Getting the most out of your water

The importance of irrigation system efficiency

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Introduction

Annual temperature, growing season temperature and aridity are projected to increase in the future for every region across Australia, with more intense heatwaves and less rainfall expected in many regions (Harris 2019). Water is already a significant cost for grape production in Australia, and lack of reliable access to competitively priced water is limiting production by restricting yields (AWRI 2021). Further reductions in water availability or increases in water costs are threatening the viability of some Australian winegrowing regions.

AT A GLANCE

- Grapevine water use can be highly variable
- Irrigation system design should match the soil, variety and rootstock to maximize efficiency
- Matching irrigation system capacity to maximum crop water demand can lead to greater efficiencies
- Regular irrigation system performance monitoring is important to detect issues before these affect grapevine growth and yield
- Non-uniformity of dripper discharge rates have a major effect on irrigation water volume applied to vineyards over a season
- Clogged drippers, blocked filters, deterioration of dripper components and mismanagement of system pressures are common issues
- Irrigation system maintenance should be conducted regularly

Vineyard water use efficiency (WUE) is the relationship between yield (tonnes) and the amount of water used to grow the crop (megalitres). Reducing water use without compromising yield or quality will increase WUE and improve total vineyard profitability. Supporting growers to optimise their water use efficiency is key to the ongoing sustainability of the Australian wine industry.

Wine industry research and extension projects and government initiatives have been focused on improving water use efficiency since the 1960s and a large amount of information is available to help growers improve irrigation efficiency. A recent search of the AWRI library found 2,246 articles on irrigation and 644 articles on water use efficiency. However, results from a recent AWRI irrigation survey showed that there is an 87% difference in Shiraz water use efficiency between the most efficient and least efficient water users in the inland irrigated grapegrowing regions of Australia (AWRI 2021). These results suggest that significant improvements in WUE are possible.

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Key factors that affect water use efficiency

Grapevine water use can be highly variable. McCarthy *et al.* (1992) reported vine water use from as little 2.5 ML/ha to more than 8 ML/ha. Vine vegetative and reproductive growth are correlated with vine consumptive water use. Large increases in yield are possible with small amounts of additional water, with increases of 1.6 t/ha up to 3.7 t/ha having been measured from an additional 1 ML/ha of water (McCarthy *et al.* 1992). The magnitude of the yield increase depends

on a number of factors including vine health, variety, rootstock, canopy size, climate, soil type, soil structure and health, water quality, the timing of irrigation applications and the efficiency of the irrigation system (Figure 1). This article will focus on irrigation system efficiency.

Irrigation system efficiency

System design

When designing an irrigation system, matching the system to the soil, variety and rootstock is key to maximising water use efficiency. Soil texture, structure and depth determine how much water the soil can hold. Different soil types should be grouped separately to allow irrigation applications to be tailored to each soil type. Similarly, different varieties and rootstocks have different irrigation requirements and should also be grouped separately.

Another key factor in maximising water use efficiency is matching the capacity of the irrigation system to the maximum crop water demand. When determining maximum crop water demand, it is important to consider the amount of water required to protect vines from damage before and during a heatwave and the ideal timeframe for delivering the water. It is also important that the system has the capacity to meet the maximum daily crop water demand in 18 hours per day to allow for downtime for repairs and maintenance.

Matching dripper discharge rate and spacing to soil type is also an important consideration when aiming to maximise water use efficiency. To avoid surface run-off and ponding, dripper discharge should not exceed the soil's infiltration rate. Lighter (sandy) soils are more permeable than heavier (clayey) soils, allowing for a higher dripper discharge rate. Drippers should be spaced to create a continuous wetted strip along the vine row. Lighter soils also have a lower water holding capacity and less lateral water movement than heavier soils. In lighter soils, a tighter dripper spacing is required to maintain a continuous wetted strip compared to heavier soils (0.5-0.6 m compared to 0.75 m). A lighter soil will also require shorter but more frequent irrigations than a heavier soil, to minimise losses from leaching.

Dripper type should also be considered. Pressure compensating drippers are more expensive, but they are able to maintain distribution uniformity in undulating ground or long rows. The importance of this is described below. Filtration is another key component of an efficient irrigation system, as it removes material that would otherwise block a dripper before it enters the system.

Irrigation system monitoring

Regular monitoring of irrigation system performance is key to detecting any issues before there is an effect on grapevine growth and yield. Distribution

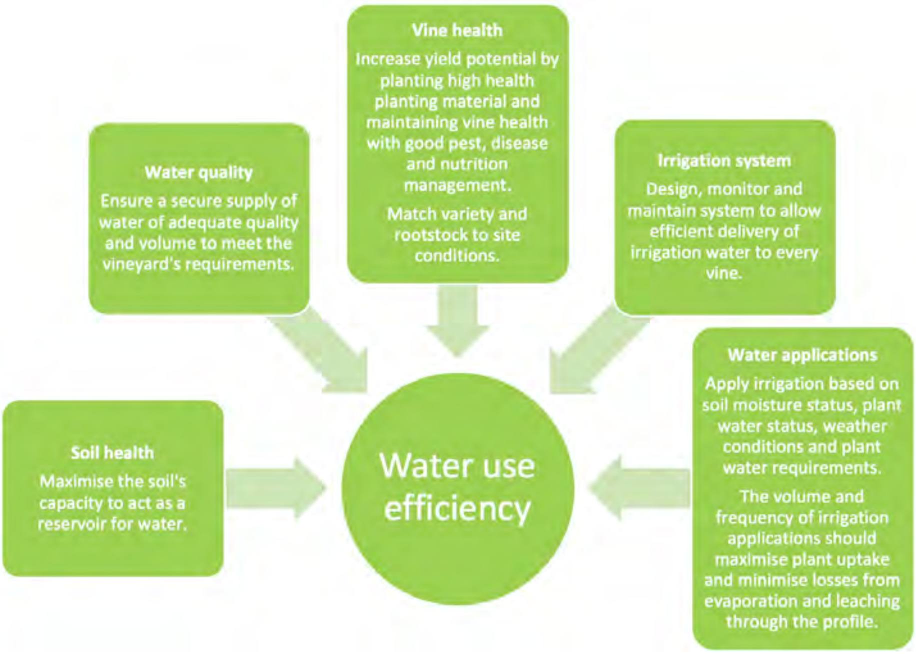

Figure 1. Main factors affecting vineyard water use efficiency

uniformity (DU) is a measure of how uniformly plants within an irrigation system receive water. Poor uniformity can lead to over-irrigation and/or under-irrigation of vines within the same block.

To determine if irrigation is being applied evenly and within the manufacturer's specifications, in-field measurements including dripper discharge and operating pressure can be used to determine dripper performance. These measurements should be conducted towards the extremities of the submain and laterals. A variation in dripper discharge of more than ±5% and a pressure variation of more than ±10% indicates an issue with the system that should be investigated further.

Hornbuckle *et al.* (2012) showed that non-uniformity of dripper discharge rates had a significant effect on the total volume of irrigation water applied to vineyards over a season. In Griffith, a dripper discharge variation of ±23% from the median was measured across a vineyard, which corresponded to some vines receiving 3.1 ML/ha over the season while other vines received 5 ML/ha. In Tatura, a dripper discharge variation of ±60% from the median was measured across the vineyard, which resulted in some vines receiving 1 ML/ha while others received 6 ML/ha. Given that yield increases of 1.6 to 3.7 t/ha have been measured with 1 ML/ha of additional irrigation, the yield loss potential from uneven distribution uniformity is considerable (McCarthy *et al.* 1992).

Despite the importance of checking DU and the relative simplicity of conducting the measurements, a recent AWRI irrigation survey revealed that 28% of respondents had never checked the distribution uniformity of their drippers and 17% had never performed pressure checks across their irrigation system (AWRI 2021). Hornbuckle *et al.* (2012) suggest that a barrier to conducting regular in-field system monitoring is the time it takes to conduct the monitoring in each valve at regular intervals throughout the season. To streamline the process, these authors used satellite-derived normalised difference vegetation index (NDVI) data (at a cost of $4/ha in 2012) to refine the DU sampling procedures. NDVI is a measure of vegetation (biomass) and its 'greenness'. Although other factors such as soil fertility, salinity, pests and diseases and plant material can influence NDVI, the authors suggest that this approach offers a guide to help target infield DU measurements, to understand if DU is a problem.

Kidman *et al.* (2017) used airborne thermal sensors to remotely sense vine water status across the Coonawarra region. As a side outcome, the data was used to identify irrigation blockages and leaks. The cost of the flights to capture the thermography data (approximately $7.10/ha in 2017) limits the practicality of using this technique to help schedule irrigation and regularly monitor irrigation system performance. To overcome this limitation, a ground-based network of low-cost continuously logging thermography sensors was used to measure real-time vine water status and irrigation system performance across a vineyard. Thermography sensors can also be mounted on drones for checking vine water status and irrigation system performance at regular intervals during the season. Similar to the NDVI data, thermal changes across a block may be related to other factors such as soil fertility, salinity, pests and diseases and plant material. In-field measurements are therefore needed to confirm any suspected DU issues. ▸

IrriSAT is a free-to-access weather-based irrigation management tool that uses remote sensing to provide site-specific crop water management information across large spatial scales. Developed in partnership with the CRC for Irrigation Futures, IrriSAT uses satellite imagery to measure NDVI and estimate crop coefficients (Kc) at a 30 m resolution (Hornbuckle *et al*. 2009). IrriSAT can be used to monitor irrigation performance, identify potential DU issues, and guide infield DU measurements; however, if more precise information is required, higher resolution NDVI data can be obtained from other suppliers. IrriSAT captures historical satellite imagery data dating back 20 years. This allows growers to measure the success of their irrigation system monitoring and maintenance practices as well as assessing any irrigation system upgrades.

Irrigation system maintenance

Regular irrigation system maintenance is key to maximising water use efficiency. The most common issues with drip irrigation systems are clogged drippers, blocked filters, deterioration of dripper components and mismanagement of system pressures. Excellent irrigation system performance can be maintained with regular flushing, chlorination and filter maintenance (Giddings 2004). However, a recent AWRI irrigation survey revealed that 21% of respondents had never performed any pump maintenance, 17% had never flushed their driplines and 11% had never cleaned their filters (AWRI 2021).

> Regular monitoring of irrigation system performance is key to detecting any issues before there is an effect on grapevine growth and yield.

Further information

An AWRI webinar titled ‘New tools and practical techniques for monitoring and maintaining drip irrigation systems’ was delivered by Jeremy Giddings (Agriculture Victoria) and Peter Henry (Netafim Australia) in July 2021. To view the webinar recording, visit the AWRI’s YouTube channel: youtube.com/c/theawri.

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The AWRI will be hosting irrigation maintenance and monitoring workshops with Jeremy Giddings and Peter Henry in the inland irrigated regions of Australia in 2022. For more information about these events, please contact the AWRI helpdesk at helpdesk@awri.com.au or 0 8 8313 6600.

Acknowledgements

This work was supported by Australian grapegrowers and winemakers through their investment body, Wine Australia, with matching funds from the Australian Government. The AWRI is a member of the Wine Innovation Cluster in Adelaide. Jeremy Giddings is thanked for his contribution to the writing of this article.

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