Department of Agriculture
Farmnote
REVIEWED 2005
No. 66/99

Irrigation techniques for winegrapes

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Irrigation can be used as a vine management tool. Young vines should be irrigated to optimise vine growth. Established vines can be irrigated to manage vine growth and to manipulate fruit quality and yield. Two irrigation techniques that can be adopted on established vines are regulated deficit irrigation (RDI) and partial root zone drying (PRD).

Vine stage

Establishment phase

Irrigate vines *immediately* after planting.

Vine water use is very low in the first 6 to 8 weeks, but the vines have a small root system that should be kept moist. Initially vine growth (including root growth) is supported by stored carbohydrates in the cutting/rootling. The soil should be kept moist to promote further root growth. If the soil becomes too wet, root growth will be inhibited. In most soil types this means applying small amounts of water daily for the first few weeks then less often.

To ensure the moisture of the soil is at an optimum install soil moisture monitoring devices (e.g. tensiometers). Maintain the soil moisture tension in the vines root zone between 10 and 60 centibars.

Young vines

The aim is to maximise vine growth in years 1 to 3. Maintaining moist soil throughout the growing season will help to achieve this. Soil moisture can be maintained by adjusting irrigation according to soil moisture readings (e.g. tensiometers or gypsum blocks). Soil moisture should be maintained between 10 and 60 centibars.

Established vines

Maintaining soils in the readily available moisture range will maximise yield throughout the growth cycle of the vines. Irrigation techniques such as RDI and PRD can also be used to manage vine growth and to manipulate fruit quality and yield.

Regulated deficit irrigation (RDI)

RDI is the control and management of water stress by irrigating at less than the full requirement of the vines and maintaining soil moisture at a relatively dry level. Using RDI can result in vine vigour control, help to produce premium quality fruit as well as good yields while conserving water.

The aim is to maintain water stress within a desirable range through different growth stages so that the response of the vine can be harnessed to the benefit of the vineyard. To achieve this requires control of the depth and timing of irrigation to achieve a certain vine response.

Growth of vines shoots and leaves starts at budburst. At flowering nearly half of the final leaf area has developed. After flowering and fruit set, berry growth is initially very rapid but then slows. Vegetative growth normally reaches a maximum between berry set and veraison. At veraison berries begin to soften, change colour, accelerate in size, accumulate sugar, decrease in acidity and increase in pH.

Water stress affects the most actively growing plant parts. If stress is imposed when the shoots are actively growing then shoot growth will slow down. Water stress during the two stages of rapid berry growth will reduce yield and disrupt the fruit ripening process.

However, at any time during the season imposing RDI will decrease yield and titratable acid. During flowering RDI will reduce yield significantly. Pre-veraison RDI will reduce vegetative growth and only marginally affect yield. Post veraison RDI will decrease yield but can increase quality. Late season RDI will slightly decrease soluble solids, yield and vegetative growth.

To implement RDI the following components are necessary:

1. ***Install soil moisture monitoring devices, determine soil water-holding capacity and root zone depth.*** To achieve water stress, control the depth and timing of irrigation in the root zone of the vines. Because RDI is a controlled irrigation system, irrigation should be applied according to soil types and varieties.
2. ***Withhold irrigation*** to dry out the root zone sufficiently, so that when irrigation commences there is control over the amount of water the vines use and thus there is control over vegetative growth pre-veraison. In practice this means that the soil moisture is monitored at the base of the root zone. When the gypsum block at the base of the root zone

(90-200 cm) reaches between 100 and 400 kPa (100 kPa for sandy soil, 200 kPa for loamy soil, 400 kPa for clay soil) begin irrigation.

3. ***Impose stress*** (pre-veraison) by short irrigations. To maintain a desirable level of stress, irrigation run time should be reduced so that only part of the root zone is wet. When stress is to be imposed only the shallow block is kept wet (about 30 cm). When *moderate stress* is to be imposed irrigate so that the top 60 cm of the soil profile is irrigated (veraison plus four weeks). Thus, keep the 30 cm and 60 cm block wet. The deeper gypsum blocks should be maintained at the levels at which irrigation began (100 kPa for sandy soil, 200 kPa for loams and 400 kPa for clay soil).
4. ***Measure evaporation and soil moisture*.** Irrigation timing should be based on maintaining soil moisture between full point and refill point. This can be determined in millimetres by trial and error by measuring the amount of water (in mm) required to re-wet the soil from the refill point to field capacity. Irrigation timing can then be based on irrigating after vineyard water use (vineyard water use = crop factor x evaporation) is equivalent to the difference in millimetres between full point and the refill point. This should be adjusted by measuring evaporation between the time the soil moisture is at full point and the refill point.
5. ***Monitor vine performance*.** This involves collecting yield, quality and vegetative growth data.
6. ***Keep record*s.** Accurate records of evaporation, rainfall, irrigations, soil moisture and plant measurements must be kept so that the schedule is applied correctly and that the response can be monitored and modified if necessary.

A typical wine grape RDI schedule for the south-west of Western Australia

Begin recording gypsum block readings, evaporation and rainfall at budburst. The soil profile at depth will begin to dry slowly and then rapidly.

Avoid stressing the vines during flowering (about 10 days). Then continue to dry out the soil profile.

When soil moisture at the base of the root zone reaches the desired level (about 100 kPa in sand, 200 kPa in loam and to 400 kPa in clays) start irrigation. This start time will depend upon soil type and the season but usually occurs in mid to late December and well before veraison.

Apply water stress during the stage prior to veraison. This is achieved by keeping the soil between 0-30 cm moist. The shallow gypsum block at this stage should be between about 10 kPa and 60 kPa. Irrigate when the 30 cm gypsum block reaches 60 kPa. At the same time keep the 60 cm and deep blocks dry (about 100 kPa in sand, 200 kPa in loam and to 400 kPa in clays) by not irrigating too deeply. These soil moisture conditions should be maintained until veraison. This will require short shallow irrigations frequently (about 2 to 4 hours depending on application rate). Use the gypsum block readings to determine the depth and frequency of irrigation.

Avoid stress at veraison (for about four weeks from the start of veraison). Achieve this by keeping the soil between 0-60 cm moist. The gypsum block in the active root zone at this stage should be less than 60 kPa. Irrigate when the 60 cm gypsum block reaches 60 kPa. This will require deeper irrigations. At the same time keep the gypsum block at the base of the root zone dry (about 100 kPa in sand, 200 kPa in loam and to 400 kPa in clays) by not irrigating too deeply. These soil moisture conditions should be maintained until veraison (plus four weeks). Use the gypsum block readings to determine the depth and frequency of irrigation.

During the final stage, from four weeks after veraison to harvest, berry growth is minimal but soluble solids continue to accumulate. A mild stress during this stage may improve quality up to harvest. Maintain soil moisture conditions where the 30 cm depth is kept moist (irrigate when the 30 cm block reaches about 60 kPa) and the 60 cm block does not get drier than 100 kPa.

Summary of a typical RDI schedule for the south-west of Western Australia

To maintain soil moisture at between 10 kPa and 60 kPa down to 30 cm a replacement of about 15 per cent of class Pan A evaporation is required.

To maintain soil moisture between 10 kPa and 60 kPa down to 60 cm a replacement of about 20-30 per cent of class Pan A evaporation is required.

Formulae to calculate irrigation requirement

Irrigation requirement = Evaporation x Crop Factor
= mm of irrigation required

To convert mm of irrigation required to irrigation run time or to litres per vine remember that:

1 mm = 1 litre per square metre

Application rate = dripper output per vine / area the vine occupies (row width x vine spacing)

Irrigation run time (hours)
= Irrigation requirement / Application rate

Trial findings

RDI should only be used on established vines with an established root system and with good quality water.

High levels of salt in the irrigation water may cause the salt to be brought into the root zone during the RDI irrigation regime.

Significant water savings can be made using RDI.

Imposition of RDI in the higher rainfall areas of the south-west prior to flowering is difficult due to high soil moisture reserves and spring rainfall in most seasons in the south-west of WA. Restriction of vegetative growth by imposition of RDI prior to veraison is limited but possible.

At any time during the season in WA, RDI decreased yield and titratable acid. Yield was reduced by a mean of approximately 10 per cent due to smaller bunches and

smaller berries. Fruit quality was improved in RDI treatments. This was due to better exposure and smaller berry size.

Partial root zone drying (PRD)

PRD is an irrigation technique whereby half of the root zone is irrigated while the other half is allowed to dry out. The drying out process releases a plant hormone called abscisic acid which reduces stomatal conductance, photosynthesis and growth of the vine. PRD may be used to reduce canopy density, improve fruit exposure and thus quality while reducing the total amount of water applied to the vine and having no detrimental effect on yield as berry size is not changed. PRD is still a relatively new irrigation technique and has not yet been trialed in WA.

Soil moisture measurement equipment

Soil moisture monitoring equipment (e.g. gypsum blocks and tensiometers) are instruments which can be used to measure soil moisture and assist in making decisions about when and how much to irrigate. Tensiometers are best used in nurseries and in young vineyards where soil moisture is to be maintained to promote growth. Gypsum blocks are useful instruments to use where an RDI irrigation schedule is to be adopted. Enviroscans can be used in both situations. For further information about gypsum blocks, refer to Farmnote No. 3/98 'Using gypsum blocks to measure soil moisture in vineyards' (Agdex 561).

Annual water requirements

Irrigation requirements for winegrapes vary from region to region due to factors such as rainfall and evaporation. Irrigation requirement can also vary from season to season depending on weather conditions. The irrigation regime chosen will affect how much water is required and is influenced by variety, soil type, crop load, trellis type and other factors. Table 1 indicates the amount of water required annually for growing winegrapes (established vines) in different regions of the State in an average season.

Table 1. Average annual water requirements for winegrapes in Western Australia

Location	Megalitres/hectare
Swan Valley	3.8
Wokalup	2.7
Rocky Gully	2.7
Donnybrook	2.5
Albany	2.4
Manjimup	2.4
Pemberton	2.1
Margaret River	1.8

Source: G. Luke, K.L. Burke and T.M. O'Brien (1987).Evaporation data for Western Australia. Technical report 65, Division of Resource Management, Department of Agriculture, Western Australia.

References and further reading

- Farmnote No. 3/98 'Using gypsum blocks to measure soil moisture in vineyards' (Agdex 561).
- Farmnote No. 24/90 'Interpreting tensiometer readings' (Agdex 561).
- Farmnote No. 25/90 'Tensiometer - preparation and installation' (Agdex 561).
- Goodwin, I. (1995). Irrigation of vineyards - A winegrape grower's guide to irrigation scheduling and regulated deficit irrigation. Agriculture Victoria.

ISSN 0726-934X