Benefiting the environment, the community and high quality grapes and wine

CHAPTER 1

The conservation and efficient use of water is crucial to minimize the risk of decreased supply and to sustain viable farming operations.

Conserving Water

Water is an increasingly precious resource. Its scarcity is a critical concern for some agricultural producers, creating serious risks to and losses in production. In most regions of California, less water is available for farming because of increased demand by many sectors of the economy, expanding human populations, changes in water policies, and/or climate fluctuations. As a result, the conservation and efficient use of water is crucial to minimize the risk of decreased supply and to sustain viable farming operations.

A. Conserving Water by Ensuring the Mechanical Efficiency of Drip Irrigation

Most winegrape growers in California rely on drip irrigation. Properly maintained and operated drip systems, in contrast to furrow and sprinkler irrigation, allow the precise delivery of minimally required water to specific zones of active roots. Besides conserving water, drip systems enable growers to irrigate with excellent precision, which is important for achieving yield and especially quality goals. Despite these advantages, many drip systems are designed and/or operated inefficiently. There are many ways to improve the efficiency of drip irrigation to avoid overuse and depletion of water supplies (SWP Workbook, page 5-1).

To function optimally, drip irrigation systems require updated and efficient features and frequent inspection. The following list details important components that should be established, monitored, and adjusted as needed.

- The system is well-engineered and includes components for flow control, air venting, filtration, back-flow prevention, fertilizer injection, and pressure compensation
- Irrigation blocks are designed to differentially schedule irrigation for "zones" of varying soil characteristics
- The system has proper operating components for flushing lines and filtering water
- The system has flow meters and water use is recorded
- The system is checked for distribution uniformity, and emitters are treated or replaced and the system pressure is adjusted if not uniform
- Pump pressure is adjusted properly
- Blockages and leaks in lines, emitters, joints, etc. are checked and replaced frequently

Regular maintenance of the components of irrigation and pumping systems is crucial to maximize efficiency and minimize water losses.

- Water is used according to monitoring/water needs, using Regulated Deficit Irrigation or similar method

Preventive Maintenance: Regular maintenance of the components of irrigation and pumping systems is crucial to maximize efficiency and minimize water losses. The following schedule in **Table 1.1** has been recommended by experts (Susan Rathbun, Cal-West Rain, 2008).

Table 1.1: Preventive Maintenance Schedule

Inspection Item	Startup	Daily	Weekly	Biweekly	Monthly	Winterization
Cleaning filters		X				
Read flow meter	X	X				
Check field pressures	X		X			
Riser hose screens	X		X			
Flush hose lateral				X		
Flush mains					X	
Inspect emitters					X	
Inspect valves/ pressure regulators	X				X	
Inspect chemical injection system	X	X				
Pumping plant	X	X				X
Irrigation controller					X	X
Filter winterization						X

NOTE: Always have the manufacturer's maintenance and operation manuals available and follow recommendations.

B. Conserving Water through Layout, Rootstock Choice, and Regional Variation

Water conservation should be considered when vineyards are designed. Where appropriate, plant vines close together (3-4 feet) within the row on low- to moderate-vigor rootstocks, such as 420A, 3309C and 101-14. This will increase the root exploration of the soils and reduce the water demand on each vine's root system. Keep in mind, however, that close planting on high-vigor prone soils is not advisable. Avoid high-vigor, drought-prone rootstocks, such as 5C, 5BB, SO4 and O39-16. On the other hand, high-vigor, drought-tolerant rootstocks such as 110R and 140Ru can be counterproductive, except on very poor (i.e. shallow, low fertility) soils. On deeper, more fertile soils, wider vine spacing may be used, but low or moderate-vigor rootstocks are recommended. Very deep soils may need little or no irrigation after vines reach mature stages of development. Shallow soils generally refer to soils from 10 to 24 inches deep, and deep soils are generally greater than 28 inches; however, the available water holding capacity in the soils, whether shallow or deep, may also be a significant factor affecting water needs. (Glenn McGourty, UCCE, personal communication, 2008).

The amount of season-long irrigation applied to California coastal vineyards ranges from none (dry-farmed) to about 8 (North Coast) and 12 (Central Coast) acre-inches per acre. On average, North Coast vineyards are irrigated with approximately 4 inches. About 2-4 additional inches are required for the Central Coast because of less winter rainfall. Growers irrigating with over 4 inches on the North Coast or 6 inches on the Central Coast can likely safely reduce irrigation by 1-2 inches. Likewise, North Coast growers irrigating with over 7 inches or Central Coast growers irrigating with over 9 inches probably can reduce rates by 2-3 inches without adverse consequences. Central Valley vineyards generally require more irrigation, both due to the more demanding climate and to the economic necessity of higher yields. Central Valley wine grape vineyards are typically irrigated with 18 to 30 acre-inches per acre of water. Some growers in the northern Central Valley applying 18 or more inches may be able to reduce irrigation by 4-6 inches. Likewise, some growers in the southern Central Valley applying 24 or more inches may be able to reduce irrigation by 6-12 inches without detriment.

Water costs vary by region, but energy expenditures and costs to irrigate winegrapes are significant throughout California. For example, in 2007-08, energy costs for North Coast vineyards were estimated at $8 to $12 per acre-inch to pump from a well and another $4 to $7 per acre-inch to pressurize the drip irrigation system (Mark Greenspan, Advanced Viticulture, personal communication, November 2008).

Limiting unnecessary irrigation benefits growers, the public, and the environment by reducing energy use and costs, air emissions, and demand for water. Water conservation in winegrapes can provide additional benefits by decreasing expensive cultural operations and increasing fruit value. Regulated Deficit Irrigation (RDI) refers to an approach to irrigation that enables water conservation and often results in other desired effects. In vineyards, RDI means applying less than the full potential water requirement on vines, usually with a drip irrigation system, to achieve properly timed mild water stress. This approach reduces vegetative vigor and can limit (or eliminate) the need for cane cutting and/or leaf removal. It can also increase grape quality and thus market value. (For more information on RDI, see SWP Workbook, pages 5-17 to 5-20, and http://www.wineinstitute.org/files/DeficitIrregationMar2002.pdf.)

C. Irrigation Based on Moisture Level: Tools for Monitoring Water Conditions

Irrigation decisions should be supported by soil and vine monitoring, not calendar scheduling (Ley, 1994). Measurements of soil and vine water status help determine appropriate irrigation timing. Accordingly, soil water reserves are used first and then replenished (Prichard, et al., 2004, Zoldoske and Jorgensen, 1990). Various tools are available for measuring soil and plant water status, as summarized below. Sometimes, patterns of water status over time are more revealing than time-specific indicators. For measurements of vine water status, logs should be kept throughout the

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Methods to Conserve Water

- Mechanical efficiency of drip irrigation
- Layout, rootstock choice and regional variation
- Cover crop management
- Waiting as long as possible before starting to irrigate
- Short and frequent irrigation
- Changes in emitter spacing
- Adjusting water volume and flow in different parts of the vineyard
- Using low-volume sprinklers and mister units for vineyard cooling during heat waves

For information on winery water conservation, see Chapter 10 of the SWP Workbook and the Comprehensive Guide to Sustainable Winery Water Management and Associated Energy (Wine Institute, 2008).

season regardless of the tool(s) used. Visual indicators, especially for shoot tips during early season, should complement decisions about irrigation timing and be recorded (Greenspan, 2007).

Note that water status measurements, either soil-based or plant-based, do not provide sufficient information to determine irrigation schedules. Rather, growers should use the soil and plant water status measurements as feedback as to whether they are irrigating excessively or insufficiently. **Table 1.2** lists several types of soil and plant water status measurement tools. New technology is being developed that may enable measurements to be automatically captured and delivered electronically to the user via radio telemetry or internet.

Table 1.2: Tools for Monitoring Water/Moisture Conditions in Vineyards

Tool or Method	Function	Est. 2008 Purchase Price (per tool)	Comments: Pro & Con
Soil Measurement Tools			
Moisture Block	Measures soil water potential	$50 per sensor plus logging / telemetry costs	Inexpensive and may be monitored continuously. Requires good soil contact.
Tensiometer	Measures soil water potential	$200	Inexpensive technology, but requires much maintenance and is not effective in the drier soil range.
TDR, Dielectric, sensors-permanent	Measures soil water content	$100-$300 per sensor plus logging / telemetry costs	Some require no soil contact. May be monitored continuously. Higher sensor costs.
Dielectric (capacitance) sensor – portable	Measures soil water content	$6,000	Less expensive and not regulated like neutron probe, but can be measured only occasionally.
Neutron Probe	Measures soil water content	$10,000	Large measurement volume for very good representation, but can practically be measured only occasionally and safety regulations are strict.
Vine Measurement Tools			
Porometer	Measures vine response to water stress – stomatal conductance	$2,500	Highly portable. Vine water status is valuable information and stomatal conductance is a measurement of the vine's response to stress. Instrument is more fragile than the pressure chamber and sample area is smaller.
Pressure Chamber	Measures leaf water potential	$2,900	Highly portable and rugged. Vine water status is valuable information, but leaf water potential can sometimes be misleading.
Other			
Automated Weather Station	Measures weather parameters for ETo and may be used to log and deliver soil moisture measurements	$2,500 to $5,000	Evapotranspiration (ETo) may be used to assist irrigation scheduling. Other useful information is also provided and most vendors provide soil moisture connectivity. Cost is high with telemetry solutions.

D. Other Methods to Conserve Water

Other methods that growers can use to reduce water consumption are described below (Greenspan, 2007).

- **Cover crop management:** Some cover crops such as native perennial grasses create high competition for water. In water-shortage situations, disking of the cover crop is one possible way to manage competition from cover crops. Another approach is to aggressively mow cover crops or disk alternate rows when water is becoming scarce. This means the vineyard floor will be more conducive to a cooler microclimate for your fruit.
- **Waiting as long as possible before starting to irrigate:** Irrigating too early in the season is a common problem; it wastes water and causes excess vine growth. You can decide when to begin the irrigation season by looking at the shoot tip growth. Usually, vines do not require irrigation if the shoots are actively growing. However, if vine growth begins to slow down before vines have achieved the proper shoot length (3-4 feet or about 18-22 nodes), then irrigation must be applied to maintain continued, but slow, shoot elongation.
- **Short and frequent irrigation:** Irrigating with small volumes and short periods of time between applications has several benefits. For example, instead of irrigating for five hours twice a week, two and a half hours four times a week may be more effective. Often, growers irrigating in this manner find that they can further reduce the overall volume applied. The downside to this approach is that it is less efficient to apply only small amounts of water, since more water is lost by evaporation. This may be mitigated by avoiding irrigations during the heat of the day.
- **Changes in emitter spacing:** You can also use a greater number of emitters per vine (or per unit length) with smaller discharge rates rather than fewer emitters with higher rates. Laying out irrigation blocks based on patterns of soil uniformity is another wise move. Those are primarily decisions made at the time of vineyard design.
- **Adjusting water volume and flow in different parts of the vineyard:** You can apply different water volumes in different sections of the vineyard. Figure out how much water can be applied without seeing much change in water content over a period of time using the soil moisture devices. Continuous measurement of soil moisture is especially useful for this purpose. If you don't know the depth of your root zone, you can use a backhoe to look at the soil profile in the vineyard and examine different portions of the vineyard.
- **Using low-volume sprinklers and mister units for vineyard cooling during heat waves:** Some growers use overhead impact-type sprinklers to wet their vineyards during periods of high heat. This uses water at a high rate. Using low-volume cooling units may save many inches of water during a typical summer weather season. If impact sprinklers are used, cycle the system on and off during operation, allowing water to evaporate from the vines and soil between cycles. Use these systems only on heat-sensitive varieties. Also, canopy management to maintain a light foliar cover shading the fruit zone may reduce or eliminate the need for evaporative cooling during heat waves.

Irrigating too early in the season is a common problem; it wastes water and causes excess vine growth.

References and Resources

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