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California Vineyards Expand Nighttime Use of UV-C Robots to Fight Powdery Mildew

Saga Robotics treated about 2,600 acres this season, offering wineries a nonchemical option that matched conventional programs in trials.

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California winegrape growers are expanding the use of autonomous robots that apply ultraviolet-C light at night as they look for new ways to control powdery mildew, a persistent fungal disease that can threaten both fruit quality and vineyard yields.

Saga Robotics, a Norway-based company, introduced its Thorvald UV-C robot to vineyards on California's Central Coast three years ago. This season, the company also moved into the North Coast and treated about 2,600 acres statewide, according to Caine Thompson, Saga's general manager for U.S. operations in Paso Robles.

The system uses low-dose UV-C light at a wavelength of 254 nanometers. The robot moves through vineyard rows at night, directing the light onto vines and fruit. According to the company and growers using the equipment, the nighttime timing is essential. In daylight, the mildew organism can use blue light from the sun to activate a repair enzyme. At night, with several hours of darkness after treatment, the fungus cannot repair the DNA damage caused by the UV-C exposure and dies.

The machines are being adopted as growers look for nonchemical ways to manage a disease that often requires repeated fungicide applications during the growing season. The robot is battery powered and built around a horseshoe-shaped array of UV-C lights that can surround the sides and tops of the vines. Thompson said it can run through the night on one charge.

At Silver Oak, the technology was tested this year in two vineyard blocks, one 10 to 11 acres of pinot noir near Philo and another similar-sized sauvignon blanc block near Oakville. Norm Peters, the company's director of vineyard operations, said the system appealed to the winery because it fit with sustainability goals focused on worker well-being and wine quality.

Silver Oak began with an initial fungicide spray in April after a delayed start with the robots. It then switched to UV-C applications every four days for about three months, through veraison in July, when grapes begin to ripen. In the sauvignon blanc block, Peters also tested whether the treatment could help control botrytis bunch rot by continuing applications on half the vines until a few days before harvest.

Peters said that in a year with heavy disease pressure, the fruit remained notably clean. Silver Oak's winemaking team is now fermenting the grapes and assessing whether the UV-C treatments changed the wine in any way. That question could be important for wineries beyond viticulture: if the system proves effective without affecting flavor or quality, it may offer the wine business a way to reduce fungicide use while automating part of vineyard protection. For producers of premium wines, that potential matters as they weigh costs, labor, sustainability goals and brand positioning.

Peters said the move to robots did not disrupt work schedules because Silver Oak normally sprays at night. He said one supervisor at each site was trained to oversee each pair of robots, and he described the response from workers as positive. Instead of replacing a task with another manual process, he said, the system required staff to learn how to manage the equipment through a tablet-based interface.

Bonterra Organic Estates also tested the technology this season. The Mendocino County producer, which is certified organic, deployed six UV-C robots across about 200 acres of chardonnay near the Russian River. Joseph Brinkley, Bonterra's senior director of regenerative organic farming, said powdery mildew is one of the company's biggest pest concerns and that the farm is constantly looking for methods that align with its regenerative approach.

Chardonnay was chosen because it is especially vulnerable to mildew and because the local climate favors disease development. Bonterra's standard mildew program usually begins soon after budbreak in April with oil applications every 10 to 14 days. Depending on conditions, that program may also include wettable or dusting sulfur until the berries reach about 13 degrees Brix, a measure of sugar content, sometime in July. After that point, Brinkley said, the fruit no longer appears susceptible to mildew.

As at Silver Oak, Bonterra used an early-season spray in the test blocks because the robots were not deployed at the start of the season. The company then shifted to twice-a-week UV-C applications until veraison. Brinkley said the treated blocks performed as well as or better than the blocks managed with oil and sulfur. He described the results as better than expected in what he called one of the hardest mildew years he could remember.

The work in California comes as researchers continue to study how best to use the technology under different growing conditions. Saga Robotics began developing a commercial UV-C system for winegrapes in partnership with Cornell University's AgriTech branch in 2020, after using the treatment successfully on fungal diseases in strawberries in the United Kingdom.

Michelle Moyers, a professor and viticulture specialist at Washington State University, said researchers now have a stronger understanding of how UV-C affects grapevine powdery mildew. The next step, she said, is to determine the best field practices for different regions and disease pressures.

At Washington State University's Irrigated Agriculture Research and Extension Center in Prosser, where disease pressure is generally lower because of the hot, dry climate of eastern Washington, Moyers and colleagues have compared standard chemical fungicide programs with UV-C applications every other week, once a week and twice a week since 2020. Separate trials are also being conducted by the U.S. Department of Agriculture and Oregon State University in Oregon's Willamette Valley, where more moderate temperatures and higher humidity favor mildew.

Moyers said UV-C is a contact treatment that leaves no residue, which means coverage is critical. The light must have a direct line of sight to the target tissue. That has led researchers to examine how vineyard practices such as leaf removal might improve results by exposing fruit and leaves more fully, much as they can improve conventional spray coverage. After the 2022 season, the Washington State team added leaf removal to its trials. Peters and Brinkley said they already remove leaves in their vineyards to improve airflow and spray deposition, so they did not need to change those practices for the UV-C tests.

The robots navigate with real-time kinematic GPS, which Thompson said provides sub-inch accuracy. Saga first maps each vineyard, including posts, vine spacing and obstacles, to create what he described as a digital pathway for the machine. The platform can work in rows from 3 to 10 feet wide and with most trellis systems that have crossarms up to 30 inches.

Thompson said growers interested in trying the system should start small, with one robot in a limited block, because the change is more than a new piece of equipment. It shifts disease control away from a tractor driver and chemical applications toward repeated light treatments managed through automation. For the wine sector, that could become an important option if field performance continues to match conventional programs in difficult mildew years and if follow-up work shows no negative effect on finished wine.