Vineyard Views
by Cliff Ohmart

Deficit Irrigation

I am impressed by the number of winegrape growers and consultants who purchased 'pressure bombs' to use in their irrigation scheduling programs this season. Furthermore, most if not all of them are using the device to implement a deficit irrigation program in at least some of their vineyards. Deficit irrigation is being talked about and used more and more in the region where I work. Therefore I thought it would be worth briefly reviewing the subject here since, like any new technique, there are growers who are intrigued by it, while others are very skeptical of the whole idea.

I will start the discussion with the observation that water and nitrogen are two vineyard inputs that many growers find difficult to cut back on. Unless a grower is producing very high-end winegrapes, yield is always an issue. More grapes mean more income. Instinct tells us that cutting back on water or nitrogen it will affect the pocket book. This is particularly true for growers who once grew other permanent crops, such as almonds or tree fruit, where conventional wisdom was to add 250 lbs of nitrogen per acre per year and always be sure that the trees never ran out of water. However, most of us realize that winegrapes don't need much nitrogen relative to many other crops and recent research has shown that providing less than full water use to some varieties, like Cabernet Sauvignon, Merlot, and Zinfandel, significantly increases wine quality. Yet it is still hard for many to take their hands off the water valve.

What is Deficit Irrigation?

Like all plants, winegrapes need water to survive and grow. The amount of water they use is determined by the energy from the sun. Solar radiation and wind cause water to evaporate from the leaves and a tension is created in the plant that draws in water from the soil. The technical term for this water use is evapotranspiration or ET. There are times when ET exceeds the amount of water available to the vine, for example when the weather is so hot that the roots cannot take in enough water to match what the canopy is loosing, or if there is not enough water in the soil. When this happens, the water tension in the vine increases and the plant experiences water stress.

Growing winegrapes in California's Mediterranean climate, where it rains mainly in the winter, means that at some point in the late spring or early summer the water in the soil in most locations will drop below the level required by the vine. Unless water is applied through irrigation vines will experience a lack of water, in other words a water deficit. Recent research has shown that water deficits can have a significant positive impact on wine quality. For example, juice from winegrapes grown under a certain amount of water deficit has a higher total acidity, lower pH, lower malate, and an increase in color. However, the size of the water deficit and the time when it occurs is important. When the deficit is too great yield is significantly reduced. Research trials in the Lodi area with Cabernet Sauvignon, Merlot, and Zinfandel indicated that around 65% full water use with

much of the deficit occurring before veraison significantly improved wine quality without significantly reducing yield.

Limited space does not allow me to go into great detail as to why water deficits improve wine quality. Moreover, not all of the answers are available yet. However, one observation is that canopy growth is reduced resulting in higher exposure of the berries to indirect light. Berry size is also reduced. It makes sense that too much water deficit results in too much canopy reduction resulting in the inability of the vines to mature the grapes properly. Furthermore, yields are significantly reduced when vines experience too much water deficit.

Types of Deficit Irrigation

There are at least 2 approaches to regulated deficit irrigation (RDI), the volume balance approach and deficit threshold plus RDI method. Both of these methods utilize the water budget approach to irrigation scheduling, which is based on monitoring and calculating the additions and losses of water from a field. The most important component of the water budget is an accurate estimate of crop ET. One starts with a generic reference figure, ETo, which is a measure of the water used by a field of four to six inch tall grass. For California growers this is recorded statewide by CIMIS, the California Irrigation Management Information Service. You can access CIMIS on the internet through the University of California IPM homepage, at www.ipm.ucdavis.edu**.** ETo is given in inches of water used per day. Each crop has a coefficient (Kc) that accounts for the difference between the crop and the grass. For example, if the ETo was 1.0 inch for the week of May 24, and the Kc that week equaled 0.61, the grapes used approximately 0.61 inches of water. That means the following week 0.61 inches of water needs to be replaced in the soil by irrigation to meet full ET for grapes. The crop coefficient varies throughout the growing season since the grape canopy varies in volume. Ask your local viticulture farm advisor where to get a table of winegrape crop coefficients for the season.

Using the above water budget approach, implementing deficit irrigation means irrigating vines at less than full water use. When using the volume balance approach for deficit irrigation you need to know the water-holding capacity of your soil and the cumulative rainfall from the previous winter so you know how much water you are starting with. You also need to know the daily grapevine ET so you know how much water is being used. A neutron probe or equivalent device is handy for making accurate determinations of soil stored water. No irrigation is applied in the spring/ early summer until the soil water is used up. When the soil water is used up you start to irrigate, but at less than the full amount warranted by the ETc (ETo multiplied by the crop coefficient). Research indicates that 30-66% of full ETc is the ideal range, which is adjusted based on the amount of canopy per acre. If the canopy is heavier than average (e.g. quadralateral trellis, narrow rows), then higher amount of ETc is applied, whereas if the canopy is lighter than average (e.g. vertical shoot positioning, wide rows), then the lower amount of ETc is applied. Experience will help fine-tune these numbers. As veraison passes, the water applied is increased slightly to help ripen the grapes, but is still maintained below full ETc. There is no need to cut the water off before harvest.

The deficit threshold plus RDI method for deficit irrigation entails waiting without irrigating until a predetermined level of water stress occurs in the plant (the threshold), then commencing irrigation for the season, but at the reduced rate as described in the above paragraph. Rather than monitoring the soil water, this method uses the pressure bomb I mentioned at the beginning of this column to monitor the plant's water status. Using the pressure bomb allows you to ignore the soil component and makes for a simpler system, letting the vine tell you when it is under water stress. To measure the vine water stress a leaf is removed from the vine at midday, and placed in the pressure bomb, with the petiole sticking up through a silicone grommet. Pressure is applied in the chamber until a bead of moisture appears on the cut end of the petiole. The pressure required to force the sap out is a measure of the level of water stress that the plant is experiencing. This measurement is called leaf water potential. As the stored soil water is used up in the spring, monitoring with the pressure bomb will start to detect mild water stress, which will gradually become more and more severe. Research has shown that it is time to start irrigating when leaf water potential reaches around –12 bars. From this point on, 30-66% of ETc is applied, just as in the volume balance approach discussed previously. It is important when sampling leaves with the pressure bomb that the measurement is done at the correct time of day, under suitable weather conditions, and the leaves are taken from specific locations on the vine.

Using deficit irrigation on a commercial basis in vineyards is pretty new and there is not yet a great deal of literature available for growers. A group of researchers at the University of California Davis, which includes Terry Prichard, Larry Schwankl, and Blaine Hanson, are in the process of writing an irrigation handbook for winegrapes that will include detailed information on deficit irrigation. This book should be available in about 12 months. In the meantime, check with your viticulture farm advisor for more information.

Does Deficit Irrigation Work?

Research has shown quite convincingly that deficit irrigation significantly improves wine quality. Some growers are already starting to implement the technique. Others are pretty skeptical of the whole idea. Some of the negative comments are along the lines of "the methods worked great on the research plots but they won't work in my vineyard". We need to recognize the fact that like any new technique, deficit irrigation cannot be applied in the exact same way in every location to every variety, rootstock, soil type and trellis system. The mechanism underlying the research is sound; irrigation deficits significantly improve wine quality. The amount of deficit and the exact irrigation schedule will vary by site, variety, clone, rootstock, and soil type. It is up to us to fine-tune the system for our own vineyards.