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Drought strategies for wine grapes

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Introduction

Under drought conditions growers will often face the dual challenges of having less soil moisture storage from rainfall at the beginning of the season, and having a reduced supply of irrigation to maintain crops during the growing season. This article discusses some basic guidelines for choosing how to manage a limited water supply to maintain acceptable levels of vine production and quality.

Pruning to adjust vine size

Altering the canopy size is one strategy to adjust vine growth to meet expected water supplies. In both dry-farmed and irrigated vineyards, the vines can be pruned more or less severely to compensate for the expected water supply in the upcoming season. Reducing the bud number at pruning will lead to fewer shoots and a lower vineyard water requirement throughout the season, however at the cost of reduced fruit production. A disadvantage of using pruning to adjust cropping levels is that this decision is made before the end of the rainfall season; spring rains may change conditions markedly, and it is not possible to "put buds back on the vine" if late heavy rains occur. Shoot thinning in the spring can accomplish the same goals, and allows the shoot number decision to be delayed until later.

Cover crop water use

Cover crops are commonly grown in vineyards to protect the soil from erosion. Most of the benefit from these cover crops occurs during the rainiest months of winter, typically December through March. The consumption of stored soil moisture by the cover crop increases sharply in the spring months of April and May; thus if the goal is to maximize soil water storage for later use by the vines, the growth of the cover crops should be terminated by late March, or even earlier in a very dry winter. If the cover crop residues are left on the soil surface, they will continue to provide protection against erosion from spring rainstorms and will also reduce the evaporation losses of water from the soil.

Deficit irrigation

Under mild water deficits, the vine transpiration rate (water loss) is reduced but the rate of photosynthesis is only minimally impacted; thus less water is used by the vines but little reduction in productivity is usually observed (Prichard et al., 2004). As the water deficit level becomes more severe, both vine growth and crop yield will be reduced. Severe water stress at sensitive growth

stages can lead to significant impacts on both the current season and the subsequent season's fruit productivity, thus the timing of the water stress is important to manage carefully. If irrigation supplies are not adequate to meet total vine water requirements in a season, the decision on when to subject the vines to water stress becomes critical.

Timing of water stress

Vine water stress early in the season between bud break and fruit set should be avoided, as it will lead to reduced shoot growth and if flowering is disrupted the cropping levels will be reduced. In dry rainfall years but where irrigation supplies are available, it will be advantageous to apply irrigation in the winter and/or early spring to ensure that this early season vine growth proceeds unhindered.

The period from soon after fruit set through veraison is one of the main phases where moderate stress levels can be applied to the vines. Water deficits at this time will have the advantages of limiting berry sizing and keeping vegetative growth in check, creating an improved microclimate for the developing fruit. Severe water stress levels soon after fruit set are undesirable as they can impact the development of buds for the following season's crop. Excessive water stress which results in leaf defoliation is counterproductive as it removes the functional leaves that are needed to develop fruit.

Moderate stress levels can also be applied from the period between veraison and harvest. As this is a period of rapid sugar accumulation in the fruit a healthy and functional leaf canopy is needed, but regrowth of the canopy is not desired; this regrowth can be kept in check with moderate stress levels. Excessive stress that results in appreciable leaf defoliation will again be counterproductive, as the ripening fruit becomes susceptible to sunburn and raisining if exposed to excessive direct sunlight.

The use of severe stress levels just prior to harvest are sometimes used by growers to hasten ripening; under drought conditions this strategy needs to be approached with caution particularly in drip-irrigated vineyards in dry regions. As there is a very limited amount of soil moisture storage at this time, sudden cutbacks in irrigation can leave the vineyard with very little available water and make it prone to suffer defoliation, particularly if weather conditions become unusually warm. Research has shown that mild water stress levels in the weeks before and through harvest can be beneficial in maintaining crop production levels and fruit quality, particularly under late harvest conditions.

Post-harvest irrigation is advantageous in areas where the leaf canopy remains functional well beyond harvest; however the elimination of this irrigation can save considerable water, at the cost of earlier leaf senescence and less carbohydrate storage in the permanent woody tissues. This in turn may lead to some reduction in early growth and productivity the following year, particularly if drought conditions extend for multiple years. Applying late-season irrigation to vines which have experienced defoliation may spur new growth in the fall, reducing stored carbohydrate levels.

In regions subject to risk of winter cold damage to the vines, post-harvest irrigation can be advantageous if soils otherwise would remain unusually dry due to lack of rainfall. Excessively dry vine tissues are more prone to suffer cold damage.

Establishing vineyards under drought conditions

The goal during the first several years of vineyard establishment is to develop a healthy and robust vine structure. Water stress during this period will limit vine growth and lead to delays in achieving full target production, thus every effort should be made to avoid stressing young vines for water. Young vines, having a relatively small amount of leaf area, will require less water per acre than will mature vines, but their limited root systems make them less able to forage for water deeper in the soil. Irrigation strategies that provide relatively frequent and shallow applications of water will often be the most efficient, particularly in soils with limited water-holding capacity. As

the vines grow, the interval between irrigations can be extended and depth of application increased. Young vines that are allowed to grow too vigorously late in the season may not harden off adequately and can be more prone to suffer from early winter cold damage; thus reigning in their growth in the fall by cutting back on irrigation can be advantageous.

Duration of drought seasons

Deep-rooted crops like grape vines can extract moisture from deep in the soil, in this way moderating the effects of short-duration drought conditions. However as droughts extend into multiple years, this supply of deep soil moisture becomes depleted and vines will no longer have access to this reserve source. Therefore even if rainfall conditions are equally dry over a number of years in a row, the vines will tend to show increasing impacts of drought over time due to the diminishing of this moisture supply that previously met a portion of the total vine water requirements. A gradual increase in irrigation applications year over year can be necessary to maintain constant production under such conditions, otherwise gradual declines in production can be expected.

Soil salinity considerations

In the drier parts of the state high soil salinity levels can reduce vine growth and degrade foliage, leading to poor fruit production and quality. The lack of winter rainfall will reduce leaching of salts from the root zone and will typically lead to increased salinity levels over time; these effects are compounded after multiple years of drought. Growers will need to be aware of the salinity levels in their soils, and apply leaching fractions of irrigation if available to flush excess salts from the root zone. This leaching is often done in the fall, winter, or spring, to avoid creating excessive growth conditions in the summer. The use of amendments such as gypsum may be beneficial for soils that are being impacted by high sodium levels, and can improve the infiltration of both irrigation and rainwater into the soil; lab testing of both soils and irrigation water are important to determine appropriate amendment applications. If salinity levels cannot be lowered by leaching, then in order to maintain normal productivity additional irrigation will be needed during the growing season to compensate for the increased salinity stress on the vines.

Frost sprinklers

Under severe water supply limitations, the use of water for sprinkler frost protection needs to be weighed against the value of that same water used to support vine irrigation later in the season. Alternative passive frost protection measures such as maintaining a bare vineyard floor surface and active measures such as using wind machines should be evaluated in such cases to reduce the water needed for frost protection. For further information on frost protection, see the following websites:

- http://biomet.ucdavis.edu/frost-protection.html
- http://cesanluisobispo.ucanr.edu/Viticulture/Frost_Protection/

References

Prichard, T., Hanson, B., Schwankl, L., Verdegaal, P., and R. Smith. 2004. Deficit Irrigation of Quality Winegrapes Using Micro-Irrigation Techniques. University of California Cooperative Extension, Department of Land, Air and Water Resources; University of California, Davis. http://cesanluisobispo.ucanr.edu/files/89518.pdf

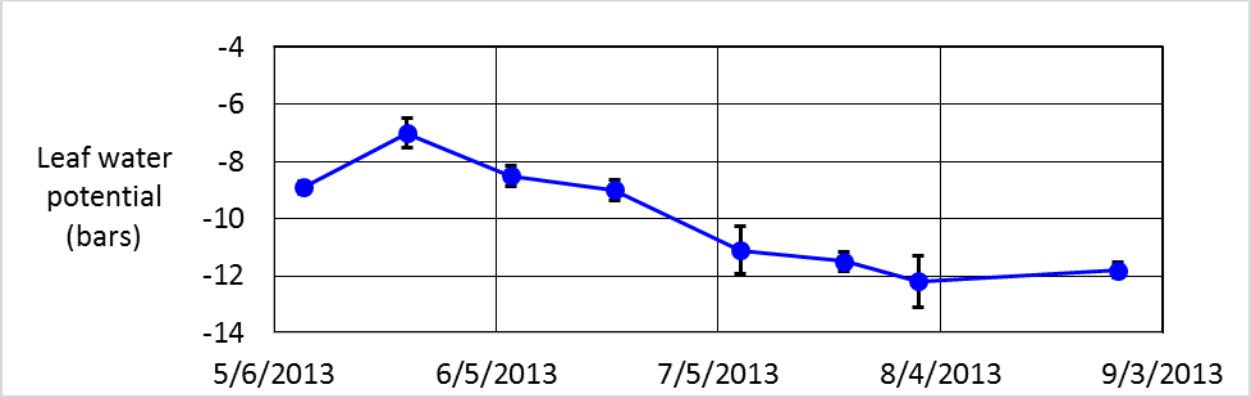

Figure 1. Leaf water potential measured throughout the growing season with a pressure chamber. The vines were under low water stress during the spring, and the water stress levels gradually increased into the summer, but the stress levels did not become excessive. This type of information helps a grower match irrigation amounts to the target vine water stress levels.

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