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New Resources for Vineyard Frost Protection

Following a three-year study of springtime air temperature inversion conditions in North Coast and Central Coast winegrape growing regions, the University of California Cooperative Extension (UCCE) has launched a website to begin posting real-time temperature data from weather stations to assist growers in deciding where to use, and when to operate, wind machines for frost protection.

This temperature monitoring technology has the potential to be used in other California grape growing regions as a new resource for frost protection.

Mark Battany, UCCE viticulture farm advisor for San Luis Obispo and Santa Barbara counties, has been gathering data on temperature inversions to assess the feasibility of using wind machines as alternatives to sprinkler frost protection.

“Sprinkler frost protection is very effective, but it uses a lot of water, and water supplies are becoming tighter everywhere,” he explains.

Water use for sprinkler frost protection has also become subject to more regulatory scrutiny in some locations, such as in the Russian River Watershed in Sonoma and Mendocino Counties, and in the Paso Robles area in San Luis Obispo County.

**Frost And California Vineyards**

All green parts of the grapevine are susceptible to frost during the growing season. The amount of damage is dependent on how long temperatures are below 32 degrees F. Damage starts when temperatures are at 31 degrees F. for more than 30 minutes. Vines are at risk for spring frost damage after budbreak and during early growth, which in California can be from February through May depending on the season and location. Spring frost can result in loss of crop, or delayed crop development and lower yields. Late season fall frosts can also be an issue, causing leaves to turn brown or fall off and stop sugar accumulation. Fruit may be damaged if the temperature is low enough.

Wind machines provide frost protection only when a temperature inversion exists. When an inversion is present, air temperature increases with height above the ground surface. A wind machine fan moves warmer air located above the blades downward toward the ground, and also blows cold air upward where it mixes with the warm air.

Wind machines are available as stationary, ground installed units, and other machines are portable and can be towed as trailer-mounted units for use where needed. Since noise produced by wind machines is sometimes a complaint from neighbors who live near vineyards where they operate, newer wind machines are available with quieter operation than older models. In addition, newer models are designed with more energy-efficient fuel use.

**Temperature Inversion Studies And Monitoring**

The temperature inversion study led by Battany was funded through a California Department of Food and Agriculture Specialty Crop Block Grant, and by the American Vineyard Foundation.

Battany designed 35-foot temperature inversion monitoring poles with two temperature sensors — one at a height of 5 feet and one at 35 feet. These poles were placed at about 60 sites each spring from 2012 through 2014. About 20 monitoring sites were located in each of three counties — San Luis Obispo, Santa Barbara and Sonoma. The data helped determine whether or not each site had useful inversion conditions. An inversion is considered useful if the temperature difference between the sensors on most nights is at least 2 degrees F.

Useful inversions tend to occur on cold clear nights with no air movement. Battany said, “A main driver is not having wind or air movement to let the stratification of temperature layers develop.”

Some locations showed inversions with as much as 10 degrees F. difference on some nights. Citing data from San Luis Obispo County for specific nights, he said, “As the night progresses, by the time it gets to the coldest part of the night (from about midnight to 6 a.m.), many of the sites had useful inversions.”

He also observed, “These inversion towers are cheap and easy to set up, and a number of growers in both the North Coast and Paso Robles have built them to evaluate conditions at frost prone sites for inversion suitability before making a major investment in wind machines that can cost $30,000 each.”

The towers are portable, but are not intended for permanent use. They can be built for about $250 each, complete with sensors and a data logger. Battany has provided instructions on materials and assembly at http://cesanluisobispo.ucanr.edu/ files/164588.pdf.

Following the three-year study, the National Oceanic and Atmospheric Administration (NOAA) recognized the value of these data and incorporated frost and inversion monitoring into its weather data for the North Coast. NOAA funded permanent weather stations (approximately $3,000 each) with inversion monitoring towers, data loggers and cellular phone technology to enable data transfer in real time. A new website for this information, “UC Frost Protection Weather Data,” is now posted at http://ucanr.edu/ sites/russianriverhabitat/Inversion\_Data/.

This website provides current data from 17 temperature inversion weather stations in Sonoma and Mendocino counties near vineyard areas in the Russian River Watershed. It includes real-time temperature data for each site at both the 5-foot and 35-foot heights with a graph for the past week. Other weather station data include rainfall, relative humidity, and wind speed. Battany said the website is still being refined and more data displays will be added before the 2016 spring frost season. Funding is available to install four more weather stations in this area, and UCCE is looking for suitable sites.

Up to 18 real-time permanent weather stations with inversion towers are planned for sites across the Paso Robles Groundwater Basin in the near future, and these will also provide data to the UC website. Battany expects to include data from some of these sites on the UC website before the end of 2016, but not in time for this year’s spring frost season.

Growers who have independently gathered data with the earlier, simple-to-install sensor towers are now installing taller towers on permanent weather stations to gather inversion data continuously. Battany said it’s simple to add a 35-foot high tower and sensors to an existing weather station. Regional grower groups with weather station networks may want to consider adding inversion monitoring to their systems.

During a presentation at UC Davis Grape Day in December, Battany cited a statewide weather network system operating across 120 locations in Oklahoma (Mesonet.org) that measures temperature inversions and other weather data.

“This is a model for what we can do in California, either on a regional basis or statewide,” he observed.

**A Closer Look At Passive Frost Protection**

Battany is also collecting more specific temperature data in the Paso Robles area to study the potential for passive frost protection measures based on trellis height and cover crop management.

Temperatures are most often colder at night closest to the ground surface. The warmest ground temperatures usually occur with bare moist ground that absorbs solar radiation during the day. Areas with cover crops or weeds should be mowed low to the ground during frost season. Tall unmowed grasses harbor the coldest temperatures (worst conditions) for frost risk.

Using a weather station with eight temperature sensors at one- foot intervals from ground level to 8 feet high, Battany has found differences up to 9 degrees F. between 1 foot and 5 feet above ground level. This indicates that training vines with a higher trellis over bare ground, or ground with a low cover crop, may offer better protection in frost-prone locations. However, he cautions that actual conditions are very site specific and each site should be evaluated before making long-term decisions.

“In the past we may not have had the incentive to look at these specific conditions this closely due to the availability of water for sprinkler protection, but now the situation is different. It’s a game of fractions of a degree of temperature, and these are now very important things to consider.”