University of California
Agriculture and Natural Resources

Vine Lines

San Joaquin Valley Viticulture Issues

October 2012

Stephen J. Vasquez, Viticulture Farm Advisor

Vine Training Height and the Air Temperature Microclimate

Mark Battany

The air temperature generally varies with height above the ground surface; the temperature is often colder near the ground surface at night and hotter near the ground surface during the day. For this reason, the choice of vine training height may have a significant influence on the temperature microclimates experienced by the sensitive vine tissues during critical spring frost and summer heat periods. This pilot project measured temperatures at one location in 2012 to help quantify how much the air temperature can change over very small differences in height. More thoroughly developed regional information will help growers choose the optimum vine training height for their growing conditions.

Background

The design decisions made during vineyard establishment such as vine spacing, row direction and rootstock are essentially permanent for the life of the vineyard and hence need to be made with careful consideration of the local conditions. The vine training method and trellis system can be altered after the vineyard is established, but at significant cost. Therefore, it is important to make the most informed decisions on vine training at the beginning of the establishment process. This work explores how the vine training height impacts the temperature microclimate experienced by the vines, to help determine if the use of different training heights may be beneficial.

In this Issue:

Traditional vine training heights have evolved very differently in countries with long histories of winegrape production (Figures 1 & 2). These traditional practices likely evolved for a wide variety of reasons which made good sense in that particular time and place; however, some of these traditional practices may currently be employed in areas where other designs would be more suitable considering the local climate conditions. Improved temperature microclimate information will help growers refine their decisions as to the most suitable training method.

The air temperature has an important role on vine

Continued on Page 2

Vine Training *Continued from page 1*

Figure 1. Short vines west of Jerez in southwestern; this coastal area has few frosts and moderate summer temperatures. Photo credit: Mark Battany

productivity and fruit quality; frosts damage young growth in the spring or mature canopies and fruit in the fall, while excessively hot summer temperatures can degrade fruit quality. During cold spring or fall nights, particularly when the skies are clear with little wind, temperature inversions often form resulting in colder air temperatures near the ground surface. During the daytime with full sunshine, the opposite occurs, with significantly warmer air temperatures occurring nearer the ground surface.

Relatively little information exists regarding how much the air temperature changes with height above the ground over the range of heights commonly used for training grapevines. Of particular interest is a better understanding of the vertical temperature gradients that occur on both spring frost nights and on hot summer days. These gradients are simply indications of how much the temperature changes for each increment of height above the ground, in units such as degrees per foot of elevation (°F/ft.). On a spring frost night, the gradient will often be positive, meaning that temperatures become warmer with increasing height; on hot summer days the gradient will often be negative, meaning that temperatures become cooler with increasing height. With knowledge of this temperature gradient information, one can then predict what the gain in temperature will be from making specific changes in the vine training height. The purpose of this preliminary project was to gain some initial understanding of the magnitudes of these temperature gradients, and to see if they could be measured at low cost.

Figure 2. Tall overhead "parral" vines near Mendoza, Argentina. This area has more risks of frost and hot summer temperatures. Photo credit: Mark Battany

Measurements

Evaluations have been underway since late March 2012 at one vineyard west of Paso Robles. This site is located in the lower area of an open valley, surrounded by low hills. Three measurement masts, each eight feet tall, were outfitted with temperature sensors at one-foot height increments between one and eight

Continued on Page 3

Vine Training *Continued from page 2*

feet, with each set to read the air temperature every five minutes. Measurements were initially taken in a mature vineyard block; after the spring frost period, measurements were taken in an adjacent fallow block with tilled bare soil.

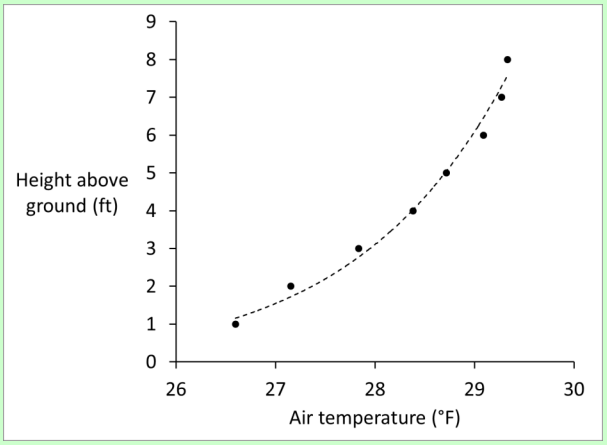

Figure 3. Pre-dawn temperature profile during three frost nights in early April. The values are averages of the temperatures between 5:00 and 7:00 am on April 6, 7 and 8, 2012.

Frost period results

There was a clear tendency for low-level temperature inversions to form at this site on the coldest frost nights of early April (Figure 3). The largest temperature gradient was observed between the lower heights (from one and four feet), while the temperature gradient was smaller at taller heights (between four and eight feet). Thus, for the purposes of reducing frost damage, the largest gains in temperature would be attained by increasing the height of very low vines; the warming benefit becomes gradually smaller as the vine height increases.

A summary of the temperature gradient conditions during the entire period with below-freezing conditions is shown in Table 1. In this table, the average temperature gradients for the lower (1-4 ft.) and upper (4-8 ft.) elevations are calculated separately. These gradient values are calculated over the entire time period when the 4 ft. air temperature was below several different temperature threshold values (32, 30, and 28 °F). The total number of hours that these cold temperature conditions existed is also indicated for each level. This chart shows that the temperature gradients were very similar for all three temperature ranges, with the same pattern of having larger gradients for the lower heights and smaller gradients for the

Table 1. Nighttime temperature gradients during freezing conditions*

Temperature at 4 ft. height (°F)	Total hours below temperature to left	Temperature gradient over 1-4 ft. heights (°F/ft.)	Temperature gradient over 4-8 ft. heights (°F/ft.)
< 32 °F (0 °C)	30	0.56	0.24
< 30 °F (-1 °C)	17	0.59	0.25
< 28 °F (-2 °C)	3	0.57	0.28

*Readings from March 27 through May 2012

Continued on page 7

Corks and screw caps: Can wine consumers taste the variation?

To help winemakers determine the best caps for their wine bottles, researchers at the University of California, Davis, are studying the performance — specifically the variability — within different types of closures.

Their goal is to determine whether consumers can taste the difference in wines that are bottled and capped exactly the same — a difference that could be attributed only to variation among each type of wine closure.

UC Davis wine chemist Andrew Waterhouse says exposure to oxygen is the most important factor in wine aging but too much can cause a loss of color, flavor and aroma. Photo credit: Joe Proudman

The researchers — including a wine chemist, a medical radiologist and a biomedical engineer — are evaluating 600 bottles of Sauvignon Blanc wine, each sealed with one of three different types of closures: natural cork, screw caps or synthetic cork. The study will monitor changes in the wine during aging, culminating in a sensory evaluation to determine if wine experts and consumers can taste the different levels of oxidation that occur in the wine due to variability within each type of closure.

Oxidation, or exposure to oxygen, is the most important factor in wine aging, according to wine chemist Andrew Waterhouse, a professor in the UC Davis Department of Viticulture and Enology. But too much oxidation can cause a loss of color, flavor and aroma.

“Our goal in this study is to determine if individual bottles might be getting a lot more or less oxygen — and therefore aging at different rates — as a result of the variation in the closures used to seal the bottle,” said Waterhouse, who is carrying out the study with UC Davis undergraduate student Jillian Guernsey.

“Ultimately, when all of the data are in, we won’t be declaring that one type of closure is superior to another. Rather we’ll be giving winemakers information about the variability of each type so that they can determine which is most appropriate for use in bottling their wines,” Waterhouse said. “If variation is high enough for consumers to notice a difference, we will work with the industry to help find ways to manage the variation so that consumers receive the wine as it was intended.”

The Department of Viticulture Enology, the largest and most comprehensive

Continued on Page 6

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Each card also includes descriptions of natural enemies as well as handy inch and metric measurement scales for easy measuring out in the field. A sturdy rivet keeps the set together so individual cards won't stray.

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Corks *Continued from page 4*

university wine program in the United States, has been at the forefront of international grape and wine innovation for 130 years. It continually partners with industry to develop practical solutions to problems that are of concern to winemakers and consumers.

The researchers have included a novel step in this study, using medical imaging technology to obtain a baseline evaluation of each of the corks. To do this, they teamed up with John Boone, a radiology professor in the UC Davis School of Medicine and an internationally known expert in designing and improving computed tomography scans for breast imaging. Boone, who also leads the cancer imaging research initiative for the UC Davis Comprehensive Cancer Center, used a new CT scanner, which he had invented, to obtain images of each of the 200 natural and synthetic corks.

David Fyhrie, a professor of biomedical engineering who also holds the David Linn Chair in Orthopaedic Surgery in the UC Davis School of Medicine, will analyze the images to look for differences in the internal structure of the corks.

All of the 600 bottles of Sauvignon Blanc wine are being stored in a temperature-controlled wine cellar at 20 °C (68 degrees Fahrenheit). Each of the bottles will be tested for darkening in wine color at three-month intervals during the 12-month study. Earlier research in Australia has demonstrated that the color of white wine is a reliable indicator of the degree of oxidation.

The researchers will use specially modified spectro-photometer devices to analyze the wine color in the bottles without opening them. Clear glass bottles are being used to facilitate color-based monitoring of oxidation based on color change.

At the study's end, the 600 bottles will be divided into three groups, based on whether they show high, average or low color change. The wines with the most and least color change will be opened for chemical analysis and sampling by members of a sensory panel, who will try to identify differences in taste and aroma between the most- and least-oxidized wines. That sensory analysis is expected to take place in during the summer of 2013.

Waterhouse said that there is also considerable interest in the comparative sustainability of wine bottle closures.

"All wine closures are made with sustainable practices, and to date I have not seen data showing a definitive difference between them," he said. "It's important for wine consumers to remember that the bottle closure is a very small part of the wine package's environmental footprint," he said.

The study is supported in part by CADE Winery of The PlumpJack Group. PlumpJack Winery pioneered the use of screw-cap closures for ultra-premium wine more than 10 years ago. ▲

Vine Training *Continued from page 3*

taller heights.

Temperature increases of a fraction of a degree per foot of height increase might not seem very significant, but in practice such small increases in temperature may be the difference between vines experiencing frost damage or not. Consider an example of raising the vine training height from 3 ft. up to 5 ft.; based on Figure 3, this would result in temperatures being about 1 °F warmer for the taller vines on frost nights.

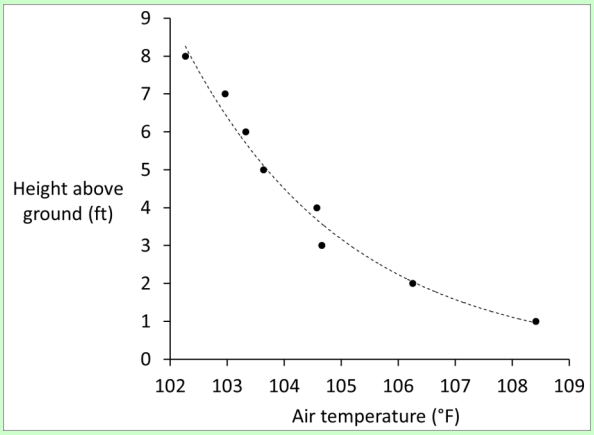

Figure 4. Afternoon temperature profile during early August. The values are averages between 1:00 and 5:00 pm during the week of Aug. 8-14, 2012. The measurements were made in a fallow field with bare soil.

Summer heat period results

The opposite pattern was observed for the temperature gradients during hot afternoons in early August (Figure 4). Notably hotter air temperatures occurred near the ground surface, with temperatures becoming cooler with increasing height above the ground. Again, the magnitude of the temperature gradients was greatest at the lowest heights, with diminishing magnitude as the height increased. Thus, for purposes of reducing high fruit temperatures, the largest gains will likely be attained by raising the height of very low vines, while less benefit will be achieved by increasing the height of taller vines.

A summary of the temperature gradient conditions during the entire period when temperatures were above 95 °F is shown in Table 2. As in Table 1, the temperature gradients for the 1-4 ft. and 4-8 ft. heights are calculated separately, for three different ranges of hot temperatures. The magnitude of the gradients under sunny daytime conditions was roughly twice as large as those observed under nighttime freezing conditions.

As these summer temperatures were measured in a fallow field, there were no vines or

Table 2. Daytime temperature gradients during hot weather conditions*

Temperature at 4 ft. height (°F)	Total hours above temperature to left	Temperature gradient over 1-4 ft. heights (°F/ft.)	Temperature gradient over 4-8 ft. heights (°F/ft.)
> 95 °F (35 °C)	200	-1.14	-0.49
> 104 °F (40°C)	50	-1.14	-0.53
> 113 °F (45 °C)	1	-1.05	-0.59

*Readings from June through Aug. 22, 2012

Continued on page 8

Vine Training *Continued from page 7*

other transpiring plants present. Under such conditions, much of the incoming solar energy is converted to heat. If actively transpiring vines or other plants were present, a considerable portion of this incoming solar energy would instead had been used in the evaporation of water, resulting in less heating of the soil surface and the nearby air. Thus, in vineyards with very sparse canopy coverage and clean tilled soil, the daytime temperature conditions may be similar to those measured in this fallow field. However, as the vine canopy coverage increases and more of the incoming solar energy is used for evaporating water from the vines, the daytime temperature gradients will likely be less pronounced than those measured at this site. Future work that relates the daytime temperature gradients to the amount of vine canopy cover would be important for assessing how taller training systems might reduce heating of fruit (Figure 5).

Figure 5. The extent of canopy cover will influence air temperature. In the block on the left, much of the sun's energy is devoted to evaporating water, while in the block on the right, more of the sun's energy heats the soil surface and raises the air temperature. Photo credit: Mark Battany

With increasing adoption of mechanized farming practices, many growers are finding that the taller vine training systems typically employed in these systems are more economical and efficient to farm, irrespective of any potential temperature benefits (Figure 6). Many of these mechanized systems now use cordons around 5 ft. high; it may be worthwhile to evaluate if even taller trellis heights are practical to farm with the currently available equipment, if future studies indicate that such heights provide useful temperature benefits.

Summary

These preliminary measurements suggest that useful temperature benefits can be attained by avoiding excessively low vine training heights in areas subject to spring frost damage and high summer heat. In very cool coastal areas with little frost risk and insufficient summer heat, a lower vine training height may be more desirable, as it may help increase the temperature to a useful extent in seasons when ripening is difficult to achieve. However, for more inland areas with appreciable frost risk and concerns about too much summer heat, there may be considerable benefits to be gained by shifting towards taller vine training heights than are

Continued on page 9

Vine Training *Continued from page 8*

currently used in many vineyards. To better understand how these temperature conditions vary by region and vineyard layout, we are planning to conduct similar measurements throughout 2013 at a larger number of locations.▲

Figure 6. The Pinot Noir vines on the left are trained on five-foot tall cordons in the Santa Maria Valley. Photo credit: Gwen Tindula

Mark Battany is the UC Cooperative Extension Viticulture/Soils Farm Advisor in San Luis Obispo and Santa Barbara Counties. Assistance in the project was provided by Gwen Tindula, UCCE Staff Research Associate.

Continuing Education meetings for private applicators, QAC/QAL and PCA license holders.

Attention private applicators, QAC/QAL's and PCA's: License holders with last names beginning with "A" to "L" must renew their license by December 31, 2012. Below are some free CE meetings to help you fulfill your requirement to obtain the necessary CE Units needed for your specific license. For more information, contact the meeting sponsors.

Cooperative Extension & Ag Commissioner's Office Continuing Education Seminar
When: Wednesday, October 31, 2012, 7:30am – 12:00pm
Where: UC Cooperative Extension, 1720 S. Maple Ave., Fresno CA 93702
Description: For more information, contact UCCE at 559-600-7285 or http://ucanr.edu/free-ce-units
Attendees must RSVP.

Fresno County Farm Bureau Continuing Education Seminar
When: Thursday, November 15, 8:20am – 11:30am
Where: FCFB, 1274 W. Hedges Ave., Fresno, CA 93728
Description: For more information, contact FCFB at: 559-237-0263 or info@fcfb.org
Attendees must RSVP.

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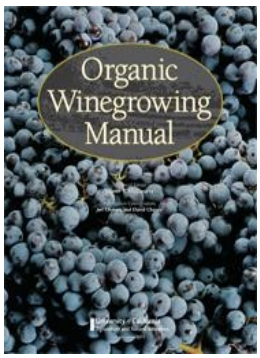

Interest in California organic wine grape production inspired this publication that provides a full-color guide with information on soil management, including soil considerations when selecting a vineyard site, developing organic soil and fertility programs and selecting cover crops. An extensive section covering weed, disease, insect, mite, and vertebrate pest management options for organic grape production is covered. The chapter on organic certification contains an overview of considerations for evaluating and selecting a certifier.

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October 31, 2012
7:30 a.m.— 11:45 a.m.
1720 S. Maple Avenue
Fresno, CA 93702
UCCE Fresno Office Demonstration Room

San Joaquin Valley Vit Tech Group Meeting
Topic: Raisin industry production issues
November 14, 2012
Location to be determined.

U.C. Davis University Extension Meetings
(800) 752-0881

Taxation and Accounting for the Small Vineyard
November 1, 2012
9:00 a.m.— 4:00 p.m.
1632 Da Vinci Ct., Da Vinci Building
Davis, CA
Section: 122VIT205

Rootstock Workshop: Identification and Use
November 28, 2012
9:00 a.m.— 4:00 p.m.
1632 Da Vinci Ct., Da Vinci Building
Davis, CA
Section: 122VIT204

Taxation and Accounting for the Small Winery
November 2, 2012
9:00 a.m.— 4:00 p.m.
1632 Da Vinci Ct., Da Vinci Building
Davis, CA
Section: 122VIT206

7th International
Table Grape Symposium

Attention table grape growers and attendees of the 6th International Table Grape Symposium, I am pleased to announce the **7th International Table Grape Symposium** will be held in Australia in early December 2013.

Persons interested in presenting a paper at the 7th International Table Grape Symposium should contact: David Oag
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If you are interested in receiving more information as it becomes available please email me at: sjvasquez@ucanr.edu

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San Joaquin Valley Viticulture Issues

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