# WATER & VINE
## Managing the challenge

**MODULE 05**

# Insights into the relationships between yield and water in wine grapes

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# YIELD AND WATER

This module has been prepared in light of providing growers and industry with immediate information that can be used to aid irrigation management decisions. The complementing powerpoint presentation has been tailored to suit specific winegrape growing regions by providing regional data on yield and irrigation water for Shiraz, Cabernet Sauvignon, Merlot and Chardonnay.

For more information and training contact your local Innovators Network member or go to http://waterandvine.gwrdc.com.au.

## 1 Components of grapevine yield development

In order to understand how to manage wine grapes under minimal water inputs, it is important to have an understanding of the annual growth cycle of a grapevine. A grapevine's annual growth cycle includes a vegetative and fruiting (reproductive) cycle (Figure 1.). These main growth events occur across five stages of the grapevine's development being budburst to flowering, flowering to fruit-set, fruit-set to veraison, veraison to harvest and harvest to leaf-fall. Vines are dormant from May through early August. The cycle of berry/yield development for grapevines tends to extend over two years with bud initiation occurring in Year 1 to harvest in Year 2 (Krstic et al., 2005). The most important stage to determining yield potential is inflorescence initiation and differentiation which begins about 18 months prior to harvest. Floral bud development and budburst are key events that influence yield followed by flowering and fruit-set where a proportion of flowers will successfully set and become berries.

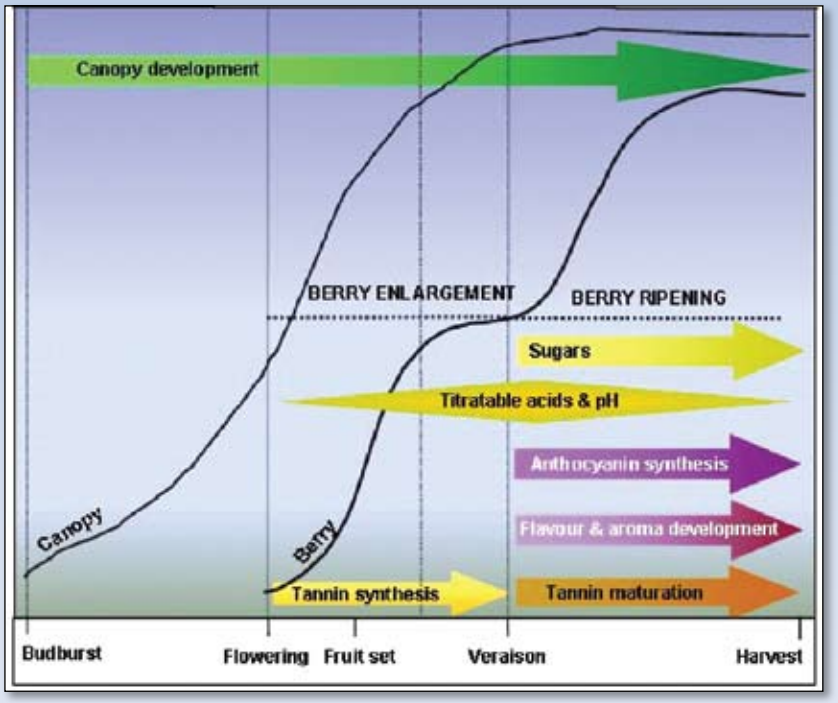


**Figure 1.** Schemmatic representation of canopy growth and grape berry development during a grapevine's growing season (adapted from Coombe, 1992; Coombe & McCarthy, 2000).

## 2 Water relations in grapevines

Various studies have used different irrigation regimes to manipulate canopy vigour and have noted that yield and quality at harvest are dependent on when the irrigation is applied in relation to the stage of berry growth.

The amount of water required at different stages of grapevine growth will depend on the variety, rootstock:scion interaction, climatic (rainfall and evaporation), soil type/depth and crop load. Figure 2 illustrates the approximate annual percentage of water required by vines at each stage of growth during the season.

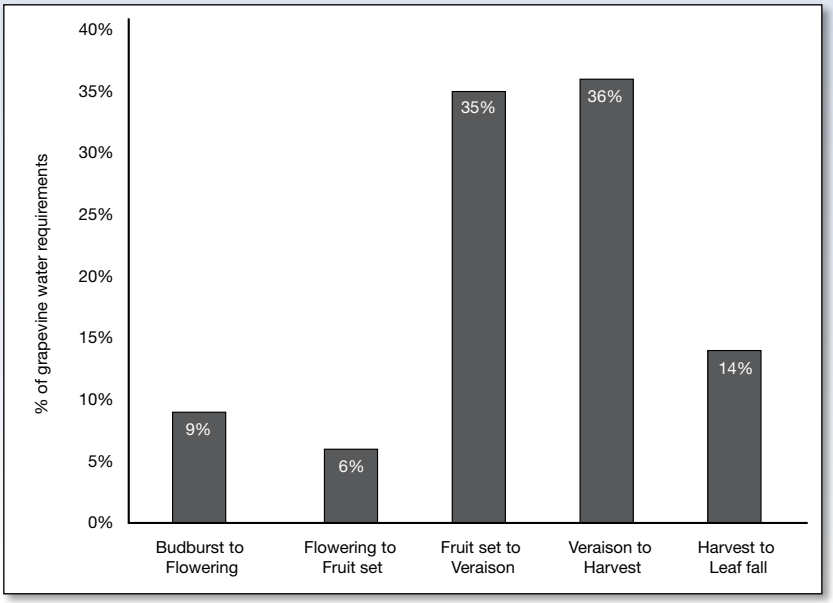


**Figure 2.** Grapevine growth stages and the approximate water requirement at each stage as a proportion of the annual requirement (Adapted from NSW Agriculture (2004).

### 3.1 Budburst to fruit set

Stages 1 and 2 include budburst, flowering and fruit-set. When combined, these stages utilize approximately 14% of the annual water requirement. They are critical stages for establishing canopy size and potential yield. Irrigations that are applied too soon will be wasted and not utilized by the vines. During this period, rapid vegetative growth ensures the development of an adequate leaf canopy to sustain production. Once the leaf canopy is fully developed, towards early to mid-November, vines flower. Water use at this time is still moderate and water stress should be avoided to ensure optimum flower retention and fruit set. Bud initiation and differentiation for the subsequent season also takes place at around the same time. High water stress at flowering can result in poor fruit set (hen and chicken) or aborted fruit (shot berries) – both of which lead to yield reductions.

## 3.2 Fruit set to veraison

Stage 3 extends from fruit-set to veraison and uses approximately 35% of the annual water requirements. This is the time that deficit irrigation strategies, such as RDI, can be used to control berry size. Severe water stress can affect bud fruitfulness. During the berry expansion phase, between fruit-set and veraison, water deficits tend to reduce berry size often resulting in a higher sugar concentration per berry. In this period of berry growth the vine is probably least susceptible to moderate water deficits. Several studies on winegrapes have shown that water deficits during this period do not impact on the accumulation of soluble solids and although berry size is reduced (and remains less irrespective of the amount of water applied after veraison) the total sugar content at harvest is not affected.

## 3.3 Veraison to harvest

Stage 4 is from veraison to harvest with vines requiring about 36% of the annual water requirements. This is the period when sugar is accumulating in the berries. It is important to maintain healthy leaf function to maximize berry sugar accumulation. Hence, severe deficits should be avoided to prevent plant defoliation. Once berries have reached maturity in mid to late February water deficits are less harmful to production and after canes have been cut, water deficits may accelerate drying of the fruit.

## 3.4 Post-harvest

Stage 5 is harvest to leaf-fall and uses at least 14% of annual water allocated at this growth stage. It is still important to maintain some leaf function during this period, especially from April-June, to ensure that the vine is able to build up sufficient reserves for the subsequent season before going into dormancy. Water stress during this stage may lead to restricted growth symptoms in the spring, particularly in young vines. In contrast, irrigation to match crop water requirement can lead to re-growth of shoots and this can compete with storage.

## 4 Relationships between yield and water

The effect of irrigation on yield is not a linear relationship (Figure 3). Theoretically, there is an irrigation threshold where yield reaches maximum productivity. Any irrigation above this level results in wasted water to deep drainage and evaporation that can also lead to excessive vegetative growth, nutrient leaching, pest and disease problems and poorer fruit quality (Figure 4).

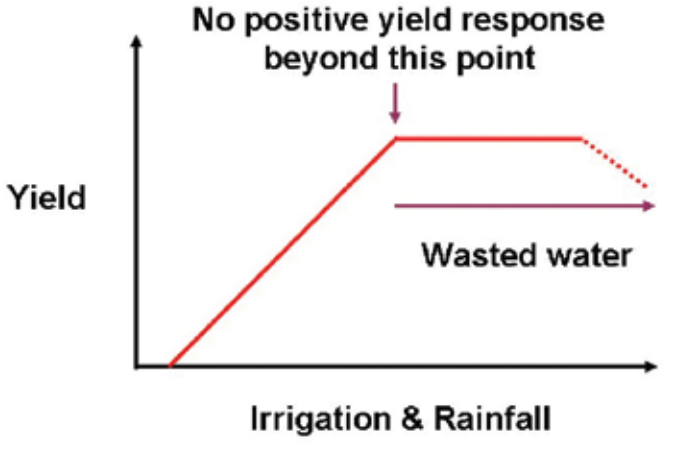


**Figure 3. Theoretical interpretation of the effect of irrigation on yield.**


**Figure 4. Theoretical interpretation of the effect of yield on quality.**

Currently the Australian wine industry has widely adopted various irrigation management strategies such as regulated deficit irrigation (RDI), partial rootzone drying (PRD) and sustained deficit irrigation (SDI) to improve and sustain water use effciciency (WUE-tonnes of fruit per megalitre of water) (Kreidemann & Goodwin, 2003). A common feature of these irrigation techniques is the reduction in available soil water, but how the water is applied is fundamentally different.

In order for growers to make a decision whether to focus on irrigating select patches (high value varieties) or applying reduced water across all patches there needs to be information on the immediate impact of water deficit on yield and quality not only in the current season but also preceding years. There are some general concepts that can be considered when trying to budget and prioritise water when water restrictions are imposed. This section describes a number of scenarios ranging from no irrigation at all to those aiming to achieve maximum yield.

- Scenario 1: No irrigation and likely abandoning of the vineyard. Vines may have to be removed because of the potential of pest and disease carryover. After one season without irrigation it may be possible to revive the vineyard in the subsequent season. Survival will depend on rootstock and variety. Ramsey grafted vines are more likely to survive than vines on their own roots.
- Scenario 2: Irrigation for survival. This scenario suggests keeping the vines alive to protect the future production capacity under very limited water supplies. To maximise the potential for a crop in the next season, it is important to maintain bud fruitfulness and retain as much of the vine's carbohydrate reserves as possible. This could be achieved by winter pruning to reduce the number of buds retained so as a small canopy is maintained. Furthermore, the removal of bunches shortly after berry set will reduce the tranpsirational demand required to ripen a crop. Irrigation should only be applied once shoot growth ceases, which tends to be near flowering. Where possible, limit shoots to approximately 30-40cm in length (6-8 healthy leaves per shoot) either by withholding irrigations or summer hedging. Large amounts of leaf loss should be avoided during veraison to harvest, as it will lead to reduced carbohydrate reserves and poor fruitfulness of the basal buds. Careful observation of the vines for signs of early water stress in conjunction with soil moisture monitoring will help in avoiding the vines shutting down.
- Scenario 3: Irrigate to minimise the loss in yield. Most appropriate is the application of either a RDI or SDI irrigation strategy. Severe stress prior to flowering and set should be avoided because of its negative impact on fruiting potential in the current and subsequent season. Post-set RDI has less impact on fruiting potential but may reduce berry size and yield. The least sensitive period to apply RDI is after fruit set around mid to late November to veraison in mid to late January. Applying a sustained deficit below the estimate plant water requirement has been shown as a successful strategy for conserving water. However it should probably not be less than 70% of crop water requirement and some reduction in yield will be inevitable.

## Useful Websites

- www.pir.sa.gov.au wine-viticulture-irrigation-developing a water budget
- www.riverlink.gov.au/waterlink/w_factsheets.html
- www.vic.dpi.gov.au/Agriculture & food-horticulture-wine & grapes-information

## Contact Details

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