Viticulture - Characteristics of the vine - Irrigation

DEFINITIONS

• Irrigation - the application of water to growing plants such as vines, effectively a man-made simulation of rainfall, which can be useful in drier regions. Few vineyard practices are more maligned than irrigation.

IRRIGATION

- In its commonly visualized form, irrigation is carried out in hot, arid regions, and employs heavy furrow or sprinkler irrigation to maximize yield for table grapes, drying grapes, and bulk wines.
- That is the background for the widely held view, especially in France, that only drylands viticulture can produce outstanding wines, and that irrigation inevitably reduces quality.
- Widespread adoption of drip (or trickle) irrigation since the 1960s has now greatly blurred the distinction.
- Although originally developed for and used in true arid climates, such as Israel, the technique has found its major viticultural use for supplementary watering. That is, the vineyards rely mainly on natural rainfall, and irrigation is used to make up deficits.
- It is extensively used in mediterranean climates which are regularly dry during the critical ripening period; or else in climates with more uniform rainfall but which might periodically suffer from drought.
- The both of these climates the capacity to avoid severe water stress potentially improves grape and wine quality, provided that irrigation does not excessively stimulate vine growth and yield.

IRRIGATION - HISTORY

• One of the oldest agricultural and viticultural techniques and was clearly practiced, for example, in Ancient Egypt, and in Ancient Armenia.

IRRIGATION - UNDERLYING PRINCIPLES

- The need for irrigation depends entirely on climate.
- · Where evaporation is high and rainfall is low, vines suffer water stress.
- Many of the world's vineyards are in Mediterranean climates where the rain falls mostly over the winter, and the summers are dry and hot.
- Water stress in the vineyard during the summer depends on how much of the winter rain can be stored in the soil.
- · Soils such as sand and gravel can hold only limited amounts of water, silts and clays much more.
- · Vines with only shallow roots because of restricting soil conditions also experience water stress.
- On the other hand, some soils are able to store so much water that vines can grow without significant water stress, despite long periods without any rain. Typically these are deep loamy or silt soils, and are commonly found on valley floors. Some of the deeper soils of California's Napa valley are representative, and these may be found side by side with shallower soils where there is a need to irrigate.
- While a modicum of water stress is desirable to encourage fruit ripening and enhance wine quality, excessive water stress has serious implications. In these circumstances, irrigation applied in a restricted fashion can actually improve quality.
- When vines have access to generous supplies of water they grow rapidly, producing long shoots, big leaves, big berries, and where yield is increased, then ripening is delayed. All of these are features of vineyards which produce poor-quality wine grapes.
- Yield is also greatly increased; depending on the severity of water stress, irrigation may improve yield by 300 per cent or more.

IRRIGATION - BASIC EXAMPLES

- Widely practiced in the New World but less frequently in the Old (although irrigation is commonplace in some of the oldest vineyards in the world in the Near East and central Asia).
- In principle it is banned in much of the European Union other than for young vines, but this is a restriction which is easy, if initially quite expensive, to flout.
- While some still believe that irrigation is intrinsically inimical to wine quality, and there are many examples of deliberate over-irrigation, some of those who deliberately instal irrigation systems in southern Europe are motivated by the desire to make better wine (Costers del Segre).

- The modern view is that excessive water stress can be as damaging to quality as can excessive irrigation and that in drier regions carefully controlled irrigation can be a useful technique for maximizing yield and/or quality.
- The ancient method of irrigation, still used in some desert areas for bulk wine production, is flood irrigation.
 - Water fed from a supply canal is run down the rows and is soaked up by the dry ground.
 - For this to work, the vineyard floor must be flat and the rows not too long.
- Furrow irrigation (Argentina) is similar but allows greater control.
- More recent developments have been sprinkler and drip irrigation (trickle irrigation).
 - Sprinklers are typically about 20 m / 65 ft apart and span several rows.
 - Dripper supply lines, usually long plastic tubes, are placed down each row, usually with one dripper at each vine.
 - Both sprinkler and drip irrigation are capable of delivering exact amounts of water fairly uniformly over a vineyard.
 - Even a well-operated flood system is less accurate.
 - Drip irrigation in the middle of the row encourages cover crops while limiting under-vine growth.

REASONS FOR IRRIGATION - SOIL

- · Soils vary in their ability to store water.
- The 'field capacity' is the maximum amount of water a thoroughly, deeply wetted soil will retain after normal drainage.
- The driest moisture content at which vines can extract water from the soil is called the 'permanent wilting point'.
 - At this point, the plant will not recover if water is applied.
- Between these two limits is the amount of available water in a soil.
- This ability to store water is highest for silt soils and lowest for coarse sands and gravels.
- The latter soils are preferred for fine wine production as there is less likelihood for excessive water supplies to the vine following rainfall.

REASONS FOR IRRIGATION - STRATEGIES

- Irrigation strategy employed by a vine-grower depends on his or her ambitions for quality and yield.
- For maximum yields the vines are not allowed to experience water stress at any stage of the growing cycle, and vines are irrigated to maintain moisture levels near field capacity.
- Such strategies are common for bulk wine production, which is often undertaken in hot, dry climates.
- Irrigation amount is measured as a depth of water applied: for unrestricted irrigation in a hot climate, up to 800 mm / 31 in of water can be applied during the growing season.
- Smaller quantities of water are applied to vines producing better-quality wine.
- The regions in which they are grown are typically cooler and more humid, so the evaporation is less, and also the rainfall is often higher.
- Further, it is desirable to have the vines experience a little water stress, so application amounts can be as low as 100 mm / 4 in, or in some years even zero, depending on weather.

WHEN TO IRRIGATE

- In desert regions where the climate is relatively constant, such as much of Argentina, California, and inland Australia, irrigation is generally done by the calendar.
- The interval between irrigations can be longer in the early spring and late autumn, but the vineyards are irritated most often in midsummer, when evaporation is highest.
- Weather stations, now commonly seen on many vineyards, are used to measure evaporation.
- In areas with more rainfall, and especially where it is irregular, irrigation has to be much more carefully timed according to measurements of either soil moisture or, less frequently, the plant water stress.
- Soil moisture:
 - The appearance and feel of the soil can be useful guide but while the surface is dry the subsoil can still be wet.
 - Tensionmeteres are ceramic cups connected to a water column which creates a vacuum as water is extracted into the dry soil. Gypsum blocks contain an electrode; as the soil dries the electrical resistance changes. Neutron moisture meters are a recent irrigation aid by which an aluminum tube is placed permanently in the soil, and a neutron source lowered into it. The meter measures the spread of neutrons from a source, which depends on soil moisture.
 - More recent equipment and methods such as capacitance probes and time domain reflectometry, developed in the 1990s, allow easier and more accurate measurement of soil moisture.

- Data may be logged in the field or transmitted by telemetry to the viticulturist's computer.
- · Plant stress:
 - Can be measured by the experienced viticulturist observing stress symptoms such as drooping shoot tips, tendrils, and leaves.
 - Leaf temperature can also provide a guide since, as vines become water stressed, leaves facing the sun are heated significantly above air temperature. This temperature difference can be determined by feel, or by a remote sensor which can measure routinely and non-destructively, but not in wind or cloud.
 - Can also be measured by the so-called pressure bomb, which is common in California.
 - A device for measuring water potential in plants developed by the American plant scientist Scholander in the 1960s.
 - Since then it has been used for studies in grapevine physiology, and more recently in California as a guide to the timing of vineyard irrigation.
 - The blade of the leaf is placed in an airtight chamber.
 - Pressure is increase until xylem fluid exudes from the cut petiole end.
 - However, water potential of the grapevine can vary from minute to minute, depending on sunshine, temperature, humidity and soil moisture content so it is difficult to interpret this dynamic value as an irrigation guide.

PARTIAL ROOTZONE DRYING (PRD)

- Australian vineyard irrigation technique designed to control vine vigor and maintain wine quality with minimum interference to yield.
- It also requires less irrigation water than many conventional techniques.
- PRD was devised in lab experiments carried out at the University of Lancaster, in England, in the late 1980s. Initially, this work had nothing to do with grapevines. According to Lancaster's Dr. Mark Bacon, this research was purely for the academic pursuit of understanding how plants communicate information regarding the soil water status from the roots to the shoots. The chief focus of these studies was the plant hormone abscisic acid (ABA).
- Developed in the field by scientists Dry and Brian Loveys from the University of Adelaide and Csiro, after observation of basic vine physiology in response to water stress.
- Using vines with divided root systems, they discovered that when only a portion of a vine's root system was drying, shoot growth was slowed.
- The hormone abscisic acid was found to be produced by drying roots, and to subsequently cause reduced shoot growth.
- Abscisic Acid (ABA)
 - One of the group of chemicals known as plant hormones or plant-growth regulators. The core members of this group are auxin, cytokinin, gibberellin, ethylene, and ABA.
 - These hormones are responsible for coordinating plant growth by acting as signaling molecules. Sent from one part of the plant to another, they give each cell instruction on how to behave and grow.
 - ABA can be a negative hormone. It usually appears when things are going wrong. When plants are stressed, the first thing they do is make ABA.
 - During conditions of water stress, the roots synthesize ABA, the first part of the plant to experience the drought, and send it to the shoots and leaves. This alerts the aerial parts of the plant to the fact that hard times are on the way, and they stop growing and close the small pores called stomata in the leaves. Stomata allow in gases for photosynthesis, but also leak out water vapor. Thus, if things are too hot and dry, the plant will simply close stomata and stop growing, retarding development. The French term for this heat-induced shut down is *blockage*.
 - Roots produce the drought signals, not the shoot itself.
 - Why does ABA reduce shoot growth and not fruit growth?
 - It may have an effect on fruit growth but the overall effect on yield is minimal or not apparent.
 - Some feeling that fruit may be relatively isolated from the vegetative part of the plant, in respect of xylem (part of the conduction system of the plant transmitting water and various solutes from the roots to shoots) connections and function.
 - The other component of this system is phloem, which conducts nutrients such as the sugars produced by photosynthesis.
 - After veraison, all water to the fruit is provided by the phloem, not the xylem.
- Physical separation of a vines root system isn't feasible in the vineyard, so the split-root system is created by use of a dual-drip system that irrigates either side of the vine.

- The irrigation regime is then switched from one side to the other at intervals of 7-14 days. This allows the roots system to dry out enough for it to signal to the shoot and leaf system that there's some water stress, but not enough for damage to occur. This also ensures repeated hurts of signaling from the root that help keep canopy growth restricted.
- The watered roots on one of the sides maintain an adequate supply to the vine so it can still function, but because of the root-signaling, vigor is reduced, water use is decreased and, potentially, the grape quality is enhanced.
- The chief benefit of PRD is the reduced water use. This is a critical issue because in vineyard areas where irrigation is practiced, water is scarce, and is likely to prove a limiting factor for viticulture in hot climates. This is likely to get worse with increasing competition for water resources and a rise in global average temperatures.
- Field experiments with Cabernet Sauvignon showed that it was possible to control shoot vigor and reduce the amount of water needed while maintaining yield and quality.
- This was achieved with two drip irrigation lines per row, used alternately for irrigation while the other part of the root system was drying.
- · Commercial evaluation of PRD begin in the mid 1990s.
- PRD is only possible where irrigation is practiced. You can't do it in areas that have significant growing-season rainfall.
- The results from these studies can be used to interpret some of the known beneficial effects of water stress, especially for red wine quality.
- PRD may alter the way a plant distributed its nutrient resources for improved fruit quality: source-sink relationships.
 - When there is a steady supply of water, the actively growing shoots act as a "sink," taking more of the carbohydrates than the fruit. There is some evidence that the reduced growth of the shoot system means that its sink strength is reduced, thus more resources are then allocated to the fruit.
- · It is also possible that such findings will explain the acknowledged terroir effects of wine quality.
 - Professor Seguin (1980s) in Bordeaux having shown the importance of some vine roots drying near the surface while the vines continue to draw water from much deeper levels.
 - He concluded that it was the drainage properties of the soil affecting the availability of water that mattered most.
 - The best terrors are those where the soils are free-drainined, with the water table high enough to ensure a regular supply of water to the vine roots, which then recedes a good deal on veraison so that vegetative growth stops and the vine concentrates its energies on fruit-ripening.

REGULATED DEFICIT IRRIGATION (RDI)

- An irrigation scheduling technique which uses mild water stress at key stages of fruit development to reduce vegetative growth and improve berry ripening and thus improve grape quality.
- · RDI was first applied on peach and pear orchards in Australia in the 1980s.
- Research showed that it restricted shoot growth without significantly affecting yield.
- It is now common practice in many vineyards in Australia, especially in those planted to black grape varieties, due to the greater benefits to grape color.
- The main benefits of this strategically managed water stress are less competition between berry ripening and vegetative growth, better water conservation, and, especially with some varieties such as Syrah, reduced berry size.
- It requires very carefully monitoring of soil water content and typically results in slightly lower yields.
- It is most effectively applied through drip irrigation.
- RDI is more stressful to the vine than PRD and its use in hot regions can cause problems if its application is followed by a spell of hot weather: vines with limited soil moisture can suffer extremes of water stress, which may, for example, lead to rapid loss of leaves.
- This situation can be alleviated by careful monitoring of weather forecasts and applying some irrigation.
- Water deficit is generally applied variably between fruit set and a month or so after veraison but is generally avoided in the later stages of berry ripening.
- The timing of the deficit still needs further evaluation.
- For example, experiments in Australia have shown that reduced irrigation prior to veraison causes a greater reduction in berry size than does less irrigation after veraison.
- However, the role of berry size in affecting wine quality is contentious.

DRY FARMING

- The practice of relying only on natural annual rainfall.
- Typically not a problem for most of Europe's classic regions such as Bordeaux and Burgundy where too much water is a greater danger than too little.

- In many wine regions dry farming is obligatory because irrigation is illegal.
- In dry regions such s California irrigation has become common practice, but some growers believe the dry farming is preferable.
- Two main reasons to dry farm: water conservation and grape quality.
- Dry farming can save as much as 16,000 gallons of water per acre annually.
- Some vintners believe dry farming leads to more intense flavored grapes. Fruit is supposed to be sweet, denser, and smaller.
- Considerations for Dry Farming:
 - · Pick a rootstock that will seek the moisture deep in the soil.
 - Vines must be spaced sufficiently to get all the moisture they can.
 - Correct soil mix is crucial to prevent moisture from escaping.