

Irrigating Grapevines with Limited Water Supplies



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Authors

Clarrie Beckingham, District Horticulturist, National Wine and Grape Industry Centre (NWGIC), Mudgee
Jeremy Bright, District Horticulturist, NWGIC Orange
Harry Creecy, District Horticulturist, NWGIC Griffith
Gregory Moulds, District Horticulturist, NWGIC Dareton
Leo Quirk, Extension Viticulturist, NWGIC Wagga Wagga
Anthony Somers, District Horticulturist, NWGIC Tocal

Referees

Dr Michael McCarthy, CRCV, South Australian Research and Development Institute (SARDI) Nuriootpa Research Centre, Nuriootpa, SA
Dr Rob Walker, CRCV, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Merbein VIC
Ron Hutton, CRCV, National Wine and Grape Industry Centre (NWGIC), Wagga Wagga NSW
Jason Smith, CRCV, Wagga Wagga NSW

Technical assistance

Mike Robbins, Jeremy Giddings and Michael Grabham (Irrigation Officers, NSW Agriculture)

Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing (March 2004). However, because of advances in knowledge, users are reminded of the need to ensure that the information upon which they rely is up to date and to check the currency of the information with the appropriate officer of New South Wales Department of Agriculture or the user's independent adviser.

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Introduction

Droughts and long dry periods can reduce the availability of water from water sources for irrigation of vineyards.

To avoid a decline in profitability you will need to make the most of opportunities to use limited irrigation water more efficiently and if necessary purchase water.

Grapevine irrigation needs good management to be successful. You can improve your irrigation management skills by attending a training course such as 'Water Wise on the Farm', which is coordinated by NSW Agriculture.

Poor water management of vineyards can reduce vine growth, bunch quality, yield, cropping potential and vine health as well as the sustainability of your enterprise.

For successful irrigation during times of reduced water availability you need to 1) make sure your irrigation system is efficient; 2) use/ implement a water-efficient management strategy; and 3) adopt water-saving tactics during the irrigation season.

The information contained in this booklet has been compiled from a range of sources. For further information about best practices of irrigating grapevines with limited water, consult the NSW Agriculture viticulture extension officer or irrigation officer for your region.

Setting up for efficiency

To improve irrigation system efficiency it may be necessary to review and service the entire water delivery component to avoid unnecessary loss of water and minimise the risk of interruptions to irrigation schedules.

Review irrigation system design and pump capacity

When planning new vineyards, check the potential for sub-surface irrigation for high water use efficiency. A professional irrigation design should make allowances for calculated readily available water (RAW) for each irrigation section of the vineyard. RAW is the amount of water that can be readily removed by the grapevine roots and is influenced by soil type, soil depth and vine rootzone. It can be calculated for the depth of the grapevine's root system and the soil type (see Figure 1).

The irrigation system should be designed to provide sufficient water to mature vines in dry seasons and to cope with a peak irrigation demand

during periods of high evaporation and the increasing water demand from young vines.

Your irrigation design should include an assessment of pump capacity and power supply to ensure that your equipment can cope with any likely increase in water demand.

Filtration design and technology is particularly important for drip systems.

Maintain the system properly

Perform maintenance on the whole water supply system at the end of each irrigation season to avoid unnecessary breakdowns and loss of water in the following season.

Late winter inspections and any additional maintenance required should be carried out as a pre-season follow up.

Maintenance includes both preventive and remedial procedures.

Pressure system maintenance should include:

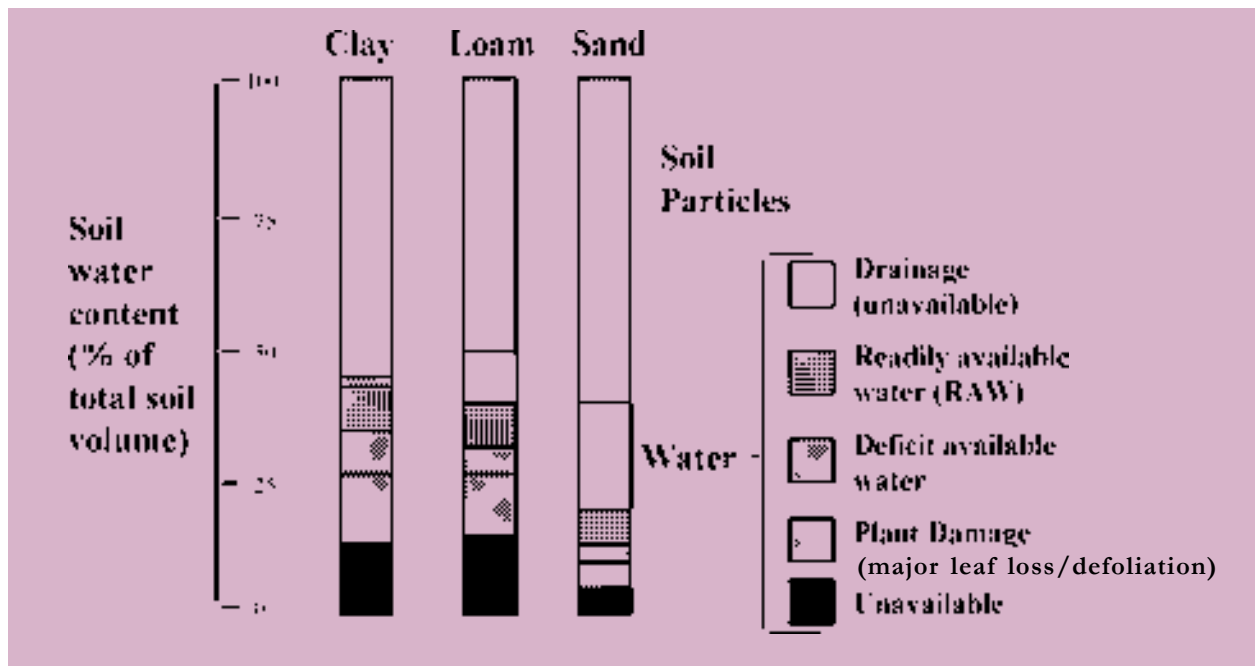
- repair and replacement of drip laterals or sprinkler lines
- annual flushing of drip laterals to remove fine clay particles, followed by chlorine flushing to remove slime that could block drip emitters.

Make sure your irrigation system system is in good working order



Checklist for ensuring efficient system set-up

- Make sure that the irrigation system, including the pump capacity, is adequate for your vineyard.
- Make sure you maintain your system regularly to keep it in good working order.
- Make sure your soil moisture monitors are operational.
- Shape the vine bank to ensure good water infiltration.
- Keep the soil in optimum condition for water infiltration.
- Check the soil pH. The right soil pH will maximise your production for minimal water use.
- Also check that the water pH is suitable. For storage dams this may change as the level of the water in the dam varies.



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Figure 1: Effect of amount of water available in different soil types

Monitor soil moisture

There is now a wide range of soil moisture monitoring devices for vineyards, so you can choose the most appropriate for your soil type and budget.

To help you make decisions on irrigation scheduling, soil monitoring devices need to be installed and operational before the irrigation season starts.

It generally takes some time for the system to settle down and provide accurate readings that reflect the true state of your soil. It may take a season or two for you to fully understand how the devices work and to operate them efficiently.

These soil moisture monitoring devices can be useful for detecting water deficiencies that may cause problems: for example, severe dryness of the soil in late winter is believed to contribute to the development of the debilitating vine condition known as **restricted spring growth (RSG)**.

For a drip system, position the soil moisture monitors within the normal wetted soil volume but not directly under the dripper, in soil that is representative of that section of the vineyard. Place the deepest sensor just beyond the rootzone to indicate if rain or irrigation has filled the soil profile (Figure 2).

Soil moisture monitoring device



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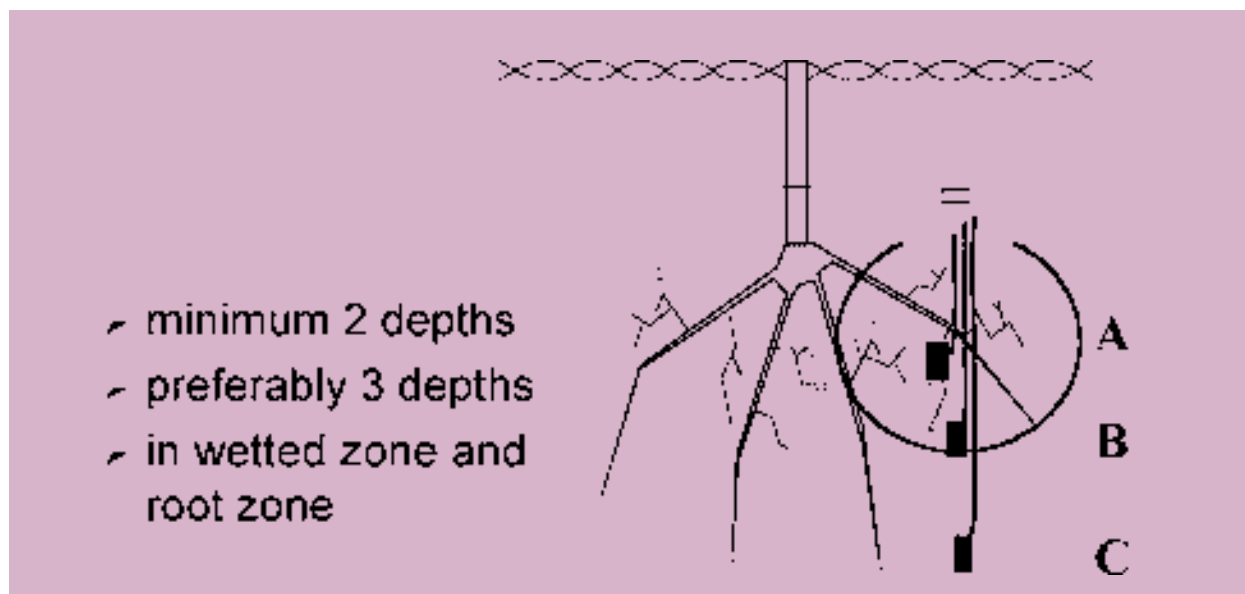


Figure 2: Measuring soil moisture. Placement of soil moisture monitors at A: 30 cm; B: 60 cm; C: 120 cm.

Moisture monitors record only the situation of the soil around them: you will need to check that the width of the wetted zone is adequate and visually observe the vine condition.

Routinely inspect the vineyard to assess the effectiveness of your irrigations, and encourage vineyard staff to report any early signs of vine wilting or irrigation problems. This way you will be able to take measures to prevent any further vine stress.

Soil bank to favour water infiltration

With drip irrigation on to a conventional vine bank a significant loss of water can result from run-off and then evaporation.

Providing a shallow furrow on top of the vine bank under the drip line will reduce run-off by ponding the water until it has soaked into the soil.

Maintaining good soil condition on the vine bank will minimise evaporative loss of water by favouring water infiltration.

Keep the soil in good condition

Maintenance of good soil condition is vital for vine health and fruit production.

The soil condition is an indicator of how well soil particles and organic matter are aggregated to form soil crumbs. Well-formed soil crumbs have adequate spaces between them for air, movement of growing vine roots, and the passage of water, all of which are vital for good vine health.

Poor soil condition on the vine bank and in the wetted zone will slow or prevent water entry and result in unnecessary loss of water through evaporation. A soil analysis may help identify why the soil is in poor condition. You may find, for example, that lack of organic matter or sodicity is the problem.

If sodicity is the problem, then you can improve the soil condition in the wetted zone by banding fine gypsum on the vine bank. Remember, though, that movement of gypsum into the soil is a slow process, unless mechanically incorporated.

When using pre-emergent herbicides it is best to choose the lowest recommended rates that effectively kill weeds and to apply them in spring, just before the vine growth season. This allows volunteer weeds to grow on the vine back in autumn and early winter and boosts the amount of organic matter in the soil by the degeneration of their roots.

Some managers prefer to use only contact herbicides to help improve soil organic matter levels.

Setting up for efficiency

Effective maintenance of soil condition in the vine bank is often challenging, requires monitoring and may need regular attention.

Control pH to maximise production for minimal water use

Ideally your vineyard soil pH should be between 6.0 and 7.5 (water) to favour vine health and proper utilisation of the nutrients in the soil surface, such as nitrogen, phosphorus, potassium, calcium and magnesium.

High pH of vineyard soils and/or irrigation water (7.5 to 8.5 (water)) can progressively reduce the availability of nutrients, particularly iron, manganese, boron, zinc and copper. In contrast, when the soil pH falls below 5.5 (water) the vines will have difficulty in obtaining important nutrients and will give smaller yields of poor quality grapes.

A low pH makes P less available. Ca and Mg leach out and high levels of Mn can develop, restricting root growth.

Soil pit, showing vine root depth and wetting pattern



QUIPRITE GRIFFITH

Wetting zone drip-irrigated vines

If there is a low pH problem at a site intended for a new vineyard, then the Agricultural lime required should be incorporated into the soil to the depth of the estimated rootzone for own-rooted vines (mostly shallow); grafted vines are mostly deep rooted and subsurface application is very difficult.

If the vineyard is flood-or furrow-irrigated and you need to apply and incorporate agricultural lime, aim to raise the soil pH to at least 6.0 (water).

To prevent a decline of soil pH in the drip-wetted zone and the subsoil, avoid using acidifying nitrogen fertilisers such as sulfate of ammonia and mono-ammonium phosphate (MAP).

Do not allow the soil pH to fall below 6.0 (water) with drip irrigation, as acidification of both the topsoil and subsoil is a very difficult problem to overcome.

Of the more commonly used nitrogen sources, urea and ammonium nitrate are the least acidifying per kilogram of nitrogen used. Calcium nitrate and potassium nitrate can also raise soil pH but are more expensive. Calcium nitrate has an advantage as calcium is a major plant nutrient and is needed to maintain or improve soil condition. For this reason you may choose to use calcium nitrate periodically.

Planning a management strategy

Once the irrigation system is operating at design specification, you will need to implement a water-efficient management strategy.

For wine grape growers it is important to talk to the winery that will be purchasing your grapes about a preferred irrigation strategy for their wine grape products.

Prepare a checklist of the options you have decided to use in the next cropping season and make sure all staff are familiar with it.

Estimate the likely water use

Estimate how much water will be needed over the next season by your existing vineyards and by any intended new plantings. Estimates should start with the irrigation water required to have a fully wetted root zone before bud burst. In making your estimates, it is useful to know the five main stages of growth and their durations for different varieties and seasonal conditions. The approximate percentage water requirements for each stage are listed in Table 1.

In dry seasons, water requirements for production and for post-harvest maintenance will increase and you will need to use water-saving techniques.

Salt-affected vines



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Checklist for water-efficient management planning

- Estimate the likely water use for the season.
- Develop a water budget for the vineyard.
- Where necessary, consider using **Partial Rootzone Drying (PRD) to save water**. **Regulated Deficit Irrigation (RDI)** may also result in some water savings. Consult your local advisor for further information.
- Remove unwanted vines to save water.
- Use a suitable vineyard floor ground cover, eg slashed cover crop or permanent sward species that minimise water use in drier times.

To avoid water and nutrient loss through unnecessary drainage, your estimates of water use should cover the delivery of water marginally past the effective rootzone in each section of the vineyard.

In districts or seasons where the salinity of the irrigation water exceeds 1.5 dS/m for own-rooted vines, estimates of vine water use should include an appropriate leaching factor for washing salt beyond the effective rootzone. As soil salinity passes the maximum recommended levels, grape yields start to decrease accordingly. The rootstocks with the best tolerance of salinity are 1103 Paulsen, 140 Ruggeri and 101-14.

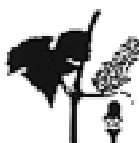




Develop a water budget

Once you have estimated the likely water use for your existing vineyard and any proposed plantings, you can compare these figures with the availability of water. These comparisons will allow you to develop a water budget for the coming season.

If you have estimated that there will not be enough water to meet the likely demand using existing irrigation practices, then you will need to ensure production is maintained or losses minimised by using management options, as outlined below.

Planning a management strategy

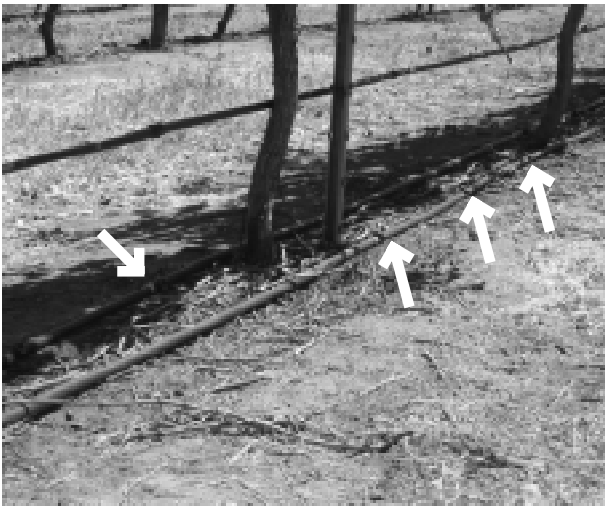
Table 1. Amounts of water used at each vine growth stage*

	Growth stage of vines	Percentage of water used over a growing season	Comments
	Budburst to flowering BB-F Vines will need 9% of water allocated at this stage of growth.	9%	Important to maintain yield. Adoption of PRD can save water throughout the whole growing season.
	Flowering to fruit set F-FS Vines will need at least 6% of water allocated at this growth stage.	6%	Important to maintain yield.
	Fruit set to veraison FS-V Vines will need at least 35% of water allocated at this growth stage.	35%	Can use RDI.
	Veraison to harvest V-F Vines will need at least 36% of water allocated at this growth stage.	36%	Important to avoid severe stress at this stage because it reduces quality.
	Harvest to leaf fall H-LF Vines will need at least 14% of water allocated at this growth stage.	14%	Water stress here may lead to RSG, particularly in young vines.
	Total water	100%	

PRD: partial rootzone drying
RDI: regulated deficit irrigation
RSG: restricted spring growth

* Adapted from Clare Valley Viticultural Landcare Group 2002, *Water and Vines – an Irrigation Ute Guide*, Clare Regional Winegrape Growers Association, Clare SA

Planning a management strategy



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STEWART FIELD CRCV 2004

PRD drip-irrigated vines. Arrows indicate drippers irrigating half the root zone.

Use PRD or RDI to save water

With Shiraz and some other varieties, **regulated deficit irrigation (RDI)** can be used to improve wine grape quality by slowing vine growth and reducing berry size. When RDI is used on white varieties, only minor stress should be used, as they are less tolerant of dry soil than are red varieties. Some water saving can be achieved during the period of reduced water application.

Significant water savings can also be made by using another irrigation technique, known as **partial rootzone drying (PRD)**. In flood- or furrow-irrigated vineyards PRD can be implemented by alternating the water supply in the inter-row spaces.

There is considerable cost involved in upgrading a drip irrigation system to use PRD; for example, it may be necessary to provide a second submain to the block during the development stage.

Both RDI and PRD can improve the soil aerobic conditions. This favours photosynthesis and sugar production in the leaves, enabling you to reach ripening targets more easily.

When you switch from conventional irrigation to PRD you may not see water savings in the first 12 months, as you will need to learn how PRD works with regard to your soil type, monitoring system and grape varieties.

If your estimated water requirements for the season are unlikely to be met and you want to keep the vines for future production, then inducing temporary moisture stress at flowering can minimise fruit set and help maintain vine condition. It may also improve fruit quality.

Caution: Seek expert advice before you use RDI or PRD, as there is a risk of excessively stressing vines if you are inexperienced, and also some soils and varieties may not be suited to either technique.

Remove unwanted vines

Save water by removing varieties not wanted by wineries and by removing poor-yielding vines that are unprofitable. These vines can be replaced by varieties that are in demand: for at least one season these young vines will use less water than the mature vines would have. However, wetting of the complete under-vine strip may require additional water, as young vines do not have the root capacity of older vines.

To avoid loss of vines and increased capital expenditure, do not replant when there is no realistic chance of sufficient water being available.

Use an inter-row crop

If you have an inter row crop – such as oats, cereal rye, a pasture mix or volunteer weeds – in the inter-

Planning a management strategy



RHONDA SMITH CSU

Sprayed-out midrow

row area, you can mow it and windrow it on to the vine bank to minimise evaporation of water from the wetted zone.

Any regrowth of cover crop or weeds can be slashed to cover the inter-row area and reduce evaporation from the soil. This will improve the amount of soil water that can be utilised by newly developed roots near the soil surface. The soil cover also helps to minimise damage to vine foliage and bunches from reflected heat. To save water you can also apply knockdown herbicides to the whole of the midrow area to reduce moisture competition after mowing.



QUIPRITE GRIFFITH

Mulch under vine

Cereal hay can be brought in to cover the vine bank, but you would need to examine the economics of this operation carefully before proceeding.

Water-efficient system operation

Make use of water-saving opportunities

If you use drip irrigation, you can use the opportunity of any effective rainfall to fill the wetted zone, as the wet soil surface allows easy entry of water at a time of low evaporation. To avoid loss of water, stop the irrigation when the soil profile is full.

Excessively dry topsoils can cause water run-off and thus significant evaporative loss of water. With drip irrigation it may be necessary in (hard-to-wet) soils to maintain adequate moisture at the soil surface to facilitate water entry at the next irrigation. Several short irrigations followed by a medium to long irrigation often helps to maintain surface moisture, enabling easier infiltration of water and providing a PRD effect in a vertical direction.

Water saving can also be achieved with drip irrigation by 'pulsing'. This water-application technique alternates irrigation from one vineyard section to another, allowing more time for water infiltration and less opportunity for water to evaporate at the soil surface. An additional benefit of pulsing is a widening of the wetted zone, especially in light soils, where rapid entry to the soil favours movement of water beyond the effective rootzone.

Checklist for water-saving system operation

- Make full use of water-saving opportunities.
- Use soil moisture monitoring to help with decisions on irrigation timing.
- Keep nitrogen levels moderate to avoid excessive growth and water use.
- Learn to recognise vine moisture stress symptoms.
- Optimise pest and disease control to maximise production with available water.

Irrigating at night can save water, but you should occasionally start the irrigation in daylight hours to check for pipe leaks.

If you are using flood irrigation, changing to alternate inter-row or twin furrow irrigation will save up to 35% of the water used in complete flooding.

Harvesting grapes as soon as fruit maturity specifications are achieved can make further savings, as water use declines when the fruit has been removed. Seek winery cooperation if you are planning to use this strategy.

Use soil moisture monitoring to help plan irrigation timing

It is important that you understand how soil moisture monitoring measurements can be used to help make irrigation-timing decisions (see Table 2).

Soil moisture measurements from different soil depths at the same location can be remotely recorded on computers, or you can simply use a nest of sensors at different depths and record the readings daily on graph paper.

Generally, the objective is to irrigate before the RAW is used up; if you irrigate after this happens then the vines will have increasing difficulty in extracting water from the soil.

With drip irrigation there is a smaller effective rootzone than with flood-irrigated vines, and irrigation needs to be done well before 50% depletion to ensure that sufficient soil water is available until the next opportunity to irrigate occurs. Many vineyards are irrigated daily, and the length of each irrigation is determined from soil moisture monitor readings and weather forecasts.

Frequent irrigations are vital in hot or windy weather, especially when the vine has developed its maximum amount of foliage for the season, because a rapid decline in soil water levels will stress the vine and reduce fruit quality.

Water-efficient system operation

Table 2. Approximate irrigation run time (in hours) for 0.5 m wetting depth (courtesy CRCV Viticulture Research to Practice 2003)

Soil type	Dripper output		
	2 L/h	4 L/h	8 L/h
Sand	0.5	0.5	0.5
Sandy loam	2.5	2	2
Clay loam	9	6.5	5.5

Note:

Litres per vine = Run time x dripper output x number of drippers per vine

Use nitrogen in moderation

Only five or six full-size leaves are required to ripen a bunch. Thus 10 to 12 leaves beyond the last bunch on a two-bunch shoot are sufficient:

Stress symptoms



any more shoot growth will waste water and reduce fruit quality.

To prevent excessive shoot growth, apply just enough irrigation water and nitrogen to satisfactorily mature the crop and maintain post-harvest leaf condition.

Own-rooted vines with drip irrigation need up to 20 to 30 kg/ha of nitrogen to grow and ripen a crop, whereas vines grafted to rootstocks require around 30 to 40 kg/ha. During the growing season the highest rates of nitrogen are required at flowering and veraison. These rates of application can be reduced by fine-tuning your irrigation technique.

To efficiently ripen grapes it is important to avoid loss of leaves caused by nutrient deficiencies, as the regrowth will lead to a greater demand for water.

Learn to recognise stress symptoms

Make sure you can recognise the symptoms of moisture stress to ensure that water-saving or quality management techniques have not unnecessarily damaged vines and crops and reduced production capacity.

The signs of temporary stress are easily seen in Shiraz. The stress usually starts with a rapid weakening of tendrils (this may happen in one day, post-fruit-set), followed by dehydration and browning of tendrils and finally tendril drop. Generally the tendrils on several nodes near the shoot tip will remain intact, although if touched they will drop off. Some managers use Shiraz as an indicator vine within other varietal vineyards.

The signs of prolonged stress are death of shoot tips and late morning leaf wilting. Your aim should be to never see these signs, as moisture monitoring should give you plenty of warning and time to take preventive action. Excessive stress results in lengthy closing of leaf stomata, halting photosynthesis and leading to a loss of sugar production and rapid decline in fruit quality.

Excessive stress can lessen the vines' capacity to produce profitable yields and can cause a 'moth-

GREGORY MOULD NSW AGRICULTURE

Water-efficient system operation



GREGORY MOULD, NSW AGRICULTURE

Protect vines from foliage diseases such as powdery mildew, as they will adversely affect leaf function and crop ripening.

Maintaining good soil condition is important in retaining or increasing populations of microbes that help control debilitating trunk diseases.

Poor soil conditions and consistent drought or flooding may predispose vines to trunk diseases.

Vines weakened by prolonged water and nutrient stress become more susceptible to infestation by boring insects; make sure that you look into the causative factors rather than just controlling the pests.

Stress symptoms

ball' taste in the resulting wine. Seek professional advice if you intend to use RDI.

To avoid water stress, stay in touch with short- and long-term weather forecasting so that you can appreciate the vines' water demands and schedule for adequate irrigation, especially when hot weather is coming.

Optimise pest and disease control

High standards of pest and disease management are essential to maintain productivity of vines and maximise your profit with the available amount of water.

In summary

To cope with reduced availability of irrigation water, irrigation management and planning needs to be very good to ensure sustainable cropping, production of quality winegrapes, and adequate maintenance of vines.

For effective pre-season planning, include a review of your irrigation equipment to enable any necessary maintenance to be done before budburst of vines.

Develop an irrigation strategy by which you can save water in the vineyard; if necessary, remove unprofitable varieties before the irrigation season.

Take into account current weather conditions, weather forecasts and soil moisture monitor readings when making tactical decisions about irrigation timing and duration.

The aim is to maximise sustainable and profitable production of quality winegrapes with the irrigation water that is available. Prolonged water stress of vines can significantly weaken them and result in reduced cropping potential and vine decline.

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