protective coating.

Researchers crack the case on why cherries crack

Too much water is a known cause of cherry cracking, but malic acid is a newly identified culprit.

by Dave Weinstock

Three German researchers have shed significant light on the process of fruit cracking in cherries. While researchers have known for many years the presence of too much water — either within cherries or cherry trees — results in cracking, little was known about the exact mechanism causing it until a few months ago.

Moritz Knoche, Max Ossenbrink and Andreas Winkler of the Institute for Horticultural Production Systems at Leibniz-University, Hannover, believe they have identified a crucial link in the chain reaction leading to cracking. The culprit is malic acid, a naturally occurring compound imparting tartness to such fruit and vegetables as apples, rhubarb, grapes and cherries.

What led them to this conclusion? "We observe a surprising and dramatic increase in cracking when sweet cherry fruit are brought into direct contact with the expressed juice of sweet cherries," they wrote in an article published in the July 2015 issue of the *Journal of the American Society for Horticultural Science*.

Sweet cherry juice caused rapid fruit cracking when water intake was limited. Cracking also occurred when cherries were placed in an artificial juice made of the majority of compounds normally passing through its cell walls as the fruit matures.

Proof came when cracking occurred at a very high rate when cherries were placed in a solution made only of malic acid.

Trail of evidence

In 2014, Knoche found what he called "a surprisingly low turgor in Stage III sweet cherries." Turgor refers to the amount of pressure pushing against the plasma

membrane in plant cells. Stage III is the final ripening period before harvest.

Knoche, the article's lead author, likened cell turgor in immature sweet cherries to that of immature grapes, another fruit prone to rain cracking. Research has shown low turgor in grapes results from a balance of pressure created by the flow of water in the spaces between grape cells (called apoplastic flow) versus the flow that passes through cell walls to adjacent cells (symplastic flow).

Other research has revealed that as fruit matures, cell wall strength weakens. In later maturation stages, it virtually disappears, and the two flows combine to cause outward pressure on the fruit's skin, leading to cracking.

Though well documented in grapes, this process was not yet proven to occur in cherries. Knoche thinks the similarity between the two fruits' structures, as well as the occurrence of cracking in both species, means it very likely does.

Some of Knoche's research has already shown excessive moisture uptake by sweet cherries causes very small cracks in cell walls. He has also observed significant tissue crushing around the pit in many cherry varieties at maturity.

Knoche and his team think these findings point to significant cell structure degradation when cherries reach maturity. So, he wondered, what are the consequences of leakage that occurs when sweet cherry cell walls can't contain cell moisture?

Trial setup

The scientists randomly selected Leibnitz University-grown Sam and Adriana sweet cherries as well as Bings procured from a local market. They selected fruit based on uniformity of size and color and an absence of visual defects.

To assure there was no water uptake, they cut the fruits' stems about one-fifth of an inch above the fruit and sealed them with a rubber coating. They then put the cherries into cold storage overnight at 2 degrees Celsius (35.6 degrees Fahrenheit), removed them from storage the following day and allowed them to reach room temperature before proceeding.

Initially, they set about determining which of the materials that are known to pass through cherry cell walls as they mature appeared when cracking occurred. Using cherries in water as controls, they compared cracking and water uptake rates of cherries in real cherry juice and an artificial cherry juice made of 98 percent of the compounds known to pass through cherry cell walls.

Next, they did the same thing with cherries in solutions comprising the individual components of the artificial juice and water controls. It was within this set of experiments that Knoche's team identified malic acid as the compound with which fruit was markedly more susceptible to cracking.

The team observed that fruit cracking was most severe at low pH levels and decreased as the pH increased and when malic acid was present in treatment solution in higher concentrations.

If cherry cell walls tend to be weaker when fruit is closer to maturity, the presence of too much water would certainly cause some cells to burst. This, in turn, releases malic acid into the space between the cells, weakening even more cell walls and creating a domino effect within the fruit, which ultimately results in cracking.

Suspected mechanism

Scientists have known for years that exposing cells to too much water causes them to burst.

If cherry cell walls tend to be weaker when fruit is closer to maturity, the presence of too much water would certainly cause some cells to burst. This, in turn, releases malic acid into the space between the cells, weakening even more cell walls and creating a domino effect within the fruit, which ultimately results in cracking.

Perhaps now, with a greater understanding of how cherry cracking occurs, it will be easier to create solutions to significantly decrease its incidence. ●

Breeding the new

The R25 variety from green tip to harvest

March 13

March 23

March 27

April 3 (Full bloom)

April 10

April 17

April 24

May 1

May 8

May 14

May 18

May 21

May 25

May 28 (Harvest)

June 1 (Harvest)

PHOTOS COURTESY OF THE WASHINGTON TREE FRUIT RESEARCH COMMISSION

cherry

WSU makes changes to sweet cherry program.

by Shannon Dininny

The 2015 season marked a rebuilding year of sorts for Washington State University's sweet cherry breeding program, with a focus on horticultural practices in the orchard, but research continues into new varieties that will meet growers' needs.

Established in 1949, the cherry breeding program had its first major release with the popular blush Rainier variety in 1952, and growers continue to seek new varieties that are easier to grow and extend the growing season — and, ultimately, expand growers' spot in the marketplace.

In 2015, research focused on trellis and netting installation for early selections, standardization of irrigation systems and phenotyping protocols, and accurate plot mapping — all of which led to improvement of tree health and uniformity.

Phenotype evaluation continued in 2015, with focus on a number of selections that previously advanced to phase two and phase three trials. One that's getting particular attention: R25, a dark red selection that ripens several days earlier than Chelan.

Trials

Phase one trials involve evaluating the initial cross; to advance to phase two, fruit must meet minimum standards for size, firmness and target market class. Phase two selections have been planted at four sites in Washington (Pasco, Prosser and Wenatchee) and Oregon (Hood River), with phase three selections planted in Pasco and Orondo, Washington, and in Hood River.

In addition to size and firmness, selections are then compared to conventional varieties in the following areas:

—Early season blush or red cherries with cracking tolerance.

—Late season blush or red cherries, especially those with resistance to mildew.

—Selections suited to mechanical harvesting without stems.

—Midseason red cherries that are bigger and firmer than Bing.

In 2015, none of the red selections in phase two met the size and firmness standards set by the Breeding Program Advisory Committee (BPAC). Several red selections did better than Bing and Sweetheart, the control varieties, but failed to meet the target, according to Dr. Ines Hanrahan, research scientist for the Washington Tree Fruit Research Commission.

"Some of this can be explained by the less than optimal horticultural conditions the trees were grown in the previous year. We amended these problems, so next year we should have a much better look," she said.

Three blush selections made the cut, "so we have a lot of material that is quite promising in the blush selections that is early to midseason timing, or between Early Robin and Rainier timing," Hanrahan said.

One red selection, Roza 2 (R2), was believed to be a Chelan replacement, but researchers saw a number of problems with it in 2015. "We had uneven maturity on the tree and a lot of pre-harvest drop. The fruit size was

11 row, so smaller than a BPAC threshold. The fruit is firm, but the maturity was one week behind Chelan," she said. "We also noticed quite an inconsistent taste with this selection."

Ines Hanrahan

R25

The earliest advanced selection in 2015 was the R25 selection, ripening within three days of Chelan. The fruit size was also not stellar, but it's a firm cherry. "It's very crunchy. It's almost like an apple — you can hear the crunch when you bite into the cherry. I think that's really fantastic," Hanrahan said.

Researchers did not observe any doubles with R25, it was not sensitive to cracking and it had good taste across several color grades. But, of course, it's not all perfect, Hanrahan said: Researchers saw uneven color development as the fruit matured, with very blotchy fruit in various stages of maturity before color finally evened out when reaching harvest maturity.

Overall, Hanrahan said several of the red cherries that were believed to be late season selections were reclassified last year as mid-season varieties, with Bing to Lapins harvest timing, following further evaluation. There also are more early-season blush selections in the program than thought, "and we feel that phase two contains quite a few blush selections that look promising and are early."

Introduction of any of the selections for commercial production is still a long way off, with at least two more years of data needed to even move to phase three evaluations, Hanrahan said, and an additional five more years of preparation.

Dr. Mike Willett, manager of the Washington Tree

The earliest advanced selection in 2015 was the R25, ripening within three days of Chelan.

COURTESY OF THE WASHINGTON TREE FRUIT RESEARCH COMMISSION

Heat wave

The record temperatures in 2015 afforded researchers the opportunity to evaluate cherry breeding selections for heat tolerance.

A number of selections showed susceptibility to the heat, with pre-harvest symptoms that included shrivel, discolored stems, on-tree pitting, soft or "cooked" shoulders and bleaching, said Dr. Ines Hanrahan, research scientist for the Washington Tree Fruit Research Commission. Post-harvest symptoms included shoulder shrivel and a lack of luster on the cherries.

The heat also altered the maturation pattern for conventional cultivars. Sweethearts and Bings, in particular, showed delayed color development. ***—S. Dinniny***

Bleaching

Cooked

On-tree pitting

Shrivel

Soft shoulder

Stem discoloration

PHOTOS COURTESY OF THE WASHINGTON TREE FRUIT RESEARCH COMMISSION

Fruit Research Commission, said there's still a lot more to learn about where the selections that are currently under evaluation are going to fit — or if they're going to fit — into the current cherry production scheme. "It's just too early to know," he said.

Direction change

Meanwhile, the breeding program is undergoing a leadership change.

Dr. Nnadozie Oraguzie, WSU's cherry breeder for eight years, is stepping away from that role to focus full-time on genetics research, according to a March 28 email to staff by Dr. Kimberlee Kidwell, acting dean of the WSU College of Agricultural, Human and Natural Resource Sciences.

Kidwell expressed gratitude to the Washington Tree Fruit Research Commission and the Oregon Sweet Cherry Commission for continued support of the program. "We look forward to partnering with you to continue building a world-class cherry breeding program at WSU that serves the needs of producers throughout the Pacific Northwest," she said.

Nnadozie Oraguzie

The entire Pacific Northwest cherry industry supports continued efforts to breed new varieties and continues to put resources into maintaining the existing germplasm so that the program can be picked up whenever a new person is hired, Willett said.

This year, in addition to maintaining that germplasm, the focus will be to learn more about phenotypes of individual selections, such as maturity date, size, firmness, color and bloom date.

"The industry feels that there is a need to have improved cultivars in both the early season and the late season, and that's the focus that the industry would like to see of any efforts going forward in the breeding program," Willett said.

WSU has hired a research associate, Bernardita Sallato, to work with the directors of the university's Irrigated Agriculture Research and Extension Center in Prosser and the Tree Fruit Research and Extension Center in Wenatchee to manage and advance the breeding material for the 2016 crop year. Sallato started April 1.

A search for WSU's next cherry breeder will begin in spring 2017, Kidwell said. ●

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Renewed focus on little cherry disease

Research underway to study leafhopper vectors of Western X.

by Holly Ferguson

Since 2010, sweet cherry growers in Washington have found an increased incidence of trees showing undersized and unmarketable fruit at ripening time. Widespread infection of cherry trees with the agent or agents causing this condition known as little cherry disease (LCD) has growers concerned about the extent of economic damage to their orchards and how long this outbreak will last.

How the infection spreads among trees has not been fully investigated although insect vectors, i.e., leafhoppers and mealybugs, have been implicated. While more information is sought on this disease, growers are advised to remove infected trees and manage insect populations with broad-spectrum insecticides. Unfortunately, these treatments often kill non-target insects and beneficial organisms.

Little cherry disease can be caused by little cherry virus 1 (LChV1) and/or little cherry virus 2 (LChV2). Western X disease, caused by a specialized bacteria named Western X phytoplasma (WX), is a related disease. LChV2 is transmitted by mealybugs, and WX is known to be vectored by leafhoppers. A 2014 study conducted by Washington State University's Clean Plant Center Northwest (CPCNW) showed that LChV2 was the most prevalent pathogen detected in cherry samples showing symptoms of LCD, followed by WX. LChV1 was rarely found and was always in co-infection with LChV2 or WX.

With Western X phytoplasma infection, symptoms include fruit that is undersized, light pink or strawlike in color, and bitter in taste. Red and light pink cherries may be seen in the same bunch. Symptoms develop slowly; a tree infected in late summer may not show symptoms until the next summer or fall. Cherry trees on Mahaleb rootstocks are particularly sensitive to WX infection and will typically decline rapidly within one to two seasons of the initial infection. Some notably different symptoms seen with infection by LChV1 and LChV2 include premature fall coloration in certain cultivars (Canindex 1), and late-ripening and flavorless fruit.

Targeting all leafhoppers with insecticide sprays when only one or two species are culprits is not economically justified.

In Washington, Western X disease was first reported in peaches at the 1940 Washington State Horticultural Association meeting and in cherries at the 1946 meeting. Work done in the early 1950s at what was then called the Tree Fruit Experiment Station in Wenatchee, Washington, determined that only certain leafhoppers were capable of transmitting the pathogen from fruit tree to fruit tree. Studies conducted by Washington and Idaho scientists showed that the geminate leafhopper

(*Colladonus geminatus*) and the cherry leafhopper (*Fieberiella florii*) were capable of transferring WX from infected cherry to healthy peach trees. The success of WX transmissions was based solely on symptoms expressed in recipient plants that had become infected through feeding by leafhoppers with WX. Since the 1960s, little attention has been paid to the role of leafhoppers in the transmission of WX in Washington cherries.

In California, where Western X disease is more prevalent, many studies on leafhoppers transmitting WX have been accomplished. California's WX disease model involves two kinds of leafhoppers: the mountain leafhopper (*Colladonus montanus*) and the cherry leafhopper. The mountain leafhopper overwinters on winter annual weeds near waterways, and in early springtime, moves on to orchard floor weeds. While the mountain leafhopper is very abundant in California cherry orchards, it does not reproduce on cherries, preferring instead to inhabit orchard floor weed hosts, flying up occasionally to feed on cherry leaves. The mountain leafhopper is believed to introduce WX phytoplasma from wild plant hosts into a cherry orchard. The cherry leafhopper, which does reproduce on cherry, is known to pick up the phytoplasma from an infected tree and carry it to another tree nearby.

Last summer and fall, Dr. Dan Villamor, research associate with the CPCNW, and I monitored leafhopper activity in cherry orchards in Yakima, Benton, Grant, Douglas and Chelan counties. Dr. Andrea Bixby-Brosi, research associate at WSU's Tree Fruit Research and Extension Center, monitored leafhopper abundance at three sites in Chelan County as well. Considering only those that potentially vector WX, the most abundant species found statewide were *Colladonus reductus* (no common name) and *Colladonus geminatus*, the geminate leafhopper. *C. reductus* is considered a candidate WX vector as it bears a close resemblance to the mountain leafhopper. No mountain leafhopper was found in any Washington orchard. In late September, a population of cherry leafhoppers was found in one organic orchard in Chelan County. We found one cherry leafhopper in late October in a conventional cherry block in Yakima County; no other conventional orchard had this species.

Molecular diagnostic testing was accomplished on leafhopper samples from 2015. DNA was extracted from either a single specimen or a pooled sample of several specimens. Using PCR (polymerase chain reaction), we probed these leafhopper samples for a short piece of a gene that is very specific to Western X phytoplasma. We found many samples positive for WX from three potential vector species: the geminate leafhopper, the cherry leafhopper, and *C. reductus*. However, finding leafhoppers positive for WX does not label them as vectors; transmission experiments demonstrating that a leafhopper can pick up WX from a donor plant and introduce it into a recipient plant need to be done for proof.

We received grant funds from the Washington Tree Fruit Research Commission to continue this work. Beginning this spring, we will monitor leafhopper traffic with yellow sticky cards placed in the orchard and in the habitat adjacent to the orchard (typically sageland). Orchard floor vegetation will be sampled using sweep nets. In addition, we will assess the potential of certain plant species to serve as hosts for WX and/or leafhoppers. Transmission experiments will be conducted to verify the vector potential of certain leafhoppers.

Targeting all leafhoppers with insecticide sprays when only one or two species are culprits is not economically justified. By updating and expanding our knowledge of the roles that leafhoppers play in the transmission of Western X disease, we can begin to move toward a sustainable, more targeted approach to leafhopper management in cherries. ●

Dr. Holly Ferguson is a research associate with Clean Plant Center Northwest at Washington State University's Prosser research station in Prosser, Washington.

Ch optir

California cherry growing conditions are tough, but growers are tougher.

by Ross Courtney

photos by TJ Mullinax

With an edge of defiance and a wink of humor, Bruce Frost grows cherries where cactus and oranges have better odds.

In the face of years of drought, salty ground water and poor winter chill, the Bakersfield, California, orchardist believes he can get his trees to hit the high-priced early market before Northwest growers swoop in and dominate the rest of the summer.

"I'm a typical farmer," said Frost, owner of Acorn Farms, an orchard at the base of the arid Tehachapi Mountains so warm he cools with overhead sprinklers in the winter. "I think I can do better than any farmer, and I'm willing to go broke trying to prove it."

A promising bloom and healthy water supply have California cherry growers optimistic about 2016. Growers are predicting a crop of about 7.5 million 18-pound boxes, according to unofficial preseason estimates.

But that's in contrast to the past two years, when orchardists, especially those south of Fresno, have been struggling. Overall, 2014 was the worst recent year for sweet cherries, when growers shipped only 2.7 million 18-pound boxes; 2015 was better with 5.9 million boxes, but still well short of the nine-year

Bruce Frost walks between new and older cherry plantings on his ranch, Acorn Farms, near Bakersfield, California, in March. His ra

nerry
nism

anch is so warm in winter, Frost uses microsprinklers above the canopy to chill the orchard.

California Cherry Board member Greg Costa checks how one of his older Bing orchards near Lodi handled several days of rain. Costa is confident California growers can be stronger than ever with investment in agricultural science.

Busy with expanding O-G Packing's cherry line in Stockton, Tom Gotelli says packers need to be ready for growth. He believes new varieties and technological improvements in sorting and packing facilities will keep California cherries one step ahead of Washington crops to market.

JARED JOHNSON/
GOOD FRUIT GROWER

Bruce Frost shows one of several cherry doubles on his ranch near Bakersfield.

average of 7.2 million boxes.

"The last two years were freaks of nature," said Mike Collins, chairman of California Cherry Board's estimate committee.

One of the largest cherry companies in the world, Stemilt Growers, sold one of its cherry orchards last year in Arvin, a diverse agricultural district on the southeast reaches of Bakersfield.

Stemilt, based in Wenatchee, Washington, owns a packing facility in Stockton that works with growers throughout California. Kyle Mathison, father of the current Stemilt president, owns an orchard in Shafter, just west of Bakersfield. He plans to sell that, too, said Erick Stonebarger, the general manager of the company's California operations.

Yield problems due to chill were part of the reason, but so were drought, land values and other economic factors. "It's not an all or nothing proposition by any means," he said.

In fact, nobody's panicking. Some growers are planting more cherries in new areas, hoping newer varieties less reliant on winter chill will continue to give them an early season edge.

New varieties

One of the fastest growing varieties is Coral Champagne, an early ripener that grows well in all parts of the state.

Growers predict 1.9 million boxes of that variety, up more than one-third from last year's record of 1.3 million boxes. A broad category of other niche varieties, most of them newer trademarked strains from private California breeders, such as Sequoia, Glen and Royal varieties, could reach 600,000 boxes, well above last year's count.

Plenty of companies are investing in expansion. O-G Packing of Stockton, one of the state's largest cherry shippers, installed a 32-lane packing line in 2013 and a 40-lane line the next year in spite of California's growing struggles, said Tom Gotelli, one of the family owners. The company lost "a couple hundred" acres over the past two years but replanted right back to cherries.

"We're having to replant a lot of cherries in Bakersfield because we have what we call dirty water, which is bad water," said Gotelli, a fourth-generation grower, referring to ground water with a high saline and boron content, a problem more pronounced in the Bakersfield area as growers turned more to wells in recent years that lower the water table as reservoirs run dry. Cherries are more susceptible to that than nuts or citrus.

O-G Packing also owns an orchard in Washington near Tieton.

In Kingsburg, just south of Fresno, KingFresh Produce installed a new cherry line worth nearly $2 million in 2015, the year after one of the cherry industry's worst seasons.

"You know, it's the old theory, if everybody is moving to the left, it's always smart to move to the right," said Keith Wilson, company president.

Wilson figured KingFresh could capitalize on geography and new Southern California acreage coming into production in Kern and Tulare counties, some of the earliest ripening areas. KingFresh is one of just a few packers near Fresno, midway between Bakersfield and Stockton. Wilson suspects he can get cherries to market more quickly with improved packouts.

In California's cherry market, growers rely on the seasonal excitement of fresh fruit. Prices start at their peak and go down as cooler, more abundant growers from Washington and Oregon fill the market.

"The name of the game is to pick early and get the hell out of the way because everybody up north is coming on top of us," Frost said.

For example, on May 5 last year, 16-pound boxes of 10-row Brooks cherries fetched between $65-$75 f.o.b. prices, according to U.S. Department of Agriculture Market News Reports. That range dropped by $20 the next week.

Keith and Lisa Wilson of KingFresh Produce installed a cherry packing facility in

2015 near Kingsburg to capitalize on cherry expansion in southern counties.

ROSS COURTNEY/GOOD FRUIT GROWER

Not so easy anymore

Once upon a time, cherries were considered a relatively easy tree fruit to grow in California. They required few sprays, about three weeks of intense labor for only two varieties — Burlat, an early ripening variety, and Bings, "the main show," said Greg Costa, a Lodi grower and member of the California Cherry Board.

The industry centered in the Santa Clara Valley south of San Francisco, a place with moderate temperatures and conducive soils with which no other cherry growing region in the nation wanted to compete. Eventually though, urbanization and high land prices in the area now known as Silicon Valley pushed the cherry farming families — mostly descendants of Italian immigrants — into the Stockton and Lodi areas of the Central Valley of California, where about 70 percent of the state's cherries are grown today.

In the 1960s, the onset of cherry buckskin disease ushered in the days of year-round maintenance and at one point took the California acreage way down. "That eliminated cherries from certain parts of California," Costa said.

The early 1990s brought about chemical bloom manipulators that helped growers overcome low chill,

Bruce Frost is one of several California growers looking for new cherry varieties that better handle the high summer heat and low winter chill and also ripen earlier. This test variety, 51-011 on Gisela 12, is an experimental variety from a California breeder planted on Frost's Acorn Farms ranch near Bakersfield.

and opened the doors to planting more acreage in the hotter south, such as Bakersfield, some 240 miles away.

Acreage has surged in the past 10 years due to rising demand in Asian markets and Canada. Bearing acreage climbed from 26,000 to 33,000 from 2007-2014, according to the U.S. Department of Agriculture. Some growers estimate overall acreage is well above 40,000 acres now.

In contrast, Washington had 35,000 bearing acres in 2014 and an estimated 40,000 acres in 2015, but produced three times the volume of California in 2015.

These days, California's well-documented droughts affect all growers, but they face other challenges specific to cherries — heat stress, salty ground water and low chill.

Cherries, more than even apples or pears, require a certain amount of winter chill to thrive the following summer. Central California has not been getting that. Some blame climate change, others the decline of fog.

California's Central Valley is famous for tule fog, a winter phenomenon named after a local grass and best known for causing traffic accidents. However, that fog also insulates fruit trees from sunshine, moderating temperatures so the trees can acquire enough chill units. Most locals and meteorologists claim the fog is on the wane.

To compensate, Frost turns on overhead microsprinklers or stretches shade netting across his canopies if the temperature climbs above 55 degrees from November 1 to late January, a time of year Washington growers would be more worried about cold hardiness.

Private breeders, meanwhile, have been experimenting with new low-chill varieties that tolerate warm winters. Growers commonly plant test plots to

In the distance to the left sits one of the southernmost commercial cherry orchards in California, managed by Bruce Frost, southeast of Arvin. To the right is the Arvin-Edison Water Storage District South Canal, and beyond that are the Tehachapi Mountains and the Mojave Desert.

see which ones work, letting the once ubiquitous Bing shrink as a percentage of the crop.

The industry still is looking for the "silver bullet," a variety that will ripen early, stay firm and resist cracking, said Gotelli of O-G Packing.

Gotelli forecasts a good future for the cherry industry due to the variety research and continued improvements to packing lines. He even forecasts a bump in the labor pool as the growing blueberry industry automates, freeing up workers for cherries.

However, he does not expect the cherry industry to expand much. "I don't think it's going to keep expanding for a little while here for California, not at the pace that it was."

Coral, Brooks and Tulare are the most common varieties in the southern part of the state, with Coral working the best so far, said Frost, who has been removing his Tulare trees and plans to take out some Brooks soon.

Heat stress during and after harvest also takes its toll, causing a higher percentage of doubles and spurs. Bakersfield averages a high temperature of 97 degrees in July, compared to 88 in Yakima, Washington.

In short, cherries are a tough crop in California.

"It was pretty arrogant of us to plant cherries down here in the desert," he said.

But Frost calls himself an optimist.

"I think we can do it down here. We've got plenty of problems, but we've also got ideas how to solve them." ●

The problem of powdery mildew

WSU researcher to study cherries' sudden transition from resistant to susceptible during the growing season.

by Shannon Dininny

There is still much to be known about why cherries are so susceptible to powdery mildew — in ways that many other fruits are not — but researchers are narrowing the window of when cherries are most susceptible to the disease and determining just how many spores pose a problem at harvest.

Mildew can affect both the leaves and the fruit on the same tree. Fungicides can adapt to deal with mildew on one or the other. A three-year project by Washington State University researchers centered on infection of the fruit itself.

Dr. Claudia Probst, project lead and research associate at Washington State University's Irrigated Agricultural Research and Extension Center in Prosser, Washington, examined trees and fruit closely, starting at full bloom, to determine if the presence of fungus has any effect on the

Scientists aren't sure why powdery mildew infects cherries in the

COURTESY GARY GROVE, WASHINGTON STATE UNIVERSITY

Pacific Northwest but not fruit in other cherry growing regions around the world.

presence of the disease at harvest and to see if resistance and susceptibility vary at different developmental stages of fruit. Environmental factors, such as temperature and relative humidity, and inoculum concentration thresholds also were taken into consideration to see how many spores were necessary to have the disease show at harvest.

Probst presented the latest findings on this powdery mildew research at several winter meetings, including November's Northwest Cherry Research Review and the Washington State Tree Fruit Association's annual meeting in December.

Seeking spores

The flowering stage has been of particular interest to researchers because, for a lot of commodities, flowers are highly susceptible to infection, Probst said. For instance, strawberry blooms are highly susceptible to infection, but as soon as the fruit reaches the white or pink stage, generally within about two weeks, it becomes fully resistant.

"This has major implications for disease control," Probst said. "This is called ontogenic resistance. It's seen in grape berries at about four to six weeks."

The good news: Cherries have a long period of resistance, which is fabulous, she said. However, cherries' resistance to mildew declines over time, which means they have no ontogenic resistance. Additionally, the period from pre-bloom to fruit set in cherries was not a critical period for establishment of powdery mildew infections, the research showed.

"Flowering precedes natural onset of disease on leaves," she said. "Airborne spores are detectable, but at very low concentrations, and cherries covered at fruit set were not infected at harvest, so the timing between bloom and fruit set is not critical for diseases that present at harvest."

Generally, Probst said, the more spores the more disease; however, few spores are needed to cause significant damage. There could be as many as 10,000 spores during the season, but cherries only need about 500 spores to see significant infection at harvest.

Other factors

Researchers also examined the effects of temperature and humidity on disease incidence and severity at various stages of fruit development. Probst called these the most "frustrating experiments" she had ever done.

"We processed thousands of these cherries, and we just couldn't get disease to develop. The only time we got disease to develop was on fruit harvested in mid-June," she said.

Disease can initiate year-round on susceptible leaves, with an optimal temperature, relative humidity and

COURTESY CLAUDIA PROBST

Powdery mildew was once only known to occur in leaves, but since 1944, the fungus has affected cherries, too — but only in the Pacific Northwest.

incubation period, she said, but "temperature and humidity alone are not enough to start infection on cherries."

In future studies, Probst will study the sudden transition from resistance to susceptibility that appears to occur in the month of June in hopes of determining the trigger.

fungus has affected cherries in the Pacific Northwest ever since. Other key cherry growing regions do not have powdery mildew issues: Chile and Turkey have no mildew. Spain doesn't even spray for it, and in Italy, a fellow researcher had to Google fruit symptoms on the Internet to tell her it's not an issue there, Probst said.

"What happened in Washington in 1944 to make that fungus decide to jump from the leaves to the fruit? That's where adaptation becomes of real interest to us."

—Claudia Probst

Overall, fruit infection is a silent and highly unpredictable process, while infections of leaves is "loud and in your face," she said. "With fruit, you have to just wait and see what you get at harvest."

Future research

Powdery mildew spores can live for up to two months on sweet cherries — a situation that is unique to cherries.

For that reason, the latest findings present new areas for research, such as examining the role of cherry fruits in the fungal life cycle, points of infection, and the impact of cherry volatiles on spore germination, Probst said. Skeena cherries, for example, produce three times more alcohol than Lapins, which could play a role.

She also aims to discover what she calls the "ABC's" of powdery mildew with hopes of achieving sustainable disease management techniques.

Prior to 1944, powdery mildew was only known to occur in leaves, but the

Germany saw it on leaves in 2004 but not since, she said, and it appears on leaves in Iran once in a while but never on fruit.

"What happened in Washington in 1944 to make that fungus decide to jump from the leaves to the fruit?" she asked. "That's where adaptation becomes of real interest to us."

Growers have an opportunity to understand more about the disease, and controlling with spray is a short-term view, she said. "The goal is to keep pathogen populations under sustained disruptive pressure and provide an additional layer of protection against the disease." ●

Spray study

On the following pages, see how researchers are looking into the best time to spray for powdery mildew.

A WSU study into powdery mildew looked at the effectiveness of applying fungicide early in the season, at midseason and late in the season.

COURTESY CLAUDIA PROBST

Spraying for

Study aims to find best time to apply fungicide.

by Shannon Dininny

Given the prevalence of powdery mildew in cherries, Washington State University researchers have spent two years — and will continue for a third — examining the effectiveness of spray applications for the disease.

The intent of the study is to see if there is a critical spray period during which the application of Quintec (quinoxyfen), a widely used fungicide in Washington, is most beneficial, said Dr. Claudia Probst, research associate at WSU's Irrigated Agriculture Research and Extension Center in Prosser, Washington.

Specifically, is the fungicide more effective early in the season, at midseason or late season?

Fungicide review

The study is being conducted at WSU's Irrigated Agriculture Research and Extension Center in Prosser, Washington, in a one-acre research orchard using a completely randomized experimental setup with four, single-tree replicates per treatment.

In addition to Quintec, the study examined the use of Fontelis (penthiopyrad) and Pristine (boscalid, pyraclostrobin) — as well as Fontelis in combination with Quintec, varying which fungicide was sprayed at different times — to determine the best treatment when compared with untreated trees. In all, eight treatments were tested.

Usually, growers would never apply a single fungicide, and in theory, all of these fungicides work to treat powdery mildew, Probst said. But a statistical analysis helps to determine if one works better than another, or in combination, when compared to the untreated control block of trees.

Overall, researchers found there was no critical spray period. None of the treatments showed significant improvement controlling incidence of mildew on leaves in either year, except for one combination of Fontelis and Quintec in 2014. However, several treatments showed promise for controlling the severity of the disease on leaves and fruit, even though the effect was only observed in one year.

For fruit, Pristine was the only fungicide that controlled both incidence and severity of the disease on fruit in both years, the research showed.

"That was a little unexpected. I would have thought the other fungicides would do really well," she said. "Some fungicides just seem to do better at controlling foliar infection, and others are better at controlling fruit infection. Overall, the incidence of disease on leaves is not a good indicator on how much disease to expect on fruit."

Quintec alone also did not control incidence or severity of the disease on leaves or fruit either year, the study showed. The Quintec-Fontelis spray

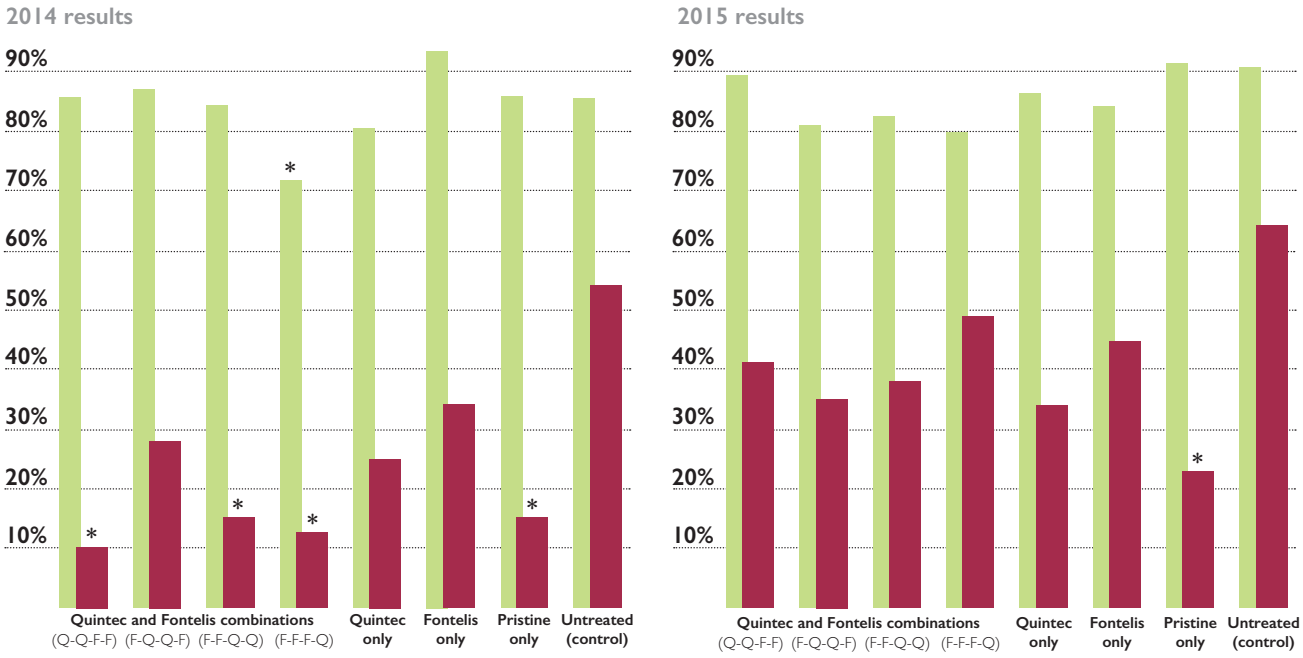
powdery mildew

Comparing fungicides

These charts show the results of a fungicide research trial for powdery mildew in cherries in 2014 and 2015. Incidence refers to the disease being present on a leaf or fruit. Severity details how much of the leaf or fruit is covered. Fungicides (Quintec, Fontelis, Pristine and a combination of Quintec and Fontelis) were applied to runoff (400 gallons per acre, or 1.5 gallons per tree). In 2014, fungicides were applied on April 30, May 14, May 28 and June 10. In 2015, they were applied April 23, May 7, May 21 and June 4.

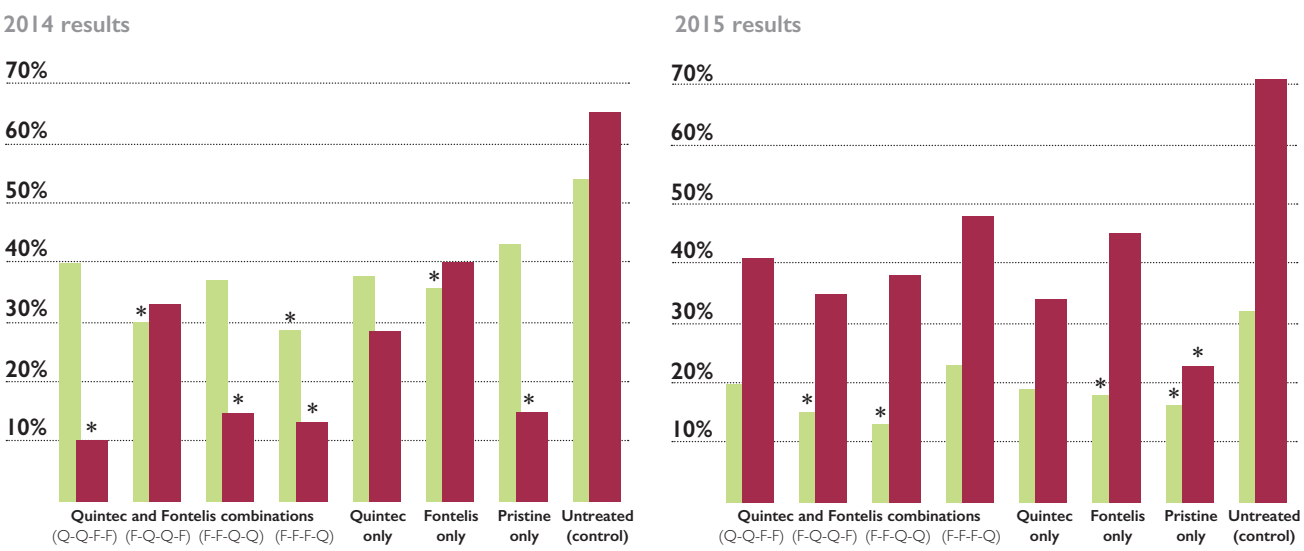
Measuring powdery mildew incidence

Leaf Fruit (Results marked with * indicate spray is effective when compared to control)



Measuring powdery mildew severity

Leaf Fruit (Results marked with * indicate spray is effective when compared to control)



SOURCE: CLAUDIA PROBST

JARED JOHNSON/GOOD FRUIT GROWER

rotations controlled fruit disease incidence and severity — and leaf severity — in 2014, but not in 2015. A similar trend was observed in two similar spray trials conducted in Quincy, Washington.

"Growers really like Quintec, because it's a novel mode of action fungicide, and it's the only one within this FRAC group," Probst said. "We wanted to see the best time to apply it, but it turns out, there wasn't a best time."

Quintec appears to lose a little bit of its efficiency over the years, she said, which could suggest there's fungal resistance building up. The researchers will examine that further in year three of the study.

"I don't think it was just the season or the heat last year," Probst said of the possibility of resistance developing. "It's more of a gut feeling, which is backed up by the results from similar trials and observations made by collaborators in Washington and Oregon, but we should know more after this year."

The fungicide applications did not affect fruit quality or pitting susceptibility. ●

The telltale mark of spotted wing drosophila's ovipositor scars are shown on this cherry. While other fruit flies deposit their eggs into the soft flesh of ripened fruit after harvest, spotted wing drosophila can penetrate through the tougher skin on cherries, blueberries and stone fruits that are still growing on the plant.

COURTESY MARTIN HAUSER, CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

How to stop a proliferate pest?

Growers and researchers are struggling in efforts to control the spread of spotted wing drosophila.

by Dave Weinstock

No one is really sure how or when spotted wing drosophila made the trip across the Pacific Ocean to the United States, but the flies were first discovered in California in 2008.

That same year, they were also discovered in Europe, and in the ensuing years, growers have detected spotted wing drosophila (*Drosophila suzukii*) in Canada, Mexico, Brazil and across the continental United States. The pest attacks a range of crops, from blueberries and strawberries to cherries and other stone fruit, as well as wild hosts, and researchers around the world are working to better understand and control it.

In the United States alone, millions of dollars are spent each year on researching this prolific pest in a coordinated approach across multiple research units to address the needs of both conventional and organic growers.

Control?

An international cohort of 14 co-authors published a paper on the global perspectives of the invasion in the September 2015 *Journal of Pest Science*. It

Infected blueberry

In just 10 days, a spotted wing drosophila larva can destroy a blueberry, feeding on it from the inside after it hatches and before it drops to the ground to transform into a pupa.

COURTESY OF ASH SIAL, UNIVERSITY OF GEORGIA

The spotted wing drosophila female attacks both ripe and unripe fruit by penetrating the skin using its large ovipositor with a serrated edge, shown in the enlarged inset below.

The male usually has darkened wing tips, which gives the species its name.

SWD IMAGES COURTESY MARTIN COOPER

compared and contrasted research findings across areas affected by the insect in Asia, Europe and the United States.

Parasitic wasps are commonly used against pests such as caterpillars, aphids and grubs; however, these bio-control agents are largely ineffective against spotted wing drosophila. "Spotted wing drosophila larvae have five times the standing immune response against the

"The rapid expansion of their range is one of the reasons why we are so concerned about this pest."

—Hannah Burrack

DAY 7 DAY 8 DAY 9 DAY 10

Northwest feels the pressure

Researchers work to give growers confidence that their spray is appropriate, timely.

by Shannon Dininny

Spotted wing drosophila has only been a problem for six years in the Pacific Northwest, but 2015 was the most challenging year so far.

Higher than normal winter temperatures, with few cold snaps, and an early and mild spring are likely the biggest contributing factors, according to Dr. Betsy Beers, entomologist with Washington State University's Tree Fruit Research and Extension Center in Wenatchee, Washington.

Temperatures were consistently higher in February and March of 2015 than the previous five years on average, resulting in high winter survival. To top that off, spring came on fast, and spotted wing drosophila (SWD) developed a lot sooner than researchers — and growers — expected, she said.

Altogether, inspectors and researchers had 369 confirmed or suspected SWD packing house crush samples in Washington last year. The previous high was 44. Some crops were abandoned in the field due to high levels of infestation.

"We're not saying the sky is falling, by any stretch, but it certainly is a bit of concern."
—Betsy Beers

Researchers in Washington, Oregon and California have been working to capture live flies for a three-year study of insecticide resistance. (Turns out, they're hard to catch.) Eight populations of SWD were screened against five insecticides in 2015: Sevin, Malathion, Warrior II, Entrust and Delegate. Three of four populations tested in Washington had some flies survive diagnostic doses, as did a few flies collected in California. None survived in Oregon, the researchers found.

"Our diagnostic dose is designed to kill 100 percent of those we spray, and we were getting some survivors," Beers told *Good Fruit Grower*. "We always repeat tests where there are survivors to make sure it's not just a fluke, but we were still seeing survivors in some of the repeat tests. We're not saying the sky is falling, by any stretch, but it certainly is a bit of concern."

Overall, although they identified a few suspect populations, the researchers are not yet declaring that SWD had developed resistance to commonly used insecticides. More populations will be screened in 2016, the final year of the study, but the results serve as a reminder to rotate insecticides to delay onset of resistance, the researchers said in a report on their progress.

What's next?

The Washington Tree Fruit Research Commission and Oregon Sweet Cherry Commission have agreed to fund a new three-year project to examine control measures for SWD. An important new objective is to determine spray thresholds, using traps and lures, that can be used to prevent unnecessary sprays or to ensure that adequate measures for fruit protection are taken in a timely manner.

In addition to working on spray thresholds, researchers will continue to test chemical control products to determine their ability to prevent an infestation. They also will test these products to determine their ability to kill larvae of SWD in fruit as a means of post-harvest sanitation.

The goal is for growers to have confidence that their spray is appropriate, timely and completely justifiable, Beers said. ●

Continued from page 47

initial attack of the wasp when compared to other *Drosophila* species," said lead author Mark Asplen, an entomologist with the Metropolitan State University Natural Sciences Department in St. Paul, Minnesota.

Researchers in Asia are looking for "specialized candidates for larval attack" in the insects' original range in Japan, Korea and eastern China. "They are in the quarantine stage being tested to determine what non-target species they also affect. Potential releases are likely several years away," Asplen said.

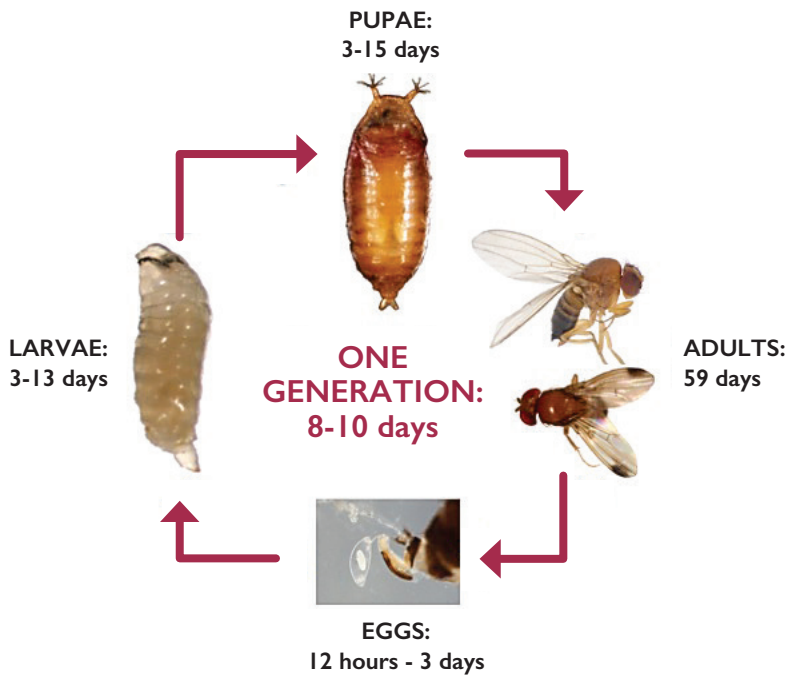
Biological control research in Europe has uncovered two parasitic wasp species showing effectiveness against spotted wing drosophila in pupal stages: *Pachycrepoideus vindemmiae* and *Trichopria* cf. *drosophilae*.

Entomologists collected *P. vindemmiae* using spotted wing drosophila-baited traps in commercial soft fruits and natural habitats in northern Italy and Spain. In laboratory trials, it showed up to 80 percent parasitism on infested raspberries.

It also has a large host range, having been reported to attack more than 60 fly species worldwide.

The second species, *T. drosophilae,* can be found in Europe, Africa, North America and Australia. It hosts on fruit-eating, pupal drosophila. There is no real information on how well this species performs in natural habitats.

Spotted wing drosophila life cycle



COURTESY OF ASH SIAL, UNIVERSITY OF GEORGIA

A major reason for concern over the spotted wing drosophila relates to the speed at which this pest reproduces.

Spiraling risks

"The rapid expansion of their range is one of the reasons why we are so concerned about this pest," says Dr. Hannah Burrack, an entomology associate professor at North Carolina State University, who is heading up the national small fruits project, a four-year, $7 million study aimed at controlling the pest.

Since 2008, USDA has funded $47.7 million in competitive research grants and Extension programming to combat spotted wing drosophila, many through the Specialty Crop Research Initiative (SCRI), under USDA's National Institute of Food and Agriculture (NIFA). That effort includes a five-year, $5.4 million project at Oregon State University headed by Dr. Vaughn Walton, which kick-started the efforts in 2010.

What sets SCRI apart from many other federal grant programs is its requirement that grant holders complete applications useful for growers and packers within the life of their projects. Applicants submit proposals reviewed by industry scientists and commodity groups. "Industry tells us which applications are important and those are the ones who are invited to compete," said Dr. Thomas Bewick, NIFA's national horticulture program leader.

The impetus for all this research came from berry growers, who were quick to pick up on a pest impact that wasn't tolerable, said Herb Bolton, national program leader for NIFA's division of Plant Protection and Pest Management.

Before spotted wing drosophila entered the scene, most commodities had well-established, lower cost production cycles. Now, because one of the few available ways to control the pest is repeated chemical application, production costs have increased considerably.

"The economic impact of this pest is enormous. Annual losses total $718 million," Bolton said.

Changes at Oregon State

Peter Shearer

Dr. Peter Shearer has resigned as entomologist at Oregon State University's Mid-Columbia Agricultural Research and Extension Center in Hood River, Oregon.

Shearer was the lead researcher on a spotted wing drosophila research project, funded by the Washington Tree Fruit Research Commission and the Oregon Sweet Cherry Commission, on insecticide resistance in Washington, Oregon and California. Dr. Betsy Beers of Washington State University will assume that role in the third and final year of the project.

Shearer also was working under a federal grant, with OSU horticultural entomologist Dr. Vaughn Walton and other researchers, on a study examining best management practices for the pest and developing tools to assess risk. Among them: a population model that researchers hope to make available in the next year or so, Walton said. A new OSU postdoctoral researcher will help with that work.

Meanwhile, Dr. Nik Wiman, an extension specialist at the North Willamette Research and Extension Center, will assume leadership of a research project on brown marmorated stink bug in pears, according to Dr. Dan Edge, associate dean of the College of Agricultural Sciences.

With Shearer's departure, two researchers remain at the Mid-Columbia station: Dr. Todd Einhorn, research horticulturist, and Dr. Yan Wang, who is focused on postharvest physiology. Several extension researchers work there as well.

"Certainly, that's getting on the low side of an experiment station. There are lots of extension people providing support, but from the standpoint of meeting the research needs of the industry, that's getting low on staffing," Edge said.

Any time a station that has a specialized stakeholder group, such as orchard crops, loses a scientist, it's always a concern, he said, but under university policy, such positions are not automatically filled. A call for proposals for new positions will go out in December. ***—S. Dininny***

The pest poses additional challenges beyond its increasing range. There is zero tolerance for drosophila in the fresh fruit market, and the flies reproduce quickly.

Depending on the temperature, the spotted wing drosophila can mature from egg to adult in just a few days, said Doug Walsh, an agrichemical and environmental extension specialist at Washington State University in Prosser, Washington. Once adult females emerge from the pupa stage, it takes up to 1.5 days to mate and within four days, each female is laying from 70 to 200 eggs.

Unlike other fruit flies, the spotted wing drosophila has a rigid ovipositor, which allows it to pierce the skin of ripening fruit to lay eggs. "By far, raspberries are at the greatest risk, followed by cherries. Blueberries and grapes are less susceptible, because their skins are more resilient," he said.

Burrack's project focuses on blueberries and raspberries. A two-year, $2 million project, jointly led by two entomologists — Drs. Ash Sial of the University of Georgia and Mary Rogers of the University of Minnesota — aims to develop organic and bio-controls for small fruits. The projects are intended to be complementary.

Organic research

The organic project with Drs. Sial and Rogers has four components. Similar to Burrack's project, they, too, will be working to build a better bug trap. They also are examining "cultural tactics," or ways to disrupt the life cycle of the insect. Among the practices they are looking at are canopy management practices to increase light and or to cool down internal plant temperatures to make an inhospitable environment for the flies.

There is only one effective organic chemical — Entrust — available to control spotted wing drosophila, and the way it is being used will lead to resistance, Sial said. Scientists in his project will be testing its use in combination with seven other compounds and three different adjuvants to find effective alternatives as well as reduce its usage.

They also will be developing extension education, webinars, meetings and on-farm demonstrations designed to keep growers abreast of the latest discoveries these projects make. ●

"The economic impact of this pest is enormous. Annual losses total $718 million."

—Herb Bolton

Good Fruit Grower special report

"It's not dying enough. It's dying, but not enough."
—Joanna Chiu

Beakers and breakthroughs

California research into spotted wing drosophila sounds like science fiction.

by Ross Courtney

Using genetically modified yeast as a biological pesticide. Deciphering olfactory signals for better baits. And engineering chromosomes to allow for only male offspring.

Some of the latest research ideas to control the dreaded spotted wing drosophila in California sound like science fiction, as scientists look for alternatives to conventional insecticides and traditional approaches.

"We're trying to be creative," said Dr. Joanna Chiu, an entomologist at University of California, Davis.

The alternative is to keep spraying harsh pesticides that throw everything else about integrated pest management (IPM) out of whack. Besides, spotted wing drosophila will eventually develop resistance to chemicals, just like most insects do.

"The real problem is the recognition that we can't keep spraying these things into oblivion," said Greg Costa, a Lodi, California, grower and packer and chairman of the research committee of the assessment funded California Cherry Board.

In 2015 and 2016, the research committee spent a combined $381,000 – 66 percent of the two years' budgets — on a wide array of projects related to control of spotted wing drosophila.

"We don't want to rely on one strategy," Costa said.

Among them:

—$173,000 toward efforts by Dr. Bruce Hay of California Institute of Technology and Dr. Omar Akbari of the University of California, Riverside, to genetically alter SWD that breed only males and would then knock down the population when released into the wild. They started in 2013. The project builds on Hay's work with fruit fly RNA replacement that was named as one of the top 50 advancements by *Scientific American* in 2007.

—$49,000 to Dr. Kent Daane at the University of California, Berkeley, to find new biological controls for the flies, specifically a larval parasitoid from Korea.

—$310,000 toward deciphering the olfactory signals and reception in drosophila-yeast communication for Dr. Zain Syed at the University of Notre Dame. Some of his results were published in September 2015 in *Scientific Reports*, an academic journal of the Nature publishing group. Syed is scheduled to begin field trials this year of his findings to develop better attractants to use in traps, Costa said.

Then, there is Chiu, an entomologist who normally specializes in the circadian clocks of animals as part of human medical research. She also collaborated with Oregon State University researchers to sequence the genome of the spotted wing drosophila in 2013.

California cherry growers spent about $40,000 for a two-year project that ended last year that allowed her to develop yeast strains that could slow down the reproductive activities of flies that eat it.

The altered yeast delivers tweaked strands of RNA to the drosophila that tricks the pest's immune system to attack its own endogenous RNA critical to survival. The concoction reduced larval survivorship, their ability to move and their reproductive fitness, according to her research paper published in early March, also in *Scientific Reports*.

Using RNA interference to manage a pest is nothing new. It has worked in aphids, termites and mosquitos. Delivery is usually the problem. Fortunately, drosophila love yeast, which occurs naturally on the surfaces of fruit.

When Chiu fed larvae her modified yeast, fewer of them made it to adulthood. When adult flies ate the yeast for three days, they all lived but reduced their activity level for several days, recovering after five or six. However, the females laid fewer eggs and fewer of those eggs made it from larvae to adults.

The news was good, but Chiu hopes to target different strands of RNA that will prove even more fatal to the spotted wing. "It's not dying enough," she said with a smile, gently pounding her fist on her desk. "It's dying, but not enough."

However, one of the best parts was the yeast only caused ill effects in spotted wing drosophila and none of its closely related cousins, which means

PHOTOS BY TJ MULLINAX/GOOD FRUIT GROWER

Dr. Joanna Chiu of the University of California, Davis, has published research on yeast biopesticide to be used on spotted wing drosophila. At left, a *D. Suzuki* genome strain sample in Chiu's lab.

the method can conceivably be used to target only the invasive pest, not an innocuous or beneficial native bug. That may help her and her grower-benefactors with one potential drawback of her proposed control method — public perception.

"This is a very risky idea," Chiu said.

The term "genetically modified" carries baggage in the eyes of consumers. To be safe, she and other researchers are trying to build genetic "on-off" switches into their methods, such as a specific nutrient in the yeast. They don't want uncontrollable Frankenbugs released into the environment either.

The growers on California's research committee haven't tried to address public opinion yet. They first want to let researchers develop some technology and build funding partnerships with other commodity groups.

But they believe the public will come around, pointing to favorable opinion of using genetics to breed diseases out of mosquitoes, for example, and comments from none other than Bill Nye, the "Science Guy" author who made waves last year for softening his stance against genetically modified organisms in July.

Besides, public perception isn't fond of heavy chemical spray programs either.

"It won't work, it's too expensive and it's anti-public also," said Rich Handel, a member of the research committee since the early 1980s and a former chair. "You know, there's just as much concern about spraying as there is GMOs."

Spotted wing drosophila has gobbled up most of the extra research funding of the California Cherry Board in recent years.

Growers on the committee consider funding research a bargain to the alternative of continued spraying, which cost $50 per acre or more three to five times per year, said Arnie Toso, a grower and member of the National Cherry Growers and Industries Foundation, a voluntary membership group based in Hood River, Oregon, that represents cherry growers.

"This research then becomes, in my opinion, peanuts," he said. ●

Organic control

Studies look into stopping spotted wing drosophila without the use of chemicals.

by Dave Weinstock

Researchers are tackling what they call "cultural tactics" to determine nonchemical farming practices — such as pruning and thinning techniques or netting — that can be brought into play to thwart spotted wing drosophila in organic orchards, vineyards and fields.

In one project of blueberries and raspberries, researchers plan to adjust the temperature and humidity inside the canopy, where the insects mate and reproduce. "How can we use pruning to open the canopy to more light? Can we create a less favorable habitat?" said Dr. Mary Rogers, University of Minnesota entomologist and organic project co-director.

They plan to evaluate the effects of pruning 20 percent and 50 percent of the canopy, as well as thinning at 6 inches apart, 9 inches apart and 12 inches apart, on the microclimate inside the canopy.

Another effort focuses on the developmental stages of the fly. It is hard to find spotted wing drosophila pupates, Rogers said. "Do they use soil as a breeding reservoir? Do they move into it?"

Acting on the assumption they do, project director, Dr. Ash Sial, a University of Georgia entomologist, said they plan to evaluate various mulches, plastics and landscape netting for their abilities to create barriers to the soil — a tactic called orchard floor management.

"We know certain mulches can raise temperatures. We'll be testing woven net versus pine mulch," Rogers said.

They will also be testing weed mats. "We will evaluate some heavier plastic products to see if they can prevent the insects from penetrating the soil. Another one is a highly reflective material, which can create a high heat to burn them," Sial said.

Fabric barriers can be effective, but are more applicable to smaller scale farms, he said.

After a year of planning, this year they'll begin testing these ideas in farm fields on the scale of normal organic production. Later in the season, they will be demonstrating those practices and results in on-farm field days and demonstrations.

For more information about this project, visit its website at: *bit.ly/1XHWVkw*

Netting

Dr. Greg Loeb, a Cornell University entomology researcher, has been involved in a multi-year project to determine if netting can effectively exclude spotted wing drosophila from small fruit.

"We know that exclusion netting, netting that is very fine, has been pretty successful for Eastern blueberry growers when put up at ripening with no spraying," he said.

Raspberries are another story. Because these fruit are

COURTESY OF GREG LOEB, CORNELL UNIVERSITY-GENEVA

Organic researchers are evaluating various kinds of materials to separate insects from fruit, such as this netting in a Stephentown, New York, blueberry field. They found no difference in temperature inside and outside the structure, only a slight increase in relative humidity inside and said insect exclusion results were "encouraging." So, too, are the results of a similar test of this netting by a group of scientists near Montreal, Quebec.

flowering and ripening at the same time, some provision must be made for pollination.

Thus far, he and his team have determined 80g nets with holes no wider than 1 millimeter will exclude the fly. "It also allows good airflow and allows plenty of light to facilitate growing," Loeb said.

Is netting a good investment? It costs $4,600 to net one-half acre, plus the cost of custom sewing to make 26-foot wide sections.

Loeb says his research is looking at that question right now. One of the growers he's working with says she thinks netting can be stored for up to 10 years if stored in UV bags.

This summer, they plan to test the use of the netting in fall raspberries. In addition, they will look at how to rescue a netted section if spotted wing drosophila penetrates it. ●

Hoppers at heart of red blotch research

Confirmation of red blotch-associated virus vector means more studies are ahead.

by Shannon Dininny

The three-cornered alfalfa treehopper (*Spissistilus festinus*) has been confirmed as a vector for red

"They were usually reported as a minor pest. It hasn't been a significant problem, but it's going to be a lot more important problem now."

— Frank Zalom

Researchers at the University of California, Davis, have identified the three-cornered alfalfa treehopper (*Spissistilus festinus*) as the first known vector for red blotch-associated virus in greenhouse experiments.

The researchers caution that the discovery does not mean the treehopper is the only vector. However, the finding opens new avenues for research to help control both the virus and the pest in areas it is known to roam.

The hopper is native to North America, but its range has largely been restricted to the southern U.S. That aligns with the spread of the virus in California and Oregon, said entomology postdoctoral researcher Brian Bahder. He spoke in February during a webinar sponsored by the University of California at Davis and the U.S. Department of Agriculture's Agricultural Research Service.

Red blotch disease was first recognized in 2008 in a Napa Valley, California, vineyard. After being confirmed as a new virus in 2011, the disease is now present in many major grape production regions of the U.S. and Canada. Leaf symptoms first appear around midsummer, though that differs by cultivar and by year. In red grape cultivars, common symptoms include red blotches originating from the leaf margin. In white grape cultivars, pale green to pale yellow patches appear.

The disease is not known to kill grapevines; however, there is a known effect on the wine produced from fruit on diseased grapevines: Total soluble solids are consistently reduced, and pH and titratable acidity are also variable.

Bahder showed graphics that highlighted the spread of the disease in California vineyards, including the UC Davis research vineyard in Oakville, a vineyard in Amador County, and a third vineyard in Santa Barbara.

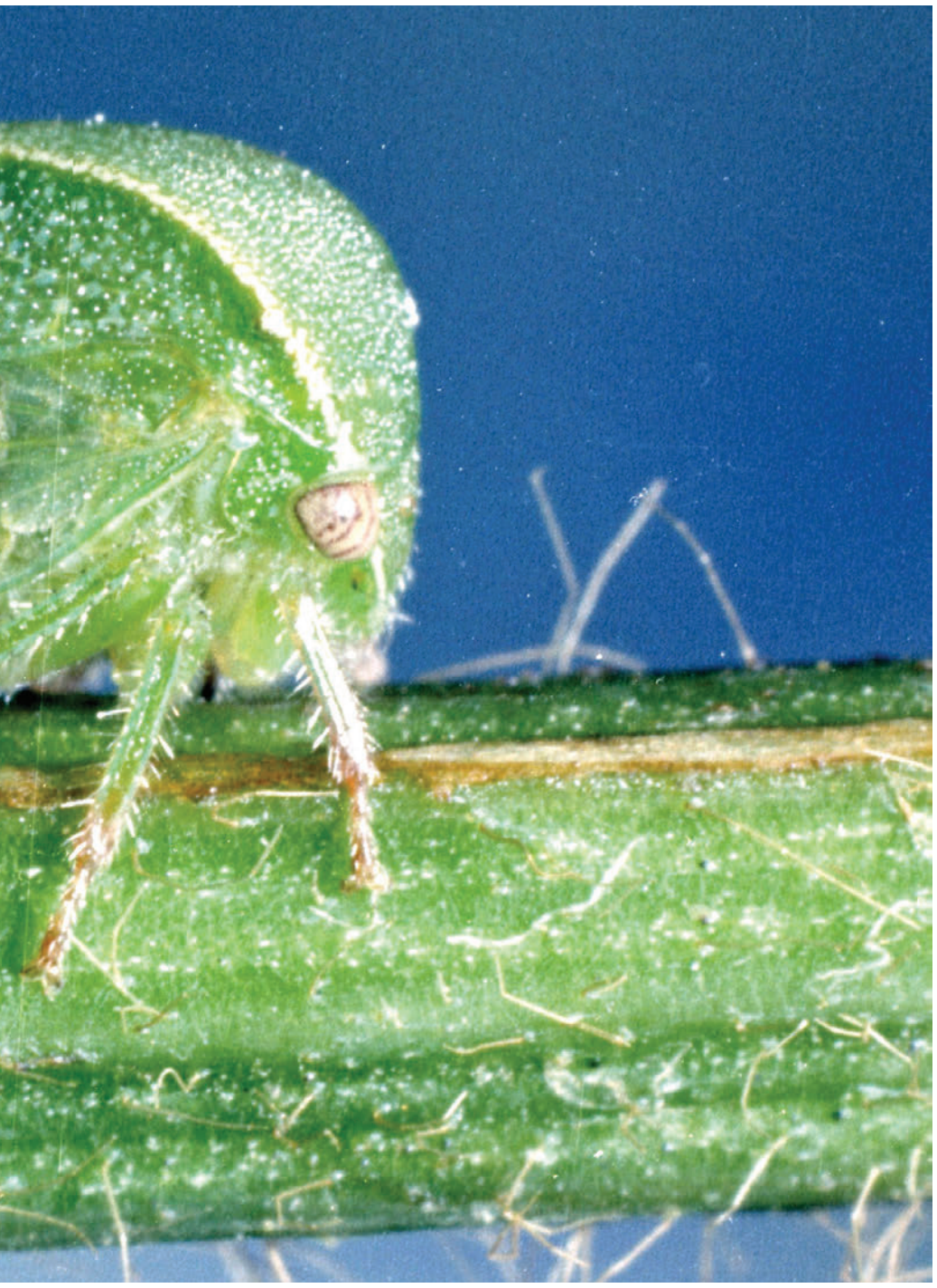
Of the latter, Bahder said the vineyard had been healthy for 70 years. "Then, in the last few years, they brought in new material from a nursery, planted it, and you can see that all of sudden, you get a cluster on the edge of the vineyard, which is indicative of a vector."

The search for a vector

Bahder focused his greenhouse tests on five species that he suspected were potential vectors for the disease, including the treehopper *(*a member of the *Membracidae* family*),* two species of leafhoppers *(Cicadellidae)*, one jumping plant lice *(Psyllidae)* and a planthopper *(Cixiidae)*.

For the experiments, Bahder placed one insect from each of these species in a greenhouse with infected vines for 48 hours, then moved them to a greenhouse with uninfected vines for another 48 hours. Just one, the treehopper, transmitted the virus to three out of 15 plants.

Bahder tested for red blotch disease using digital PCR, which he said is more sensitive than quantitative PCR; however,



COURTESY OF CLEMSON UNIVERSITY, USDA

blotch disease, but researchers say there may be others.

he didn't start detecting red blotch until three months after inoculation, and even then, it was at an extremely low concentration.

The finding was particularly interesting, Bahder said, because grapes are not the preferred host for the species. The three-cornered alfalfa treehopper prefers legumes, grasses and, befitting its name, alfalfa — plants found in riparian areas on the edges of vineyards. That may help to explain distribution of the disease in vineyards, he said.

What does it mean?

There is no record of the three-cornered alfalfa treehopper in Washington. "There's something precluding it from being here," Washington State University entomologist Doug Walsh said. To the south in Oregon, the disease is spreading some in the Willamette Valley and the Rogue River Valley.

In California vineyards, the treehopper has long been viewed as merely a nuisance. Generally, growers were not advised to spray for the pest because it was rare that populations were high enough to cause significant damage to the vines, said UC Davis entomologist Frank Zalom.

"They were usually reported as a minor pest," he said, referring to the situation in that state. "It hasn't been a significant problem, but it's going to be a lot more important problem now."

Since the announcement, researchers already have confirmed that the pest overwinters in vineyards, which was previously unknown, and found overwintering adults that were infected with the virus in the salivary glands. That would mean they are capable of spreading the virus, Zalom said.

Going forward, more research will center on the biology of the treehopper, such as whether adults can transfer the virus through eggs to nymphs, and when nymphs and adults move from ground cover to the vines themselves. ●

Research leads to better control for grape disease

Saved fungicide sprays for powdery mildew keep $2 million-plus in grape growers' pockets.

by Melissa Hansen, Washington Wine Commission

"At a minimum, seven sprays were usually made, sometimes nine. Now, growers can stop at five, and some are stopping at even less, depending on the year."
— Michelle Moyer

Grape powdery mildew control programs, often requiring six to 10 fungicide applications, used to drag on for most of the growing season. Through research supported by the Washington State Wine Commission, growers have been able to shave off one or more fungicide sprays to save the industry more than $2 million annually.

Grape powdery mildew, a problem worldwide, can render a season's worth of inputs and efforts into discarded cull fruit. Most *Vitis vinifera* varieties are susceptible to the disease. Telltale symptoms are white or grayish coatings on green tissue, but other signs include dark lesions on green shoots, distorted young leaves and shriveled and cracked fruit.

Washington State University's plant pathologist, Dr. Gary Grove, now director of the university's Irrigated Agriculture Research and Extension Center in Prosser, Washington, spent much of his career working on the fungal pathogen, studying fungicide efficacy and optimum spray timing and developing disease resistance management strategies.

In the past, powdery mildew control programs were typically calendar-based, says Dr. Michelle Moyer, WSU extension viticulture specialist who has continued grape powdery mildew research. "Growers used to spray every 10 to 15 days, depending on the choice of fungicide, disease pressure and the season," she said. "At a minimum, seven sprays were usually made, sometimes nine. Now, growers can stop at five, and some are stopping at even less, depending on the year."

Each fungicide application costs an average of $45 per acre, which includes material and the operator's time but not the cost of the tractor and sprayer. With an estimated 53,000 acres of wine grapes in Washington, each fungicide application represents nearly $2.4 million collectively spent by growers. On top of the cost, growers must carefully manage their fungicide program and rotate classes of fungicides to prevent development of resistance.

Key discovery

One of the more useful scientific discoveries made by WSU was determining the pathogen's life cycle in eastern Washington. Grove found that cleistothecia (a structure of powdery mildew that swells and releases spores when temperatures are above 50 degrees Fahrenheit and there is 0.1 inch of rain) are the primary source of inoculum for powdery mildew epidemics in eastern Washington. Cleistothecia overwinter in the bark of trunks and on leaf litter on the vineyard floor. That tidbit, combined with other research, has shaped Washington's current control program.

Cleistothecia

WSU researchers found that the primary inoculum supply is exhausted by the end of bloom period. For years, grapes were thought to be susceptible from bloom through veraison, and spray programs reflected that belief. However, New York scientists demonstrated that grape berries developed resistance as they age — known as ontogenic resistance — and were only susceptible from pre-bloom until three to four weeks after fruit set.

In the mid-1990s, Grove worked with a powdery mildew risk index developed by University of California known as the Gubler-Thomas model. Although the model helped industry interpret data and show that disease develops poorly during hot, dry weather, Grove said it was too conservative for eastern Washington growing conditions.

Timing

Moyer further explained that growers can delay disease progression in the vineyard and help clusters avoid infection by timing fungicides when fruit are most susceptible.

"Early vine development of around 6 inches of growth is typically coupled with spring rains — when infections start in the vineyard," she said. "Spraying much before that likely won't provide additional control in the vineyard and just cost you additional sprays." The ontogenic resistance of fruit at three to four weeks after fruit set indicates that sprays directed at keeping clusters free of disease can be slowed or stopped after that point.

"Fortunately for eastern Washington growers, this timing also typically coincides with 100-plus degree days with ample sunshine," Moyer said. "This plant-based resistance, unfavorable weather conditions, and plant stress from deficit irrigation help keep mid- to late-season mildew at bay."

Three sprays or less

Richard Hoff, director of viticulture for Mercer Canyons, a Prosser, Washington, wine producer, believes that growers have the upper hand in eastern Washington because of the region's hot, dry climate, canopy style and irrigation management that results in open, airy canopies with controlled growth. Cultural practices that reduce vineyard humidity and encourage

PHOTOS COURTESY WASHINGTON STATE UNIVERSITY

White grapes and leaves infected with powdery mildew. Researchers have found a reduced time frame for when grapes are susceptible to the disease, which allows growers to better focus their fungicide sprays.

canopy air movement help manage the disease.

"Powdery mildew control programs are part science, part art because you have to factor in things like your canopy management style, current and forecasted weather patterns, and what type of disease pressure is in your area," Hoff said. "Last year was so hot and so dry that I felt we could start our fungicide program at 9 inches of shoot growth instead of our usual 6 inches."

Hoff applied only three fungicides on Mercer Canyon vineyards for powdery mildew last year (May 3, May 18 and June 3), with the exception of Riesling acreage that received four sprays. "In July, I was a little nervous," he admitted. "But it turned out fine."

Waiting until 9 inches of shoot growth is not something he would try in wet years like 2011. "I'd stay with 6 inches of shoot growth as a starting guide in wet years. But with our open canopies and deficit irrigation, most growers can easily get by with five sprays in a normal year."

Some growers, like Paul Vandenberg, owner of Paradisos del Sol, a small family winery and vineyard in Washington's Rattlesnake Hills appellation near Zillah, have been able to eliminate all fungicide and insecticide sprays. Vandenberg's vines are trained to a modified trellis he described as a "horizontally divided, quadrilateral cordon" system, which keeps the canopy open, and he uses deficit irrigation to control vine vigor.

Hoff credits WSU research for helping growers know the critical timing of when to put on sprays, but also when to stop. WSU researchers have helped growers apply research knowledge (timing of initial infections, when fruit is most susceptible, and when mildew does not develop well during hot, dry conditions) to effectively develop their own weather and phenology-based spray models. ●

Melissa Hansen is research program manager for the Washington State Wine Commission and former associate editor with Good Fruit Grower.

Good to Go

For a complete listing of upcoming events, check the Calendar at **www.goodfruit.com**

May

May 18-20: Washington State University Viticulture and Enology Program's British Columbia Okanagan Valley educational tour, *wine.wsu.edu*. For more information, email Theresa Beaver at *tbeaver@wsu.edu*.

June

June 1-2: Pear Bureau Annual Meetings, Portland, Oregon, *usapears.org*. Schedule includes Processed Pear Committee, Pear Bureau Northwest and Fresh Pear Committee. For details, call the Pear Bureau at 503-652-9720.

June 13-14: Postharvest Technology of Horticultural Crops Short Course, Davis, California, UC Davis Campus and field tour, *postharvest.ucdavis.edu/Education/PTShortCourse*.

July

July 20: Cornell Fruit Field Day, field stops and presentations on current research underway at Cornell in berries, hops, grapes and tree fruit, New York State Agricultural Experiment Station, Geneva, N.Y. 315-787-2341, *bit.ly/CornellFieldDay*

September

September 13-15: Fresh-cut Produce: Maintaining Quality & Safety Workshop, Davis, California, UC Davis Campus, *postharvest.ucdavis.edu/Education/FreshCut*.

September 14-16: Macfrut 2016, Italian Fruit & Vegetable Trade Fair, Rimini Fiera, Italy, *macfrut.com*.

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age / *32*

crops / *Cherries, wine and juice grapes, row crops, corn*

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family background / *Neil studied business and worked with the National Oceanic and Atmospheric Administration (NOAA) and maritime companies around the nation before returning to join his father, Tom Garrison, on the family farm about eight years ago.*

How did you get your start?

I grew up out here and was working in the fields pretty regularly, moving hand lines, sprinklers, all types of chores. Growing up in a small town in an isolated area, when I was older I was excited to leave and see the world. I went off to college then got into the maritime industry. Through that, I was able to see and experience a lot of things away from the farm. After a number of years doing that I recognized the value of what was here at home: from the lifestyle that it offered to some of the benefits of working the land and working with your family.

What was the first thing you had to learn?

Some of the things that I needed to get under my belt were irrigation steps. Water use, especially in tree fruit and wine grapes, was really new to me, and I didn't have a lot of understanding of how it all works. It was one of the first things I studied up on as soon as I returned home. Irrigation is a priority in the summer because nothing grows without water in the West.

What challenges do you face?

One of the biggest challenges was learning how to function professionally with your parents as a member of a business, rather than, 'Oh, it's my dad telling me to go do my chores again,' mentality. Figuring out how to work with a parent was a huge personal challenge that first year or two. I had to think of my past work outside of the farm and think, 'If this wasn't my dad and this was one of my other bosses, how would I be handling this situation right now? Would I be getting fired up or would I take the advice and move on with my day?' Once I started doing that, our workplace dynamic changed and things became a lot easier.

How do you approach diversification?

Diversification forces you to focus your plan, because when you are overly diversified, it leads to real management headaches. We've found when we had too many irons in the fire, we needed to bring the number of crops down a bit. We eliminated apples because it was pulling us in too many directions at once.

Being diversified ... you really do have to be good at a bunch of different things.

by TJ Mullinax

More from this interview and other Young Growers at goodfruit.com/yg.

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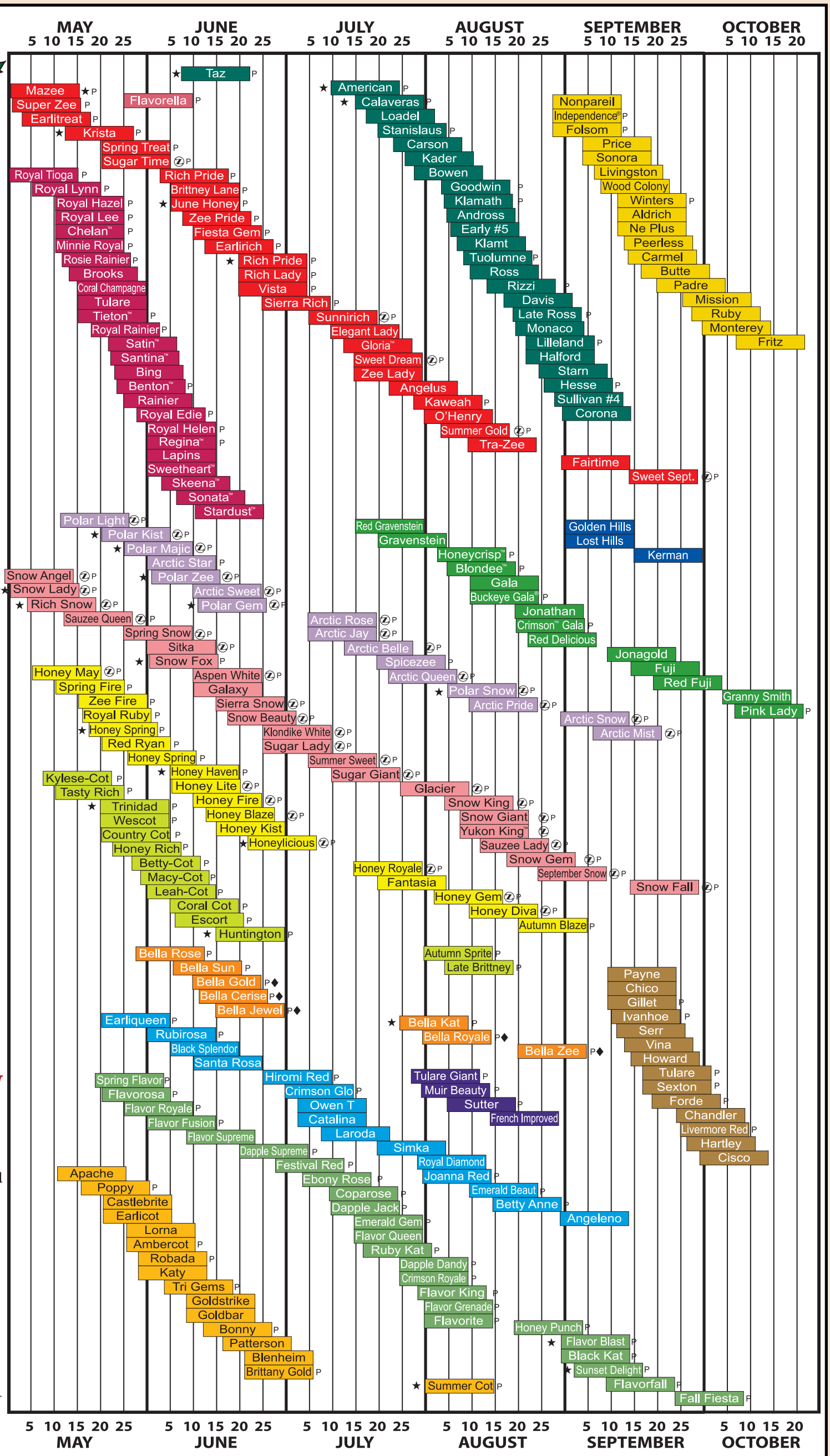

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- Scarlet Spur II
  Red Delicious

APPLES on EMLA 106

- Adams Apple®
  Red Delicious
- Scarlet Spur II
  Red Delicious

APPLES on EMLA 111

- Lodi
- Adams Apple®
  Red Delicious
- Scarlet Spur II
  Red Delicious

APPLES on EMLA 26

- Gale Gala®

- Honeycrisp
- Scarlet Spur II
  Red Delicious

APPLES on EMLA 7

- Redfield™ Red Braeburn
- Idared
- Red Jonaprince™ *Jonagold*

APPLES on M 9 (RN.29)

- Gale Gala®

CHERRIES on MAZZARD

- Benton™
- Black Republican

- Early Robin®
- Lapins
- Regina™
- Skeena™
- Stella

PEACH on SEEDLING

- Red Globe

APRICOTS on SEEDLING

- Goldbar™
- Goldstrike™

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