Oregon Wine Research Institute

Stakeholder Report

Oregon State University

As the Oregon Wine Research Institute celebrates its eighth anniversary in 2016, we are proud to share this report of its achievements. The OWRI was launched after Oregon's visionary wine industry recognized that research was key to its ability to compete with the great wine-producing regions of the world. Industry leaders approached Oregon State University with the idea of creating a unique entity that would increase collaboration among researchers at the university and the U.S. Department of Agriculture.

Today, thanks to funding from OSU, the Oregon Legislature and $2 million in startup funds from the industry, the OWRI is a virtual center under the umbrella of OSU's College of Agricultural Sciences. We have offices and labs at OSU's Corvallis campus and several of the university's research and Extension centers around the state. Our mission is to address the needs of Oregon's more than 1,000 vineyards and nearly 700 wineries through research and educational outreach. Our 17 experts — some from OSU and some from the USDA — have specialties in viticulture, plant diseases and pests, enology, flavor chemistry, sensory analysis and the molecular biology of plants.

You can find us across the state, including in southern Oregon, the Columbia River Gorge and northeastern Oregon. On any given day we may be examining grape clusters for mealybugs, weighing canes from pruned vines, peering at yeast under a microscope, or sticking our noses into wine glasses. Or maybe we are writing a guide on vine balance, teaching winemakers how to use a spectrophotometer or giving a talk on aroma compounds that we broadcast live online. We also mentor graduate students and teach undergraduate viticulture and enology courses, shaping the next generation of scientists, vineyard managers and winemakers.

Our "vine to wine" approach to research promotes interdisciplinary collaboration along the wine-production continuum. Such research aims to help growers and winemakers better understand how what they do in their vineyards and cellars impacts the quality of their wines. For example, our scientists are studying how nutrients impact not only yield, flower development and fruit set but also fermentation rate, consumer preference and wine aroma and flavor. We've also teamed up with OSU's Department of Applied Economics on two projects: helping wineries make marketing and pricing decisions that take into account consumer preferences, and helping vineyards understand how climactic and geographic features in Oregon's wine appellations contribute to the value of their properties. Additionally, we partner with Chemeketa and Umpqua community colleges and scientists around the globe.

We couldn't perform our work without the support of industry groups, legislators, foundations and government entities. For the 2014-15 fiscal year, 45 percent of our $1.9 million budget came from the state, 28 percent was from the OSU Foundation and the remaining 27 percent came from grants, which funded research. But it's not only financial support that we receive. Vintners make wines for our studies, and growers graciously allow us to conduct research in their vineyards, including 15 that are involved in a cluster thinning trial.

So we raise our glass in a toast to say thank you and to celebrate the OWRI's accomplishments and its continuing partnership with the state's vineyards and wineries. May you taste the results of our collective work in every glass of Oregon wine.

Cheers,

Mark L. Chien

Mark Chien
OWRI program coordinator

Produced by OSU's Extension and Experiment Station Communications department
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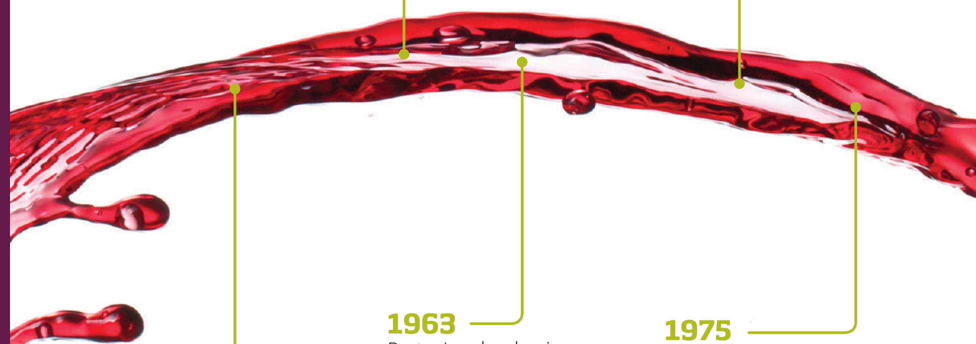
Cover photo: Pinot Noir grapes ripen on the vine. Photo by Lynn Ketchum
Contents photo: Mark Chien savors a glass of wine at Bethel Heights Winery. Photo by Lynn Ketchum

Historical highlights

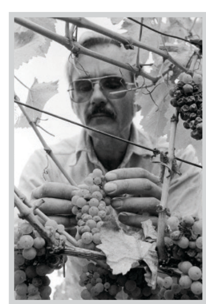
Oregon's modern-day wine industry started with a handful of passionate pioneers with a dream. Over the decades, hundreds joined these risk-takers to make Oregon a producer of world-class wines. OSU has supported them on this journey, providing research-based answers and on-the-ground education. Here's a look at some of the milestones.

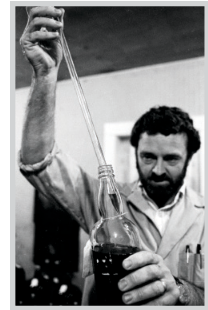


1951
Ralph Garren begins his 35-year tenure at OSU in small-fruit physiology. He identifies sites best suited for growing wine grapes, establishes technical notes for grape growers and provides tissue analysis and sample kits.

1956
Hoya Yang begins a 42-year career at OSU, where he researches acid-reducing yeast and conducts sensory evaluations to improve wine quality.

1963
Porter Lombard arrives at OSU's Southern Oregon Research and Extension Center, where he later plants OSU's first research vineyard. He studies cold and frost damage in grapes and supports southern Oregon's new grape industry.

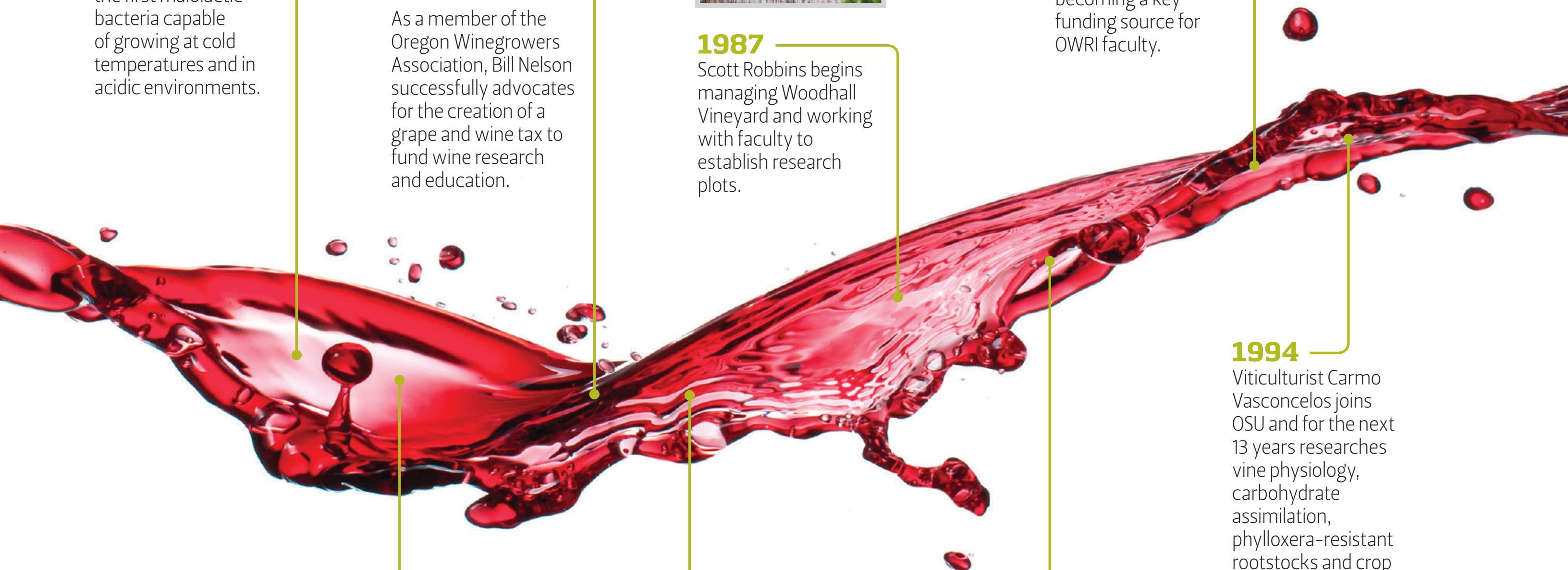




1970
David Heatherbell joins OSU, where he researches ultrafiltration of grape juice, characterization and removal of unstable proteins, and malate and tartrate in Oregon grapes.

1975
OSU obtains a grapevine quarantine permit from the USDA to import vinifera varieties into the U.S. as a result of work by David Adelsheim and OSU plant pathologist Ronald Cameron.

1976
Barney Watson begins working at OSU, eventually becoming an enologist with the university's Extension Service. During his tenure, he isolates the first malolactic bacteria capable of growing at cold temperatures and in acidic environments.



1983
Steve Price begins working at OSU with Porter Lombard. Price later develops a now widely used method of estimating crop yield that includes measuring cluster weights during lag phase.

1984
With OSU's help, the first Dijon clones of Pinot Noir and Chardonnay are legally imported into Oregon.

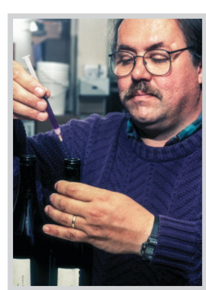
OSU organizes the first International Cool Climate Enology and Viticulture Symposium, which takes place in Eugene.

As a member of the Oregon Winegrowers Association, Bill Nelson successfully advocates for the creation of a grape and wine tax to fund wine research and education.

1986
Frank and Betty Baynes donate their 26-acre Woodhall Vineyard, just south of Corvallis, to OSU for research and teaching purposes.

1987
Scott Robbins begins managing Woodhall Vineyard and working with faculty to establish research plots.

1988
Food scientist Mark Daeschel helps get lysozyme, a natural enzyme, approved for use in wine to destroy spoilage bacteria and reduce sulfites.

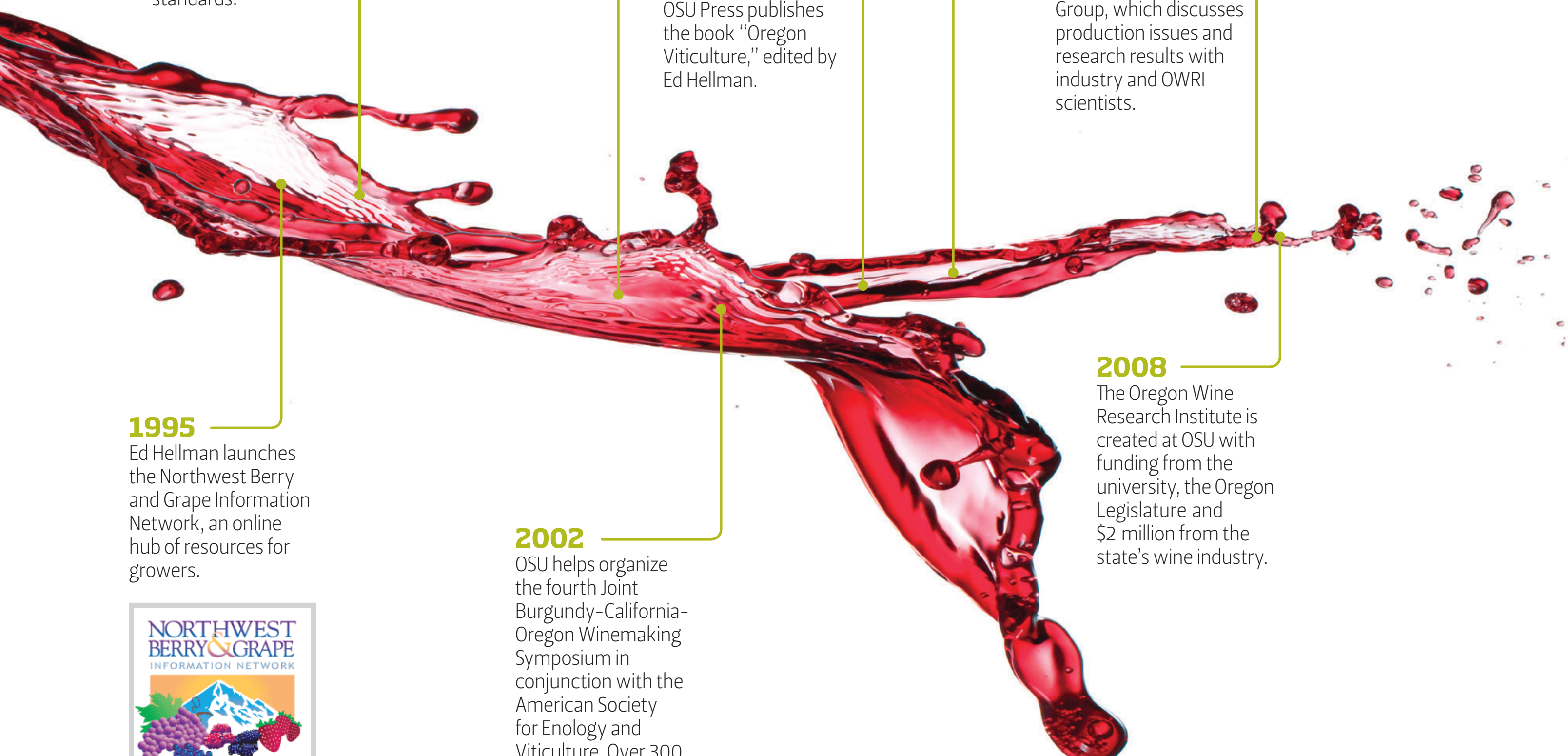


1990
The OSU Plant Clinic is the first to identify phylloxera in a commercial vineyard in Oregon. Over the next few years, OSU and the USDA's James Fisher study the conditions that support these root insects in Oregon, develop strategies to manage them, and conduct trials on rootstocks that resist them.

The Northwest Center for Small Fruits Research is created, becoming a key funding source for OWRI faculty.

1994
Viticulturist Carmo Vasconcelos joins OSU and for the next 13 years researches vine physiology, carbohydrate assimilation, phylloxera-resistant rootstocks and crop levels.

Ed Hellman is named as the viticulture educator for OSU Extension in the northern Willamette Valley.



1995
Ed Hellman launches the Northwest Berry and Grape Information Network, an online hub of resources for growers.

1997
Carmo Vasconcelos helps create the Low Input Viticulture and Enology (LIVE) certification program for vineyards and wineries that meet environmentally friendly production standards.

2001
OSU hires chemist James Kennedy, who researches tannins, phenolic compounds and berry ripening. He is instrumental in developing the enology and viticulture option in OSU's Department of Food Science and Technology.

2002
OSU helps organize the fourth Joint Burgundy-California-Oregon Winemaking Symposium in conjunction with the American Society for Enology and Viticulture. Over 300 winemakers attend this prestigious event in Portland.

2003
OSU Press publishes the book "Oregon Viticulture," edited by Ed Hellman.

2007
OSU commits to a full-time viticulture research position in southern Oregon to address regional vineyard issues.

2008
OSU's Patty Skinkis joins Allen Holstein, the head of vineyard operations for Argyle Winery, in co-chairing the Willamette Valley Viticulture Technical Group, which discusses production issues and research results with industry and OWRI scientists.

2008
The Oregon Wine Research Institute is created at OSU with funding from the university, the Oregon Legislature and $2 million from the state's wine industry.

Lynn Ketchum photos

Communications and outreach

The mission of OSU's Oregon Wine Research Institute is to conduct multidisciplinary research, foster collaboration between internal and external stakeholders and pass our knowledge on to the industry. Our ultimate aim is to further improve the quality of Oregon grapes and wine production and enable growers and winemakers to make informed decisions.

To ensure that vineyards and wineries benefit from our knowledge, we inform them of our work in a variety of ways, including those outlined on this page. As OWRI's communications and outreach manager, my goal is to ensure that these valuable resources end up in your hands. If you would like to learn more about our communications and outreach programming or subscribe to our Vine to Wine newsletter, please don't hesitate to contact me at danielle.gabriel@oregonstate.edu.

Sincerely,

Danielle Gabriel

Danielle Gabriel
OWRI communications
and outreach manager

OWRI website

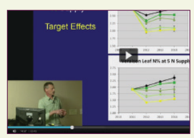
Extension publications, newsletters, information about upcoming events, scientific papers, PowerPoint presentations and recorded seminars are all online at owri.oregonstate.edu.

OWRI Viticulture and Enology Technical Newsletter

Created in 2007, this semiannual newsletter contains articles from our faculty in all disciplines related to grape growing and winemaking. Archived copies are available on our website.

Vine to Wine newsletter

Emailed to subscribers, this monthly newsletter contains information on new publications, recent happenings at the OWRI, upcoming events and recommendations from our faculty on handling issues in the vineyard and winery.

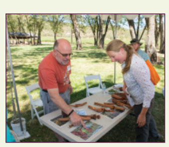


Seminars

In 2011, the OWRI implemented a seminar series to provide relevant information to the industry in an interactive, real-time format. Seminars are filmed on campus and streamed live online. They're recorded and archived on our website for later viewing. Past topics have included chiral monoterpenes in Pinot Gris wines and the impact of malolactic fermentation on the color of red wine.

Extension publications

The OSU Extension Service's catalog contains about 20 research-based publications — many written by OWRI faculty — to answer your day-to-day questions in the vineyard and winery. Topics range from scouting for powdery mildew to measuring dormant pruning weights of grapevines.



Workshops

Our hands-on workshops provide growers and winemakers the opportunity to connect with faculty and learn new techniques and management tools. Past topics have addressed vineyard taxes and common faults in wine.

Grape Day

At this annual event on campus, our faculty members present the latest advances in their research. The event, which is open to the public, drew a record attendance of 165 people in 2015.

Balancing act

By Gail Wells

On a bright morning in Oregon's Dundee Hills, Oregon State University viticulturist Patty Skinkis moves through the rows of grapevines like an industrious bee, pencil in hand and clipboard under elbow. Behind her, the vines sweep down like a river, framing Stoller Family Estate's winery and tasting room at the bottom of the hill.

She's visiting one of her research plots, the site of a 9-year-old study comparing different methods of managing a vineyard floor. The study is part of her overall work to help growers achieve that elusive condition known as vine balance — the happy equilibrium between a vine's fruit yield and canopy size that produces quality fruit and healthy vines.

Vine balance can be altered by what's on the vineyard floor, Skinkis said. Weedy competition can be a killer when the vines are small, but it isn't such a problem in well-established vineyards. In fact, a little competition can be good, she said, because western Oregon's climate and soils tend to produce a riot of growth in grapevines. "These high-vigor vines can have problems with fruit quality and ripening," said Skinkis, who arrived at OSU in

Lynn Ketchum photos

Above: An infrared gas analyzer measures photosynthesis, evapotranspiration, water vapor and temperature in grape leaves.
Left: Patty Skinkis prepares to monitor the amount of light hitting different areas of a grapevine canopy at Stoller Family Estate's vineyard.

> *Patty has been a great addition to Oregon's grape industry. Her outreach and research have definitely made me a better grape grower.*
>
> – Tim Scott, vineyard manager at Archery Summit

2007 and is also a specialist with the university's Extension Service.

Skinkis, who is a member of OSU's Oregon Wine Research Institute, established a study where grass was grown in the alleys between the rows to provide competition, and the soil was tilled in others to remove competition. For the next three years she monitored soil moisture, water stress in the plants and vine growth. She determined that using a grass cover in the alleys slowed the vines' growth without stressing them for water, and without harming yield. Her lab found that grapes from vines grown with grass had more color and perhaps better quality.

With the vine size altered between different vineyard floor practices, Skinkis investigated how thinning of Pinot Noir clusters affects the quality of the fruit. Oregon Pinot Noir growers typically thin their grapes during mid-season, when berries pause in growth, aiming for a yield of 2 to 2 ½ tons per acre. Many growers believe that smaller yields produce better fruit. But thinning is expensive because of the manual labor required. Does it really make a difference in quality? Skinkis addressed this question through various studies throughout Oregon. She thinned vines down to one cluster per shoot — a conventional strategy that reduces yield by about 40 percent — and left others unthinned.

Not surprisingly, the thinned vines yielded less fruit than the unthinned ones. After the fruit was evaluated for various components, its overall quality proved to be influenced more by the vineyard floor management practice than by thinning of fruit to achieve lower yields. "So vine vigor, as affected by vineyard floor management, not crop thinning, had the larger impact," said Skinkis.

To determine optimum thinning strategies that produce the best fruit while sustaining vine balance, Skinkis is conducting a 10-year study that compares different crop thinning levels at 15 Willamette Valley Pinot Noir vineyards. Findings after three years suggest that thinning has less impact than anticipated. There was often no difference in fruit ripeness measures at harvest (sugars, acids, color and other indicators) between fruit from nonthinned vines and from those that had been thinned by 40 percent or more.

OWRI researcher Elizabeth Tomasino conducted sensory trials of wine made from the crop load study's first-year harvest. She found that neither winemakers nor consumers expressed a preference for wines made from grapes from lower-yielding vines. While wine from future vintages needs to be analyzed together with vineyard and fruit data, Skinkis said, this finding suggests that fruit from low-yielding vines doesn't necessarily make the best wine.

Crop thinning did not affect vine vigor (as measured by dormant-season pruning weights) or canopy leaf area in the first three years of the trial, Skinkis said. And — as she found before — across all sites, the vine vigor, not the yield, likely accounted for site differences in fruit quality. "Fruit thinning is important for yield management," she said, "but it isn't the main reason vines produce high-quality fruit."

Skinkis' work is supported by the OWRI, the Oregon Wine Board, the U.S. Department of Agriculture, the Oregon Agricultural Research Foundation and the Northwest Center for Small Fruits Research.

Putting grapevines on a diet

By Gail Wells

In western Oregon, with its abundant rainfall and relatively rich soils, grapevines live off the fat of the land. But ancient wisdom holds that scarcity and struggle in the vineyard build character in wine.

"There's an old saying, 'Starve the vine to make great wine,'" said Paul Schreiner, a plant physiologist with the U.S. Department of Agriculture and a member of Oregon State University's Oregon Wine Research Institute.

Schreiner is not exactly starving vines, but he is putting them on a diet. At OSU's Lewis-Brown Farm in Corvallis, his Pinot Noir grapevines grow inside black containers that are nestled inside similar containers sunk into the ground. This "pot-in-pot" system allows Schreiner to drip precise nutrient mixes into each plant.

The results are clearly visible. One five-vine block sports a thick cascade of leaves, while a neighboring block has sparser leaves and thinner shoots. Yet some of the leaner vines produced just as many grapes as their leafier siblings, and wine made from the deprived grapes had more intense aromas of dark fruit and flowers. "We're looking for that nutritional sweet spot," Schreiner said. "We want to give the vine enough of the right nutrients to get both acceptable yield and excellent bouquet and flavor in the finished wine."

When he says "we," Schreiner means a team that personifies OSU's vine-to-wine approach. His own lab conducts the viticulture and plant physiology aspects of the research. Patty Skinkis' lab collects canopy metrics, and James Osborne's lab makes the wine. Michael Qian's lab analyzes fruit and wine aroma chemistry, and Elizabeth Tomasino's lab conducts the sensory testing. The team also includes Idaho-based USDA researcher Jungmin Lee, whose lab measures amino acids, phenolics and other important components in fruit and wine.

Lynn Ketchum photos

Above: A device helps monitor the moisture of the soil in one of Paul Schreiner's potted vines.
Above left: By tying mesh bags around clusters, Schreiner studies how the nutrient levels of vines affects how many flowers develop into fruit.
Far left: Schreiner looks for water bubbling from a grape leaf petiole in a pressure chamber. The device monitors whether vines are getting enough water.

Of the Big Three food groups of plants (nitrogen, phosphorus and potassium), nitrogen influences vine growth the most. In many western Oregon vineyards, there's already plenty in the soil. It makes vines grow like crazy, producing big leaves that can shade the fruit and delay ripening. The key question for many growers is not how much to add but how much to take away, through such measures as sod cover between vine rows.

To find the best diet for grapevines, Schreiner dripped different amounts of nitrogen, phosphorus and potassium into his pots-in-pots. Doses started at a moderate nutrient level that would develop a healthy canopy, and were stepped down to various lower levels for each nutrient.

The vines grew less vigorously as nitrogen declined — no surprise. The leafiness of the plants and the yield of fruit both went down, and so did another important measure: yeast-assimilable nitrogen (YAN), the form of nitrogen in the berries that feeds the yeast during fermentation.

All these measures declined at different rates, though. So how much nitrogen would it take to produce the best combination of plant vigor, yield and YAN? Schreiner ran a statistical analysis and found his sweet spot at the point where the leaves contained between 1.8 and 2 percent nitrogen at veraison, the point at which the berries start to turn color.

When leaf nitrogen was about 2 percent, vine vigor and YAN dropped a bit more than 20 percent, and leaf area dropped by about 15 percent, while fruit yield stayed the same. These values are likely to result in good wine and good vine balance, Schreiner said. Less YAN means slower fermentation, which can alter the flavor and aroma chemicals in wine — something some winemakers may desire. If YAN drops too much lower, however, fermentation doesn't happen.

Dropping phosphorus and potassium didn't influence the vines or the grapes nearly as much, although when there was no potassium, juice was too acidic and too low in sugar to make good wine. And over time, Schreiner said, too little potassium will cause a fruit-damaging condition called late bunch-stem necrosis.

His team found that the low-nitrogen treatments produced higher levels of desirable chemicals — in particular, tannins, which alter Pinot Noir's mouthfeel, color and aroma perception. In sensory trials, wines made from the leaner vines were judged to have a more intense aroma of dark fruit.

Schreiner has started a new study in a vineyard near Amity with historically low fruit YAN. "My work suggests that dropping nitrogen may improve quality," he said. "If that's true, I want to start at a site with low nitrogen, and see what happens when we add some in the vineyard, as compared to adding it in the winery, a common practice."

Schreiner's pot-in-pot trials were funded by the Northwest Center for Small Fruits Research, the Oregon Wine Board, the OWRI and the USDA. Schreiner also conducts research on soil-dwelling nematodes, the relationship between vines and water, and beneficial root-fungi relationships in grapevines and other plants.

Ripe for research

By Gail Wells

Lynn Ketchum photos

A cluster of ripening Pinot Noir grapes is a painter's delight, with colors shading from silver-green to dawn-pink to deep rose to plum. Soon the cluster will be a uniform blue-black. But now the berries seem to be in a race, the dark-red overachievers sprinting toward the finish line, the paler laggards struggling to catch up.

Why don't they all ripen at the same time? Molecular biologist and genomicist Laurent Deluc, who joined Oregon State University's Oregon Wine Research Institute in 2009, has built his research around that seemingly simple question and its corollary: Could uniform ripening produce consistently excellent vintages and more manageable vineyards, too?

> *From my first conversation with Laurent, it was clear he brought a skill set, energy and professionalism that could help the industry.*
>
> – Mike Kuenz, general manager of David Hill Vineyards and Winery

To investigate this, for the past four years Deluc and his graduate students, plus an army of helpers, have spent the two-week flowering season at the university's Woodhall Vineyard tying colored strings around every grape flower in selected Pinot Noir clusters. Each color corresponds to a different flowering date. It's tedious work, requiring nimble fingers, good eyesight and the ability to squat or stoop for long periods. The strings stay on through summer and fall, enabling the team to track each berry from hard green bolus to plump, juicy grape.

The first thing Deluc studied was time of flowering. It would make sense that berries from early flowers would ripen first. But did they always? Deluc's doctoral student Amanda Vondras backtracked the red and green berries from the onset of ripening to their flowering date based on the color of the thread. Most of the early berries came from early flowers, but not all — a significant minority of the late berries developed from early flowers, and vice versa.

Then, at the onset of ripening, Vondras compared the sweetness of green berries that had grown from early flowers with that of green berries from late flowers. She did the same for the red berries.

She expected that, in both groups, the berries from the late flowers would be lower in sugar. But they weren't — the sugar content was the same. That meant the later-flowering berries within each group had managed to develop the same sweetness as their earlier siblings, in a shorter time.

If flowering time is clearly not the only factor in variable ripening, what else could it be? Deluc and Satyanarayana Gouthu, a postdoctoral researcher on his team, are probing deeper, looking into the complex cocktail of hormones that govern ripening — in particular the delicate handoff between auxin, which holds back ripening until the right moment, and abscisic acid, which takes over and pushes the fruit into ripeness.

Deluc and Vondras had noticed that the laggard berries — the ones that were still green at the onset of ripening — contained more

Above: Laurent Deluc uses fine color-coded threads to tag tiny grape berries. **Below:** An infrared thermometer takes the temperature of ripening grapes.

seeds on average than the red berries, and the seeds in the green berries weighed more, relative to the total weight of the berry.

Deluc and Gouthu speculated that the extra-bulky seeds in the green berries were producing larger quantities of auxin, the "hold back" hormone. This would be logical, because some ripening hormones, including auxin, are known to be released into the fleshy fruit from the seeds. But were the seeds the only factor? Or was some other influence — perhaps genetic activity at the larger plant level — causing the laggard berries to delay their ripening?

To find out, Gouthu looked at two key sets of genes: those that trigger the plant to manufacture auxin, and those that respond to auxin already present. They found less activity in the first group of genes (because the auxin was already manufactured), and more activity in the second group (because there was more auxin in the fruit).

This suggests that the weightier seeds in the green berries are mostly responsible for those berries' slower ripening pace, Deluc said. But the mystery isn't solved yet. As the berries moved toward full ripeness, the differences in gene activity nearly disappeared. The green berries caught up with the red ones and crossed the finish line at the same time.

Deluc continues to probe deeper into the genes that drive the ripening process. "This variable ripening is a very basic aspect of grapevine growth, but with very particular applications," he said. "If we know exactly the mechanisms that decide when the fruit will enter its ripening, we might be able to develop different strategies to promote it, or delay it, depending on the environmental conditions you are in."

Deluc's research is funded by the Oregon Wine Board, the OWRI and OSU's College of Agricultural Sciences.

Going viral

By Gail Wells

Bob Martin studies grapevine viruses for Oregon State University's Oregon Wine Research Institute. He investigates symptoms such as blotchy red or veiny yellow leaves, mosaic-like leaf mottling, shrunken fruit and gnarled graft joints with dead roots. He and his team grind up diseased tissues and extract viruses. They sequence their genomes and feed the genetic fingerprint into a worldwide database, looking for a match with one of the hundreds of viruses that infect wine grapes and other small fruits.

Martin, who is also a virologist for the U.S. Department of Agriculture, coordinates this work with colleagues in Washington and Idaho, contributing to a growing body of knowledge about viruses in Northwest fruits.

Sometimes his investigation turns up a known culprit, like grapevine leafroll virus, a serious disease in California and an emerging problem in southern Oregon. Leafroll disease delays ripening, lowers yields and impairs quality in grapes. If a virus proves to be grapevine leafroll, Martin will tell the grower to look for the vector — mealybugs, which feed on diseased plants and transmit the virus through their needle-like mouthparts.

Sometimes the team discovers an unknown cousin of a familiar virus. When that happens, they comb the database for clues to the newcomer's family tree. From this genetic research, they develop tests that breeders and regulators later use to screen plants for the virus.

Right: Bob Martin examines a Pinot Noir vine that tested positive for grapevine red blotch-associated virus.

Lynn Ketchum photos

Top: Severe reddening of leaves is a symptom of grapevine red blotch-associated virus. It is unknown how the virus spreads.
Above: At workshops, Martin brings his collection of grafted vines to show how viruses can result in necrosis where the rootstock and scion join.

Martin led the team that conducted the first comprehensive survey, in 2000, of viruses in Oregon and Washington vineyards. They discovered three strains of leafroll virus and estimated that about 7 percent of Oregon vineyards had it.

In California, leafroll virus is spread by vine mealybugs. Martin's team didn't find any vine mealybugs in Oregon, even in vineyards with the virus. They did find a close relative, grape mealybug, but they didn't know whether it was the vector. So they caught some grape mealybugs and let them chew on clean plants to see if symptoms developed. They did. Then they isolated a virus from the newly infected plants and tested it to see whether it was one of the same leafroll strains they'd found. It was.

Mystery solved — and it was good news, because, according to studies from OWRI entomologist Vaughn Walton, the grape mealybug is slower to reproduce and slower to spread than its more damaging California cousin.

> “Bob has been at the vanguard of virus detection all over the state. Besides doing research, he has made his lab available for testing as growers discover sick vines.
>
> – Allen Holstein, head of vineyard operations for Argyle Winery

Thanks in part to Martin's work, the Oregon Department of Agriculture imposed an emergency quarantine in 2007 that stiffened Oregon's plant-import restrictions. In Washington, his survey prompted more-rigorous testing of vines propagated for nursery stock.

Martin, who has been with the OWRI since 2009, and his team are now working on another mystery that emerged several years ago in the form of irregular red leaf patches in a Napa Valley vineyard. Similar symptoms later appeared in a dozen states, including Oregon. It looked like leafroll virus, said Martin, but when researchers at Cornell looked under an electron microscope they got a surprise: A spherical-shaped virus instead of the hair-like leafroll virus.

The newly discovered virus, dubbed grapevine red blotch, fits within a family of viruses spread by leafhoppers and whiteflies, but its actual vector remains a mystery. It's been detected in several southern Oregon vineyards, and a few in the Willamette Valley.

The best way to avoid red blotch and other virus problems, Martin said, is to plant only virus-tested, certified plants. “And if you have problems in your vineyard,” he said, “test before you do anything. You want to know for sure what you're dealing with.”

Martin's research on winegrape viruses has been funded by the OWRI, the Oregon Wine Board, the USDA's Agricultural Research Service, and the National Institute of Food and Agriculture.

Getting the bugs out

By Tiffany Woods

Vaughn Walton, an entomologist at Oregon State University, knows the intimate details of the insects he studies. He learns about their sex lives, their favorite foods, how many kids they have, how much they drink, what they weigh and where they travel. Using that information, he then helps devise ways to outsmart them. It's all part of his mission of providing growers with environmentally friendly options for controlling insects.

One of those pests is the brown marmorated stink bug, which clings to harvested grapes and secretes an unpleasant cilantro-like scent into juice or wine when it's flattened in a grape press. Walton and fellow OSU entomologist Nik Wiman are studying how much damage the insects cause to grapes and what temperature makes them eat more. The project, funded by the California Department of Food and Agriculture, will give growers an idea of what regions in the West Coast are more susceptible to damage from the pest based on their climate, said Walton, who joined OSU in 2006 and is a member of its Oregon Wine Research Institute.

As part of the project, on a row of Pinot Noir at OSU's vineyard in Corvallis, Wiman snapped golf ball-sized cages onto leaves and put a stink bug in each one. Some were on the warmer west side of the vine while others were on the cooler east side. Sensors recorded the temperature and humidity and how many times the pests pierced the leaves with their needle-like mouths. On those same vines, Walton's graduate student Erika Maslen tied organza

Lynn Ketchum photos

Above: A brown marmorated stink bug clings to ripening grapes.
Above right: A tiny cage with a stink bug inside records how many times the insect pierces a grape leaf with its mouth.
Left: Vaughn Walton checks organza bags that contain stink bugs and are tied around grape clusters. He aims to see if the insect damages the fruit.

bags containing stink bugs around grape clusters. She planned to later inspect the grapes for damage. Walton expects to have results in early 2016.

The brown marmorated stink bug arrived in Oregon in 2004 and has since spread throughout the state. It's well known that it's a deft hitchhiker, but Walton and Wiman wanted to know how much ground it could cover on its own. So Wiman glued stink bugs to tiny pivots that recorded the number of rotations they made. He found that they can fly up to 47 miles in 24 hours, although 80 percent of the tethered insects flew no more than about three miles a day. These numbers will help predict how fast the bug can spread, said Walton, who shares his knowledge with growers as a specialist with OSU's Extension Service.

Another pest that Walton knows well is the spotted wing drosophila, which was first reported in Oregon in 2009. Although the fly lays eggs in ripening fruit, Walton and a team found that the tough skins of grapes are a natural defense. The real concern, the scientists found, is that in wet years, the fly feeds on rain-cracked grapes, and in the process, it can transmit bacteria and yeast that produce undesirable aromas in wine. So Walton, who directed the USDA-funded Spotted Wing Drosophila Project, and graduate student Kyoo Park are testing aromatic organic substances in the lab and field to see if they can entice the fly away from fruit.

Another way to foil the fly without using synthetic pesticides is to enlist the help of parasitic wasps that lay eggs in the fly's larvae or pupae. Walton's research assistant Betsey Miller traveled to the fly's native South Korea and collected four different species of wasps, which are now in quarantine at the University of California at Berkeley while scientists make sure they won't attack other insects besides the fly. Walton has conducted his own research on other parasitic wasps. With funding from the USDA's National Institute of Food and Agriculture, he and his colleagues tested three species from Oregon and Italy but found that the wasps weren't effective, so he has now pinned his hopes on the South Korean wasps.

The grape rust mite is another target that Walton and his colleagues have set their sights on. They found that it chews on developing buds in Oregon vineyards, producing what's called short shoot syndrome. Fortunately for growers, another mite known as *Typhlodromus pyri* has a voracious appetite for these tiny morsels. Walton worried that commonly used pesticides might be hurting this beneficial bug. So his lab crew sprayed *T. pyri* with six different products. The findings led the researchers to recommend that growers minimize their use of oils and sulfur, and instead use synthetic pesticides.

The newest enemy on Walton's radar is one that has yet to be identified. Funded by the Oregon Wine Board, he and research assistant Daniel Dalton are searching for the carrier of the virus that causes red blotch in grapevines. It's known that mealybugs transmit a virus that causes a similar-looking disease known as leafroll, but Walton thinks a different insect transmits red blotch because of the differences in the way the two viruses have spread in vineyards.

"The bottom line," Walton said, "is that we should be thinking about these insects before they become problems. That's exactly what we're doing."

Breaking the mold

By Gail Wells

By the time Walt Mahaffee arrived in Corvallis in 1996, powdery mildew had become a problem in Pacific Northwest vineyards. The fungal disease infects leaves and grapes and, if unchecked, makes the wine taste like sweaty gym socks. It can also predispose the berries to infections by other pathogens like the fruit rot *Botrytis*.

An epidemic can explode virtually overnight, Mahaffee said, "and your vineyard can go from seemingly normal to looking like a child has been playing with a bag of flour." But very often, initial signs point to an outbreak, but then it doesn't happen.

This unpredictability grabbed the attention of Mahaffee, who is a plant pathologist with the U.S. Department of Agriculture and a scientist with Oregon State University's Oregon Wine Research Institute. He and his students delved into the basic ecology of fungal-host interactions. Today their work is paying off in practical solutions for growers, including disease-forecasting models, cultural practices to prevent or minimize infection and ways to optimize timing of fungicide sprays.

The powdery mildew fungus, native to the eastern United States, is an obligate parasite, meaning it needs its host — grapevines — to live and reproduce. Spores disperse in spring and infect new growth. These infections can release another

Lynn Ketchum photos

Above: Using tweezers, Walt Mahaffee removes stainless steel pins from a spore trap. He'll analyze them back at the lab to see if powdery mildew adhered to them. **Left:** Mahaffee checks the solar power connection to a spore trap.

generation of spores in as few as five days; up to 35 generations of spores can emerge in a growing season, Mahaffee said.

"We've done a lot of work on its basic biology in the Northwest," he said, "learning how pathogen and host respond to each other in a nonnative environment."

In one of his first experiments, he and graduate student Tyrone Hall moved potted grapevines into and out of planted vine rows daily for three seasons, trying to understand the relationship among spring weather, spore release and infection of new tissue. They saw weather that, according to the literature, should have caused spores to be released but none were. When spores did appear, it was usually later than expected. They concluded that early-spring spore release was out of phase with vine growth; spores were released when there was no new tissue to infect. That was why outbreaks were so unpredictable.

To prevent trouble, growers typically start spraying fungicide early in the spring. Mahaffee and Hall's work suggested that some of the early sprays might not be needed. Mahaffee and a collaborator developed simple-to-use spore traps and enlisted growers to install them in their vineyards. To identify the trapped spores, he and graduate student Lindsey Thiessen adapted a genetic test developed with Washington State University collaborators Gary Grove and Jennifer Falacy.

Some growers agreed to hold off spraying until they'd detected spores. At the end of the three-year trial, these growers had knocked three to four sprays off their schedule, reducing their fungicide use by 20 percent, Mahaffee said.

Some larger wineries have now adopted the test kit, he said, and three consulting companies are offering spore testing as a service. He and Tim Miles, a University of California collaborator, are adapting the DNA test so that it can identify fungicide-resistant strains of powdery mildew by their genes.

how fungal diseases — or insect outbreaks, pesticides or even gusts of cold air — move through a vineyard. "We're helping growers better manage risk," he said, "by giving them tools to predict what's likely to happen in their particular canopy architecture and terrain."

His vision for the future: precision agriculture that uses predictive models integrated into smart tools to identify and solve problems. "Imagine this," he said. "You climb into your tractor, and you turn on your computer screen, and it shows you everything that's going on right where you

> *Walt has helped me eliminate a number of costly sprays because of his research into the life cycle of powdery mildew. I've been able to forgo about two fungicide applications each year, saving me about $100 per acre.*
>
> – Rob Schultz, vineyard manager at Stoller Family Estate

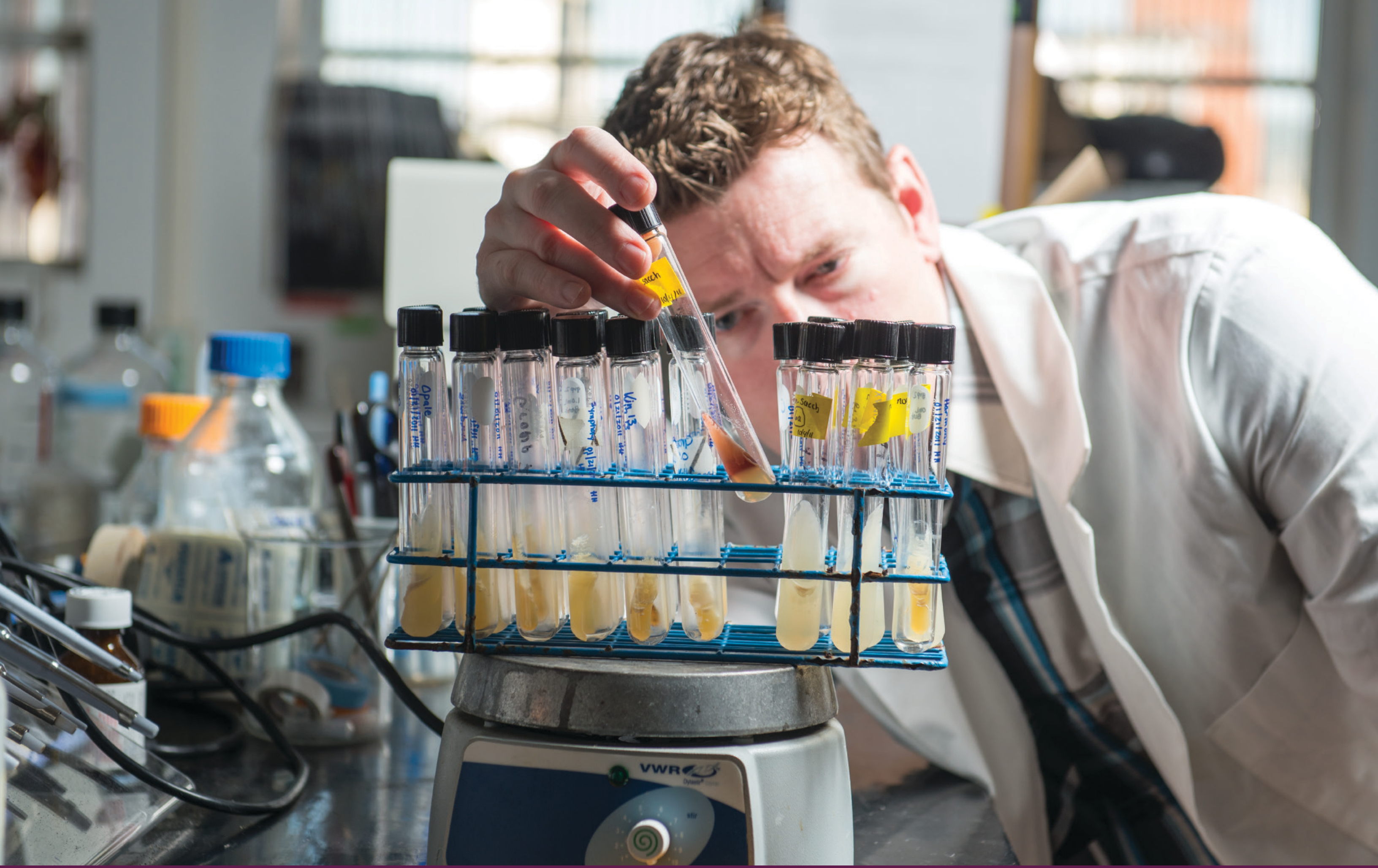
are. You drive down a row and see that the sensors picked up powdery mildew spores this morning. So you tell the computer to apply the exact amount of spray exactly where it's needed."

That vision is not far from reality, he said. "With the speed of technology development, I predict that 20 years from now today's biggest goals will seem small."

Mahaffee's lab is also studying how powdery mildew and other pathogens spread through a vineyard. To simulate the movement of wind-driven spores through a canopy, he and collaborators from OSU (Chad Higgins, Patty Skinkis and Chris Still) and the University of Utah (Rob Stoll and Eric Pardyjak) set up a three-dimensional array of measuring devices in a vineyard near Amity. Then they released tiny fluorescent plastic pellets and captured real-time micro-measurements of how they swirled, swooped and finally settled.

With these and other measurements, Mahaffee and his collaborators are developing detailed models for predicting

Mahaffee's work is funded by the USDA's National Institute of Food and Agriculture, the National Science Foundation, the Oregon Wine Board, Viticulture Consortium West, and the Northwest Center for Small Fruits Research.



The microscopic world of wine

By Tiffany Woods

James Osborne has made a lot of really bad wine. Wine that smells like a hospital ward or like you stepped in something. Wine that tastes acrid and metallic, like a copper penny. Wine that reminds you of nail polish remover, rotten eggs or a wet dog.

It's all part of his job as a microbiologist with Oregon State University's Oregon Wine Research Institute. He studies how tiny organisms — like yeast and bacteria — can mean the difference between wine that lands on the pricier top shelf at the store or the bargain bottom level. And as an enologist with the OSU Extension Service, he uses his research results to help vintners solve problems in their cellars.

For example, winemakers were finding that their red wines weren't so red after undergoing malolactic fermentation, which lessens the acidity. Osborne wanted to know if this secondary fermentation was in fact reducing the color, and if so, was there anything that could be done about it? With funding from the American Vineyard Foundation and the Oregon Wine Board, he found that the process did indeed diminish color in Pinot Noir and Merlot and that the culprit was *Oenococcus oeni*, *I have changed some of my barreling down practices as well as malolactic inoculations after talking with James and listening to his presentations.*

– Elizabeth Clark, winemaker at Airlie Winery

a bacteria that winemakers commonly add to wine to induce malolactic fermentation. Osborne, however, found that this microbe breaks down acetaldehyde and pyruvic acid. These two compounds are important to the development of polymeric pigments, which play a role in long-term color stability and account for most color in older red wines.

So what to do? Focusing on Pinot Noir, Osborne tried several fixes. He lengthened the period in which wine is left in contact with grapes skins prior to malolactic fermentation with the hope that more polymeric pigments might form. But that actually produced wines with a lighter hue. He added pyruvic acid. No dice. He added acetaldehyde. That restored about half the color and polymeric pigments. Taking his lead from an old winemaking technique, Osborne postponed the malolactic fermentation for up to six months. Although some color loss was still noted, polymeric pigments did not decrease. Starting malolactic fermentation later than normal, however, means delaying the addition of sulfur dioxide and possibly increasing the risk of spoilage. After all this, Osborne concluded that Pinot Noir color can be improved by delaying malolactic fermentation for six months but that wines must be stored at cool temperatures during that time to prevent spoilage.

Lynn Ketchum photos

Left: James Osborne scrutinizes test tubes containing various yeast cultures.
Below: *Metschnikowia pulcherrima* is a strain of yeast that Osborne isolated in a study on how non-Saccharomyces yeast that are on grapes prior to fermentation affect wine quality.

Osborne, who has been at OSU since 2006, has also focused his attention on another stage in the winemaking process: cold soaking. After grapes are harvested, some winemakers chill them in a tank prior to fermentation because they believe it improves color, flavor, aroma and mouthfeel. Osborne wondered if there was any truth to the aroma part, and if there was, what was causing it? He had a hunch that the rugged yeast that survive this cold bath played a role. Yeast are a ubiquitous fungi that float in the air and coat surfaces, including grape skins. So when grapes arrive at a winery, they bring their single-celled friends with them. These freeloaders then enjoy an all-you-can-eat buffet in the grape juice, gorging on the sugar as they convert it into alcohol and carbon dioxide.

Funded by the Oregon Wine Board, Osborne isolated yeast strains out of cold soaks then grew them in petri dishes in his lab. Beautiful teal streaks and white knoblike dots came into focus like a slow-developing Polaroid picture, allowing Osborne to identify the strains based on their color and shape. He then made wine with these strains and called on colleagues Michael Qian and Elizabeth Tomasino to assess the aromatic properties using lab equipment and human sniffers. The researchers found that cold soaking does influence smell regardless of whether yeast are present. But when they are, each individual strain has its own effect on the aroma. As a result, Osborne said, winemakers might want to manage their cold soaks accordingly to encourage or limit growth of the yeast.

Another project Osborne is working on involves *Brettanomyces bruxellensis*, a yeast that can cause problems for winemakers. Whenever vintners smell bandages, they know "Brett" is in the house. This opportunistic guest makes itself at home in oak barrels and can be difficult to kick out. It loves to dine on certain phenolics, and in the process, releases its trademark odors, which have been described as medicinal and horse manure, among others. With funding from the Northwest Center for Small Fruits Research, Osborne looked at winemaking practices that could unwittingly encourage the growth of Brett. He found that the growth of a strain of *O. oeni* called Vinoflora during malolactic fermentation increases the phenolics that Brett noshes on. This results in Brett producing high levels of its telltale stench. Consequently, Osborne recommends that winemakers avoid using this particular strain in barrel-aged red wine. In the meantime, he is evaluating more strains of bacteria to see if they increase the phenolics that feed Brett's appetite.

Making scents of wine

By Tiffany Woods

Michael Qian smells scents emitted from a machine that separates the aroma compounds in wine.

Michael Qian has a nose that would make a bloodhound jealous. Give him any scent and he'll tell you the chemical compound responsible for it.

Rancid cheese? That's easy: butyric acid. Rose? No problem: benzenethanol. Banana? Isoamyl acetate.

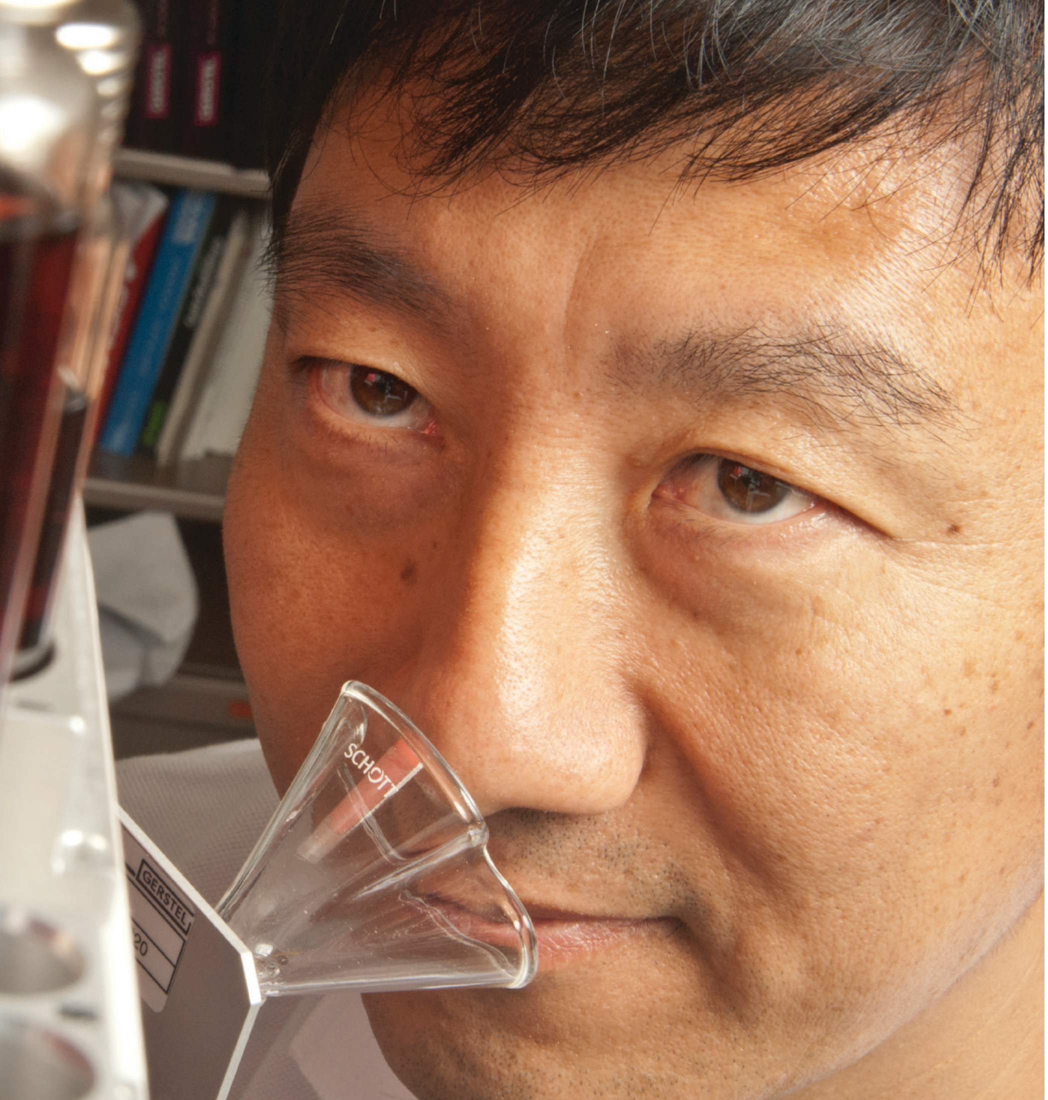
Qian's sensitive nose is actually a machine called a gas chromatograph-mass spectrometer/olfactometer, which can identify smells in everything from a rotten egg to shampoo. The device graphs the compounds on a computer as it puffs the corresponding aromas into the air through a little glass cup. All Qian (pronounced chen) has to do is press his nose into the cup as if smelling a flower, and there it is, the scent of cloves, black pepper or perhaps honey. Qian, a flavor chemist at Oregon State University and a member of its Oregon Wine Research Institute, uses this bionic beak to understand how what happens in the vineyard and cellar affects the aromas and flavors of the resulting wine.

For example, he wanted to know how cluster thinning might influence wine chemistry. He collaborated with OWRI viticulturist Patty Skinkis on a three-year study that consisted of three thinning techniques in which they left one cluster per shoot, 1 ½ clusters per shoot and one cluster every two shoots. Defying conventional thought, they found that crop thinning does not actually improve the aroma in Pinot Noir grapes and wine.

Qian and Skinkis also turned their attention to the amount of leaves on Pinot Noir vines. For three years, they studied vines in which none, half or all of the leaves around clusters of pea-sized berries had been removed. They found that when all leaves around a cluster were clipped off, there were higher concentrations of desirable compounds in the grapes and wine that were responsible for mouthfeel and aroma.

Qian also teamed up with OWRI plant physiologist Paul Schreiner to study the impact of applying different levels of nitrogen, phosphorus and potassium in the vineyard. They found that potassium and phosphorus didn't affect the aroma of Pinot Noir wine but that nitrogen did. They observed that as nitrogen increased, so did most alcohols, esters and grape-derived aroma compounds in the wine.

Additionally, Qian has studied the impact of irrigation on aroma compounds in Syrah, Malbec and Merlot, with the aim of helping growers use water efficiently while



Lynn Ketchum photo

> *Using his unique analysis techniques, Michael was integral to a three-year closure study with wine companies Argyle and Gallo-owned G3 Enterprises. This was an important step toward understanding the sulfur chemistry involved in wine aging.*
>
> – Rollin Soles, Roco Winery owner and winemaker

producing premium grapes. He conducted a three-year study in which Merlot vines in Idaho received only a third of their water needs. Qian concluded that limiting irrigation decreases the concentration of negative compounds and increases positive ones in grapes and wine. Compared to vines that received all the water they required, the wine made from the water-deprived vines had increased concentrations of compounds associated with aromas described as floral, tropical fruit, stewed apple, smoky, spicy and clove.

Qian, who has been at OSU since 2001, has taken his research overseas. He and international colleagues looked at different Pinot Noir leaf canopies at a vineyard in Tasmania, Australia, and found that as vine vigor decreased, soluble solids in grapes and phenolics and anthocyanins in wines increased while titratable acidity and yield diminished. Wines from vines with the least amount of vegetation had higher concentrations of fruity aroma compounds. In another study in Tasmania, Qian and his counterparts explored the impact of sunlight and ultraviolet radiation. They exposed some Pinot Noir clusters to sun and shaded others. They also shielded some with a polycarbonate sheet to block UV rays while they used an acrylic sheet on others to allow UV wavelengths to pass through. They found that sunlight, particularly the UV rays, increased wine anthocyanins and grape-derived aroma compounds.

In addition to the vineyard, Qian looks at how winemaking practices affect aromas. He aims to understand the interaction between the compounds in the grapes and the subsequent ones in the wine. He's asking: Are they the same? Were non-aromatic ones in the grapes converted to aromatic ones in the wines? What kind of role did the yeast play? "From grape to wine there's a transformation. I'm trying to find the link between grape quality and wine quality," he said.

Qian has partnered with OWRI enologist James Osborne and researchers from Spain to identify nontraditional strains of yeast that enhance the aroma of wine. Not all of the aromas that Qian studies, however, are pleasant. He researches off-flavors so flawed wines don't end up in consumers' glasses. For example, he identified hydrogen sulfide, methyl thioacetate and methanethiol as the culprits behind a stinky, rotten egg smell. Working with Osborne, he is now investigating the formation of these sulfur-containing compounds during barrel aging.

Qian's work has been funded by the Oregon Wine Board, the Northwest Center for Small Fruits Research, the American Vineyard Foundation and E. & J. Gallo Winery.

Research so good you can taste it

By Tiffany Woods

In a classroom on Oregon State University's campus, a handful of taste testers press their noses into glasses of Pinot Noir. They swirl, sniff, sip, swish and spit. As they roll and chew the wine in their mouths, they try to pin down exactly what it is they're tasting and smelling. Was that geranium? Maybe bay leaf? How about toasted bread? Is it silky or syrupy? Metallic, steely or soapy?

The evaluators, who included Oregon winemakers, were participating in a sensory test to determine if soil, climate and grape-growing and winemaking practices affect the flavor and aroma of Pinot Noir from sub-regions of the Willamette Valley. Now in the data analysis phase, the project

Elizabeth Tomasino (right) instructs Elizabeth Clark, the winemaker at Airlie Winery, on how to fill out a survey during a taste test on campus.

Stephen Ward photo

is led by enologist Elizabeth Tomasino, who joined OSU's Oregon Wine Research Institute in 2012 as the scientist at the very end of its "vine to wine" research spectrum. She's the one her colleagues and Oregon's wine industry turn to when they want to see how what they're doing in the vineyard and winery influences what ultimately ends up in the glass.

Tomasino is an indefatigable researcher overseeing a mile-long list of sensory tests. You'll find her surrounded by cases of donated wine, popping corks like a bustling sommelier, pouring wine into glasses by the dozens and handing out spit cups and crackers. The goal of these tests is to provide vineyard managers and winemakers with valuable insights that they can use to market their wines, guide production practices and understand what factors impact the quality of their wines.

Stephen Ward photo

Black glasses are used in some of the taste tests so evaluators are not influenced by the color of the wine.

One of her projects, funded by the National Institute of Food and Agriculture, started a few years ago when a new invasive pest known as the brown marmorated stink bug was found clinging to grapes in Oregon vineyards. Although it doesn't end up in the final product, when the bug is flattened in a grape press it emits a cilantro scent, which may taint the wine and is generally perceived as a flaw. Tomasino and OSU entomologist Nik Wiman wanted to know what chemical compounds the stink bug secreted. So they tossed clusters of Pinot Noir grapes and stink bugs into a destemmer and made wine, which they later analyzed.

They found that the main compound secreted was the green, musty trans-2-decenal. With the help of graduate student Pallavi Mohekar, Tomasino served sensory evaluators Pinot Noir and Merlot spiked with eight different amounts of a food-grade version of the chemical to find out at what concentration it was off-putting to panelists. The result: Once the level hit 12 micrograms per liter, the majority of evaluators said they didn't like the wine. For winemakers with too much cilantro taint, Tomasino is investigating ways to remove it using filtration and fining agents.

Funded by the Oregon Wine Board, Tomasino is also investigating chemical compounds known as chiral terpenes. Naturally occurring in grapes and released by yeast during winemaking, they add citrus and floral notes to white wine. Tomasino identified many of the chiral terpenes that are in Pinot Gris and Riesling wines and determined that the origin of the grapes affects the types and concentrations of them. To do this, she first developed a method to measure them in white wine. After that, doctoral student Mei Song looked for 15 terpenes in more than 50 Pinot Gris wines, about half of which were from Oregon.

Among the data, Tomasino teased out a few other conclusions: The compounds that cause coniferous and lilac aromas were present in all the wines, but the compounds for floral, green, clean smells and herbal, bitter citrus peel were not in the wines. The types and levels of terpenes in Oregon Pinot Gris differed from those in Pinot Gris from New Zealand, New York and Italy, but they resembled Washington's. And Oregon Pinot Gris was characterized by higher levels of a compound responsible for strong earthy, leafy aromas.

Tomasino later conducted a similar study on more than 200 Riesling wines from around the world, including 30 from Oregon. She found differences in chiral terpenes not only based on the origin of the grapes but also on the age, dryness and sweetness of the wine. Now that she knows which chiral terpenes are in the Pinot Gris and Riesling wines, Tomasino is looking into whether they actually contribute to the aroma; their mere presence doesn't necessarily mean that wine drinkers can detect their scent.

"In the long term," Tomasino said, "I'd like to figure out what in the vineyard or winery is causing these chirals and what is the perfect composition of them for different styles of wine."

Southern Oregon wines come of age

By Gail Wells

The Willamette Valley has long been thought of as the place to grow great wine grapes in Oregon. But an emerging treasure lies just south in the valleys and hills tucked between the Umpqua River and the California border. With its varied microclimates and complex soils, southern Oregon is home to more than 100 wineries and over 200 vineyards, which grow diverse varieties ranging from Albarino to Zinfandel.

When grape growers and winemakers need help, they can turn to Oregon State University's Southern Oregon Research and Extension Center (SOREC) in Central Point. Over the years, a succession of viticulturists has conducted a variety of experiments. They've looked at how thinning fruit clusters impacts yield and fruit quality and how pruning leaves affects methoxypyrazines, the chemical compounds that can impart an herbaceous aroma to wine. Additionally, OSU's Oregon Wine Research Institute helps winemakers, has supported the Rogue Valley Winegrowers Association's grape symposium, and works with the association to set research priorities on topics that include how to best manage crop loads, canopies, diseases, pests and the region's increasingly scarce water supply.

"We're finding ways to fine-tune irrigation to manage vines better," said Andy Swan, a research assistant at SOREC who has been conducting experiments on water usage.

If grapevines don't have to conserve water, he said, they'll divert it into making a big, shady canopy, which is not so good for producing premium grapes. The solution is to give the plant just enough water to grow a more balanced canopy, which results in higher-quality fruit.

Research conducted by OWRI faculty on "deficit irrigation" in southern Oregon began in 2010 when four successively lower levels of irrigation in Tempranillo and Cabernet Sauvignon vines were tested in the Rogue, Applegate and Umpqua valleys. The experiments, funded by the American Viticulture Foundation, continued through 2011 — a cool, unusually moist season that made it difficult to draw clear conclusions.

In 2014, researchers installed three levels of drip irrigation on Tempranillo and Grenache grapevines in the Umpqua Valley. Control vines got enough water to fully replace the soil moisture lost to the atmosphere through the vines, ground cover and soil. The second set of vines got half as much water as the control vines throughout the irrigation season. The third set got 30 percent until the onset of ripening; after that, the amount was bumped up to 50 percent until harvest.

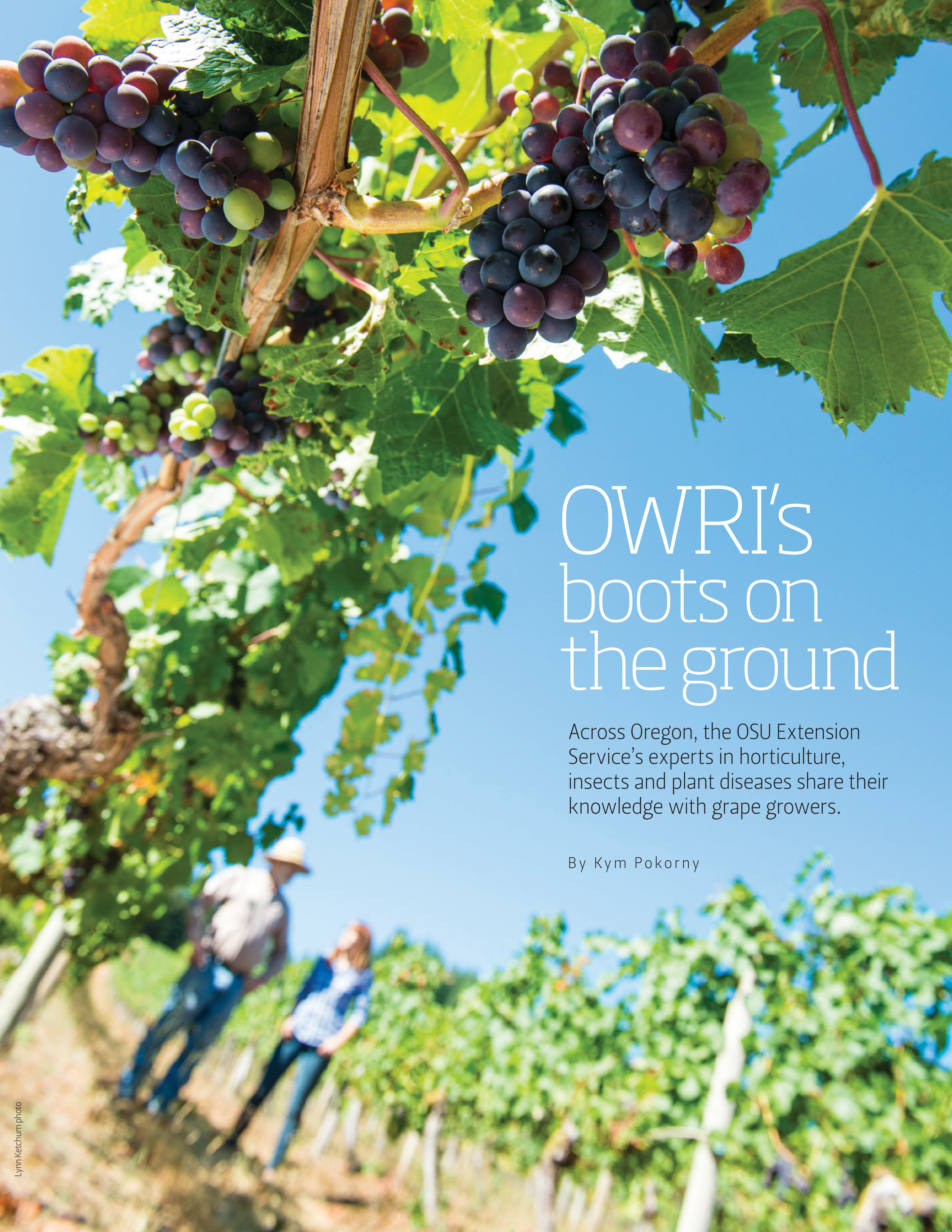
Water use can vary widely across vineyard sites and from season to season, so it's hard to determine precisely how thirsty vines are. A conventional estimating method calls for combining local weather-station data with information from the site, including the amount of light reaching the vines when the sun is at its zenith, and then running everything through a formula.

To test the accuracy of this method, researchers wrapped vines in plastic balloons and used a gas analyzer to compare the air inside with the air outside. This revealed how much the vines were transpiring and hence how much water they were using. The researchers also took weekly readings with other instruments, including a leaf pressure chamber, which gauges a vine's ability to extract water from the soil to replace the water the vine lost to the atmosphere.

When a conventional calculation was run for water use after veraison, it showed that each vine used an average of 6.3 gallons of water per day. But the balloon measurements revealed that each vine actually used 8.2 gallons per day. This suggests that the standard calculation may be underestimating the actual water needs of the vine because it doesn't account for water lost at night.

Tiffany Woods photo

Located along the Rogue River just north of Gold Hill, Del Rio Vineyards and Winery has more than 200,000 vines.



OWRI's boots on the ground

Across Oregon, the OSU Extension Service's experts in horticulture, insects and plant diseases share their knowledge with grape growers.

By Kym Pokorny

Lynn Ketchum photo

Oregon's wine industry spans the state through 18 American Viticultural Area designations. From southernmost Jackson and Josephine counties to Umatilla County in the northeast, vineyards grow grapes as distinctive as the striking geographic diversity they represent. But they also face challenges ranging from persistent pests to damaging diseases. To help, Oregon State University's Extension Service posts faculty members throughout Oregon, as well as on its campus in Corvallis, including Patty Skinkis, James Osborne and Vaughn Walton. These experts scout for insects among grapevines, peer at pathogens under microscopes and discuss solutions and best practices with growers. Here are five who are associated with the university's Oregon Wine Research Institute, each from a different region.

Rogue Valley

During a visit to Quail Run Vineyards in Talent, OSU entomologist Rick Hilton reaches into his canvas apron for a screwdriver and stoops down to peel off a craggy piece of grapevine bark. Underneath, a fuzzy, white mealybug is sucking out the plant's sap.

Since 2008, Hilton has been battling grape mealybugs, which transmit grapevine leaf roll virus, a disease that delays ripening and decreases yields. During an explosion of the pest, he set to work teaching growers how to identify and count the insects — the first line of defense in an integrated pest management approach that advocates using pesticides as a last resort.

"You can't know what you're fighting unless you know what it is, so you've got to ID and monitor the pest before you do anything else. That doesn't always mean not using pesticides, but it can mean using less," said Hilton, who is based at OSU's Southern Oregon Research and Extension Center in Central Point.

His educational outreach proved so successful that Daniel Sweeney, the assistant vineyard manager of Quail Run, was able to spot something unusual in 2014.

Above: Rick Hilton scouts for pests. "Rick has been an indispensable resource for our farm," says Daniel Sweeney, assistant vineyard manager of Quail Run Vineyards. "He has always made an effort to make timely field visits and to be available for any question." **Below:** Vineyard owner Stephen Reustle checks the sugar content of his grapes using a refractometer as Steve Renquist takes notes. "I look to OSU Extension and Steve when I can't figure out vineyard issues myself," says Reustle. "He is a healthy crutch for all grape growers to lean on and a driver of innovation in the vineyard."

Stephen Ward photo

He snapped photos on his cell phone and emailed them to Hilton.

"We found a Gill's mealybug, an entirely new mealybug never seen in Oregon before," said Hilton. "It is possibly a carrier of leaf roll virus. Finding it so soon has allowed us to get ahead of the curve and potentially hold off a serious problem."

Umpqua Valley

In a temperate pocket along the banks of the Umpqua River, Stephen Reustle found a perfect piece of land to start a vineyard. Before making an offer in 2001, he called OSU's Steve Renquist. Right away, the Extension horticulturist liked the angle and southern exposure of the sloping 25 acres, but he suggested Reustle take some soil samples.

"There are more than 100 types of soils in the valley," said the Roseburg-based Renquist, "each of them with special needs."

Sure enough, the land had three distinctly different profiles running across the hill in horizontal stripes. Renquist recommended that Reustle work around the inconsistencies by choosing three rootstocks appropriate to the soils and planting top to bottom. That was the advice Reustle needed. He bought the land, named it Reustle – Prayer Rock Vineyards, and started growing grapes that now produce award-winning wines, including a Syrah that won five gold medals at competitions in 2015.

Renquist arrived in the Umpqua Valley about a year before his first meeting with Reustle and began surveying winegrowers to find out what their needs were. By far, marketing rose to No. 1 on the list of priorities. They wanted people whizzing by on Interstate 5 to stop and get to know the Syrah, Tempranillo and Riesling wines that set the area's fledgling industry apart.

His response was to encourage the winegrowers to form a cohesive group that produced the Umpqua Valley Winegrowers

Above: Jay Pscheidt inspects a grapevine infected with crown gall. The disease can girdle and eventually kill the vine.
Right: Known by its telltale white dust, powdery mildew can shrivel grapes. "Jay's research on fungicides for powdery mildew and *Botrytis* is the backbone upon which the whole industry builds its spray programs," says Morgan Curtis, a horticulturalist for Wilco.

Lynn Ketchum photos

Marketing plan. Billboards went up at strategic exits, brochures appeared at visitor centers and hotels, and wine clubs formed to give customers discounts and other incentives. Today the Umpqua Valley is home to 70 vineyards and more than 30 wineries.

"Now," Renquist said, "people know where we are."

Willamette Valley

Plant pathology Extension specialist Jay Pscheidt stands in an OSU research vineyard on the edge of Corvallis. The vines look alarmingly off kilter, but that's OK. This is where the disease expert conducts experiments to determine the effectiveness of pesticides on grape pathogens. For 27 years, he has run hundreds of chemicals through their paces with funding from the companies that develop them. After crunching the data, he ranks the pesticides from poor to excellent.

A walk through the vines is enough for Pscheidt to get a good idea of what's going on, but leaves, bark and tissue go back with him to the lab at the OSU Plant Clinic for analysis and diagnosis. Results

Lynn Ketchum photo

Lynn Ketchum photo

end up in the Pacific Northwest Plant Disease Management Handbook, a project he helped shepherd from pamphlets to an 846-page book, which is now online as a searchable website with full-color photographs. Growers turn to it for everything from how to control powdery mildew to how to identify the symptoms of *Botrytis*. Pscheidt also contributes to Extension's annual Pest Management Guide for Wine Grapes in Oregon.

Pscheidt, who is based at OSU's campus, also spends time fielding questions from the industry and visiting vineyards to offer advice to growers. Several years ago, he was approached by a panicky grower who thought his vineyard had been infected with downy mildew, a devastating disease for grapes in Europe that's also a problem in the eastern United States. "We hadn't found it in Oregon vineyards, and it would be a huge problem if we did," Pscheidt said.

Because the grower was describing symptoms that, to Pscheidt, seemed similar to mite damage, he had a suspicion it wasn't downy mildew, which rots the fruit before ripening. When he visited the vineyard and discovered he was right, Pscheidt decided a good strategy to keep track of possible future infestations was to offer a steak dinner to anyone who found downy mildew on their grapes."I've never given out a dinner," he said.

Columbia Gorge

At an OWRI-organized field day for grape growers, OSU horticulturist Steve Castagnoli is talking about using tractor-powered pesticide sprayers efficiently and safely. He tears open a wrapper, removes a piece of yellow paper and hangs it on a Cabernet Sauvignon vine. His audience looks puzzled.

After hearing about calibration, fan speeds and nozzle adjustment, the card appears pretty low-tech. But, said

Opposite: Steve Castagnoli (center) leads a group through Del Rio Vineyards during a demonstration on how to spray pesticides effectively.
Right: As harvest approaches, Clive Kaiser and Lori Kennedy, a co-owner of Don Carlo Vineyard in Milton-Freewater, check in on the grapes. "Clive has been a tireless advocate for the development of our winegrowing community in Oregon's Walla Walla Valley," says Casey McClellan, winemaker and co-founder of Seven Hills Winery. "He is a problem solver and has a passion for helping the industry improve and be successful economically and in terms of quality."

Lynn Ketchum photo

Castagnoli, a simple piece of paper can determine the effectiveness of sprayers. The cards, he explained, react with the water and turn shades of blue so growers know how much spray reached a vine, if any. Then adjustments can be made.

"I had never heard of spray cards before," said Paula Luz of StoneRiver Vineyard. "They're going to be very useful."

Two years ago, Castagnoli started looking for ways to spray that will increase efficiency and improve performance. Through a grant from the Western Sustainable Agriculture Research and Education program, he learned how to optimize sprayers to give the greatest coverage with the least environmental impact. Now he's sharing that information in workshops with growers around the state, particularly in the Columbia Gorge, where he works with about 30 vineyards.

"Typically sprayers aren't very efficient," said Castagnoli. "Some of that is related to how they're designed, but a lot of it is how they're configured and operated. So my focus is to educate growers how to spray in the best possible way."

Walla Walla Valley

At one of the leading vineyards on the Oregon side of the Walla Walla Valley, an acre of grapevines looked sickly. Growth was stunted or nonexistent. Clive Kaiser suspected that the herbicide 2,4-D had drifted onto the field from another farm.

Since he started as an OSU Extension horticulturist in 2006, Kaiser has seen the problem many times. Although the Oregon Department of Agriculture bans the use of the chemical in a small zone on the Walla Walla Valley's floor from May through November, growers in other areas are allowed to spray year round.

"It can drift several miles," said Kaiser, who works from his office in Milton-Freewater. "So 2,4-D can cause serious damage."

Kaiser looked for a solution. Through trial-and-error, he found that a commercial product known as Stimplex, which stimulates plant growth and is derived from seaweed, rouses the vines to push out lateral buds. A three-spray regimen did the trick. "We turned the whole block of vines around," Kaiser said.

The goal, though, is avoidance rather than treatment. So Kaiser is working with the ODA to widen the area where spraying is banned and change the timing of herbicide application from a specific blackout period on a calendar to one based on the phases of a grapevine's development. If 2,4-D spraying ends when bud break begins, damage won't occur in the years when growth starts early, he said.

In the newly designated Rocks District AVA, a 3,770-acre alluvial fan of the Walla Walla River, Kaiser also works with grape growers to combat mealybugs, one of the more frustrating problems for the area's young wine industry. "I'm always beating the drum to get everybody up to speed about mealybugs. They need to know how they move, what the timing is and how to treat them," he said. "It's a case of education."

And that's what it's all about: education, the heart of what all of OSU's Extension experts do. Whether it's teaching growers about mealybugs or soil types, OSU is here to help – from Medford to Milton-Freewater and everywhere in between.

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