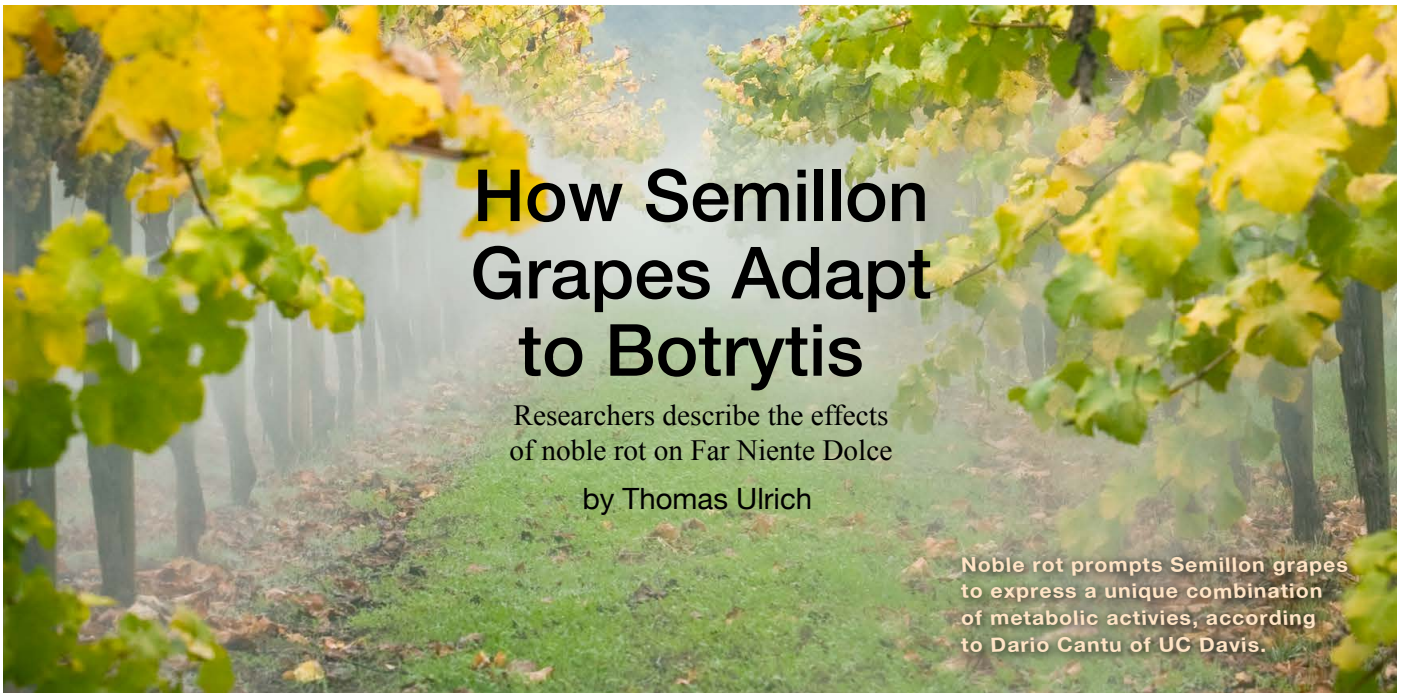


How Semillon Grapes Adapt to Botrytis

Researchers describe the effects of noble rot on Far Niente Dolce

by Thomas Ulrich

Noble rot prompts Semillon grapes to express a unique combination of metabolic activies, according to Dario Cantu of UC Davis.

Every year, winemaker Greg Allen waits as Napa Valley Sémillon takes its sweet time to mature. His staff and a team of researchers from the University of California, Davis, have demonstrated that grapes from John's Creek vineyard are as hard at work in early November as the Far Niente field crew gearing up for late harvest.

Part of the 11,000-acre Coombsville sub-AVA, the 17-acre vineyard straddles some of what's left of a volcanic vent that collapsed under its own weight 5 million years ago. The crescent-shaped caldera borders the Napa River to the west, the Vaca Range to the east and Mount George to the north.

Warm air rising from the valley floor draws coastal fog off the San Pablo Bay, moderating daytime temperatures and fueling a seemingly endless summer of misty mornings, warm days and moist nights. A temperate autumn extends the vintage, lengthening hang time and delaying harvest.

The valley's maritime climate, hillsides that block the wind and trap humidity, and well-drained, nutrient-poor soil make the grapes ripe for *Botrytis cinerea*. Unlike bunch rot, which saps life from vines under a swath of moist mid-summer air, noble rot enhances the aromas, color, flavors and texture of wine made from late-harvest grapes, such as Far Niente Dolce. By late fall, the grapes have ripened. Botrytis, a fungus that overwinters in the soil and on the vine, has drained moisture and nutrients from the infected berries and is rewriting the sensory profile of Sémillon grapes.

"Noble rot reprograms berry development and metabolism," says Dario Cantu, plant geneticist and professor from the Department of Viticulture and Enology at UC Davis. "The interaction of the fruit and fungus stimulates metabolic pathways otherwise inactive in white-skinned berries, leading to the accumulation of additional compounds and creating the unique flavor and aroma of botrytized wines."

When conditions are right—still air, high humidity, light rain and air temperatures that range from 58° to 82° F—the velvety gray fungus penetrates cracks in the cuticle of the grape, softening and dehydrating the berry. Threadlike hyphae trigger the nuclei of host cells to express genetic traits that redefine the sensory attributes for late-harvest wine. The sugar, acid and trace minerals that the mold leaves behind help define its character.

Sweet idleness

Twenty years of experience cultivating, harvesting and fermenting late-harvest grapes has turned Greg Allen's world inside out. "The key to making late-harvest wine is to reverse conventional wisdom," he says.

KEY POINTS

***Botrytis cinerea* triggers the nuclei of host cells to express genetic traits the redfine the sensory attributes for late-harvest rapes.**

Unlike bunch rot, noble rot enhances the aromas, color, flavors, and texture of late-harvest grapes.

Noble rot accelerates the development of grapes beyond what's merely ripe; red blotch turns back the clock shortly after véraison.

Most vignerons look for ways to reduce mold in the vineyard. Allen searches for ways to cultivate it.

The vineyard team has developed a "T-top" trellis for ripening late-harvest grapes. "Normally, a vineyard manager would create an open canopy allowing sunlight into the fruiting zone," he says. "We've developed a trellis that shades grapes from sunlight, protects them from the wind and traps humidity."

Each step—from growing Sémillon grapes to aging Dolce late-harvest wine—lengthens the journey and intensifies the vintage.

While the pink hue of Botrytis can show up in individual grapes anytime from September through December, crew members do not harvest these thin-skinned, tightly clustered grapes until the berries turn purple. Once the infected grapes have matured (see "Red Blotch is Hardly Noble"), the crew scatters across the vineyard equipped with needle-nosed snips. "They recognize the difference between grapes infected with Botrytis and other fungi and molds," Allen says. "We discard the copper-colored berries and raisins, looking for dimpled fruit."

If a storm threatens to destroy the crop, they pick the most dimpled berries and leave the rest behind. "We harvest at an hourly rate of 15 pounds per person, with a yield of about 1 ton of fruit per acre," he says.

How sweet it is

At first, Allen picked by the numbers, but he tossed out the refractometer years ago. "It's a delicate balance," he says. "If we harvest the grapes too late, the juice may be both too concentrated with sugar and not have the acidity to offset the sweetness." Over time, the pH increases as acids are metabolized. While the mold consumes some of the sugar, ultimately the Brix increases as the berry dehydrates.

Today, Allen and crew harvest to taste.

"We sort the grapes in the vineyard," Allen explains. "Berries that do not meet the day's harvest criteria are removed from the cluster. The crew places what's left into half-ton bins that they load onto flat-bed trucks and transport to the winery."

John's Creek vineyard rewards those who wait.

"The long hang time allows the grapes to produce many more metabolites, aromas and flavors than sweet wines made with raisins or distilled spirits that some winemakers add to stabilize the fermentation

and balance the sugar-to-alcohol ratio," Allen says.

By the time the grapes reach the winery, *Botrytis cinerea* has rewritten the script. After evaluating three vintages from John's Creek vineyard, Cantu discovered that noble rot induced Sémillon grapes to express a unique combination of metabolic activities, some of which are more common to Cabernet Sauvignon or Sangiovese grapes.

History in the making

A decade ago, scientists described the genome (or the complete set of genetic material) for Vitis vinifera. They spelled out the chemical sequence of 30,000 genes found in 19 pairs of chromosomes, the rod-shaped structures containing tightly coiled strands of DNA.

Within a single chromosome, millions of base pairs, which scientists abbreviate as a combination of A, T, G or C (adenine, thymine, guanine or cytosine) join two strands of nucleotides to form a double helix. Each group of three nucleotide bases or triplet code (G-T-A, for example) produces a specific amino acid. Each sequence of triplet codes or gene composes a precisely worded sentence that instructs messenger RNA (ribonucleic acid) and a ribosome to assemble amino acids into a protein that acts as a building block or catalyst for cell growth or fermentation.

Unlike the Sémillon genome, which is fixed except for occasional mutations, a gene can vary the wording of transcripts based on details like soil moisture, variety or whether a grape is infected with *Botrytis cinerea*.

To understand how Sémillon grapes adapt to the fungus, Cantu explored the set of all transcripts or genetic instructions present in infected grape cells simultaneously.

For Sémillon, Cantu's team detected an increase in transcripts from genes that regulate phenolic compounds including the red pigment anthocyanin. "Remarkably, noble rot induces the biosynthesis of anthocyanins, complex flavonoids whose development is normally limited to red-skinned grapes," Cantu says.

The pigment that Cantu detected in the laboratory reflects the change in pigmentation

"We've confirmed the importance of these metabolic pathways in infected grapes by measuring the concentration of metabolites and analyzing enzyme activities," Cantu explains.

Secondary metabolic pathways triggered by noble rot also generate aromas, flavors and textures that are unique to late-harvest wines. Cantu discovered that infected Sémillon cells express higher concentrations of several other phenolic compounds.

"Acetophenones and phenolic glycosides showed an increased abundance at all stages of the infection," he explains. Antioxidants and antimicrobials first, they help shape the sensory profile of the grapes and the wine.

Terpenes can also influence aroma. "Monoterpenes, triterpenes, sesquiterpènes and terpene glycosides accumulate at all stages of noble rot," Cantu says. "Fatty acid aroma precursors also increase as the infection progresses."

Glycerol, mannitol and sorbitol concentrations increased significantly in infected berries along with free galacturonic acid, arabinose, galactose, rhamnose, mannose and xylose.

"We profiled metabolites (for the aromas and flavors) of late-harvest wines produced from the John's Creek vineyard and corroborated that key compounds from noble rot carried over to the wines," Cantu says.

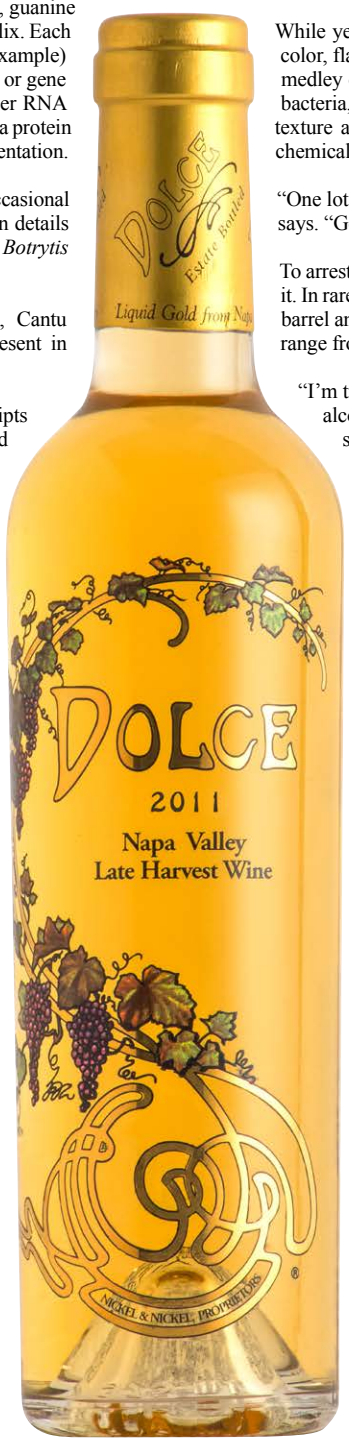
Earthy to elegant

At the winery, the crew weighs the fruit and loads it into the press. The immediate goal, according to Allen, is to prevent "a microbial zoo" from spoiling the fruit.

He separates two-thirds of the juice into small batches and inoculates each with one of five strains of commercially available yeast. Weak fermenters, they are well suited to the high osmotic pressures of concentrated juice. Wild yeasts ferment the rest of the vintage.

"Every batch of juice ends in a stuck fermentation," he says, recalling a viticultural and microbial mix that defies conventional wisdom. "The juice contains so much glucose, fructose and ethanol that the yeast die or go dormant before it can convert all of the sugar to alcohol."

Some winemakers—most notably vignerons from the Alsace region of France, vinify late-harvest wines toward dryness. The yeasts convert much of the sugar to alcohol. Allen strives to balance residual sweetness with acidity.



While yeast affects the balance between ethanol and acid, the aromas, color, flavors and textures of Dolce late-harvest wine are the work of a medley of microorganisms. Yeast, together with other fungi, mold and bacteria, produce flavors and aromas, combine molecules to enhance texture and rely on enzymes and catalysts to accelerate a number of chemical reactions.

"One lot may ferment too far; another may not ferment far enough," he says. "Generally, I let each fermentation find its own sticking point."

To arrest a batch that converts too much sugar to alcohol, he refrigerates it. In rare cases of persistent fermentation, he removes the wine from the barrel and filters it. With an initial Brix of 35°, he looks for batches that range from 12.5% to 14% alcohol.

"I'm trying to avoid a finished wine that's cloyingly sweet or overtly alcoholic," he says. "I am looking for a balance between sweetness, acidity and a texture that is oily and mouthwatering but carries the fruit flavor long into the finish without bitterness, heat or the thickness of syrup."

Just before bottling, Allen adds about 10% Sauvignon Blanc to the blend to balance the Sémillon, instill tropical fruit flavors and retain acidity that ensures Dolce's texture.

He combines 10 to 20 batches into a master blend with an alcohol concentration of about 14%, residual sugar of about 12° Brix and moderate acidity. "I achieve this balance by blending," Allen says. "With more than 32 months of barrel aging, we taste various combinations to find the best the vintage can offer."

For centuries, winemakers have associated Botrytis with rich textures and complex aromas and flavors. "It is clearer now that the mold's effect is much broader," Allen says. "Its mere presence induces the accumulation of a wide range of precursors for aroma, flavor and texture that concentrate as the berries dehydrate."

"Winemakers can spend entire lifetimes exploring how to craft great wines fermenting grapes infected with noble rot," says winemaker Greg La Follette. "Yet as our techniques and the practices of our forebears are informed by a more complete understanding of grape chemistry and physiology, we are on the verge of a deeper, more intimate discussion with the land."

Aroma, acid, ethanol, flavor, sugar and tannin combine to embody the varietal character of a mature wine grape. Yet, as Allen, Cantu and others have discovered, climate and vineyard practices can dramatically influence the color, taste and texture of wine. Exploring how these factors affect the fruit addresses what may be the greatest challenge the industry faces during the first half of the 21st century: producing quality grapes and a memorable bottle of wine in a rapidly changing world.

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