

AN INTRODUCTION TO REGULATED DEFICIT IRRIGATION IN SUNRAYSIA

Jeremy Giddings
NSW Agriculture, Dareton

Regulated deficit irrigation (RDI) is the practice of applying less than the vines irrigation requirements, in a controlled, repeatable manner at critical crop growth stages. Water deficit is usually applied immediately after fruit set to control vegetative growth and if necessary berry size. It has proven to be a successful irrigation management strategy in vigorous Shiraz vineyards. When correctly applied there can be a significant improvement in wine grape quality, however, there will likely be a reduction in yield.

RDI is becoming a common management practice in Sunraysia to help improve the wine quality of red grape varieties. RDI is being carried out in a variety of ways throughout the district. This is understandable as there is no recipe or format that exists for growers looking to adopt RDI for the first time. Applying RDI is highly vineyard specific, and will depend on seasonal conditions, winegrape variety, rootstock, soil type, irrigation system type and desired end product. It is a relatively new practice to viticulture, and there is still a lot to learn.

This booklet presents growers comments and current management practices which should be considered before carrying out RDI in Sunraysia. It does not describe in detail the way in which *you* should carry out RDI. Management should be adapted to suit your situation. Many factors need to be considered, meaning RDI is one of those practices which cannot be interpreted from a text book and be broadly applied to a vineyard.

The most common factors which need to be considered are;

IRRIGATION SCHEDULING

Irrigation scheduling is the most important management practice which must be adopted in order to successfully (and safely) carry out RDI. Continuously logged moisture monitoring tools with multiple sensors placed throughout the profile are most suitable due to the high degree of monitoring necessary during the RDI period. Four to five sensors are recommended throughout the profile, including some below the rootzone to determine watertable and neighbouring irrigation effects. The more sophisticated tools give the grower confidence in what they are doing over the whole season, not just through the RDI period. "My soil moisture sensor gives me the confidence to go harder now that I have something to look at" was one comment received.

Testwells are also recommended to indicate the presence of watertables. If watertables are present this water remains available to the vine and does not allow stress to occur. Watertables also increase salt uptake by the vine.

IRRIGATION SYSTEM

To correctly carry out RDI irrigation systems must be well designed, maintained and monitored. It is very important that the irrigation system applies even amounts of water throughout the vineyard.

Poor distribution uniformity (DU) is a common irrigation problem in Sunraysia, and is readily highlighted by RDI, particularly when salinity is an issue. As only small amounts (eg 2 hours of drip irrigation) of water are applied during the RDI period, dry zones can readily form within the irrigation pattern. As well as applying a higher than necessary level of moisture stress, salt will also build up in these dry zones, and as the vines are already under stress they will be more prone

to salt damage. Good uniformity is also important when re-wetting the profile following RDI, to ensure all vines become adequately irrigated.

All pressurised irrigation systems can be used to carry out RDI. However, the irrigation system must be designed to be flexible to allow each variety to receive its own irrigation requirements. This may mean extra valves and submains, and in some cases variable speed pumps. Water supply must also be frequent and have the ability to irrigate the vines at short notice, particularly during periods of hot weather. This may be a major impediment for some growers in certain parts of pumped districts in Sunraysia.

Drip Irrigation

In many ways drip irrigation is the most suited system as RDI can be rapidly and confidently applied compared to full cover systems. Drip irrigation is an advantage if rainfall occurs prior to or even during RDI (Figure 1). The combination of restricted rootzones and dry mid row areas to absorb rainfall allows vines to be readily placed under some level of moisture stress. Emitters should be closely spaced (50-60cm) to ensure that all vines receive some water when applying low amounts during RDI.

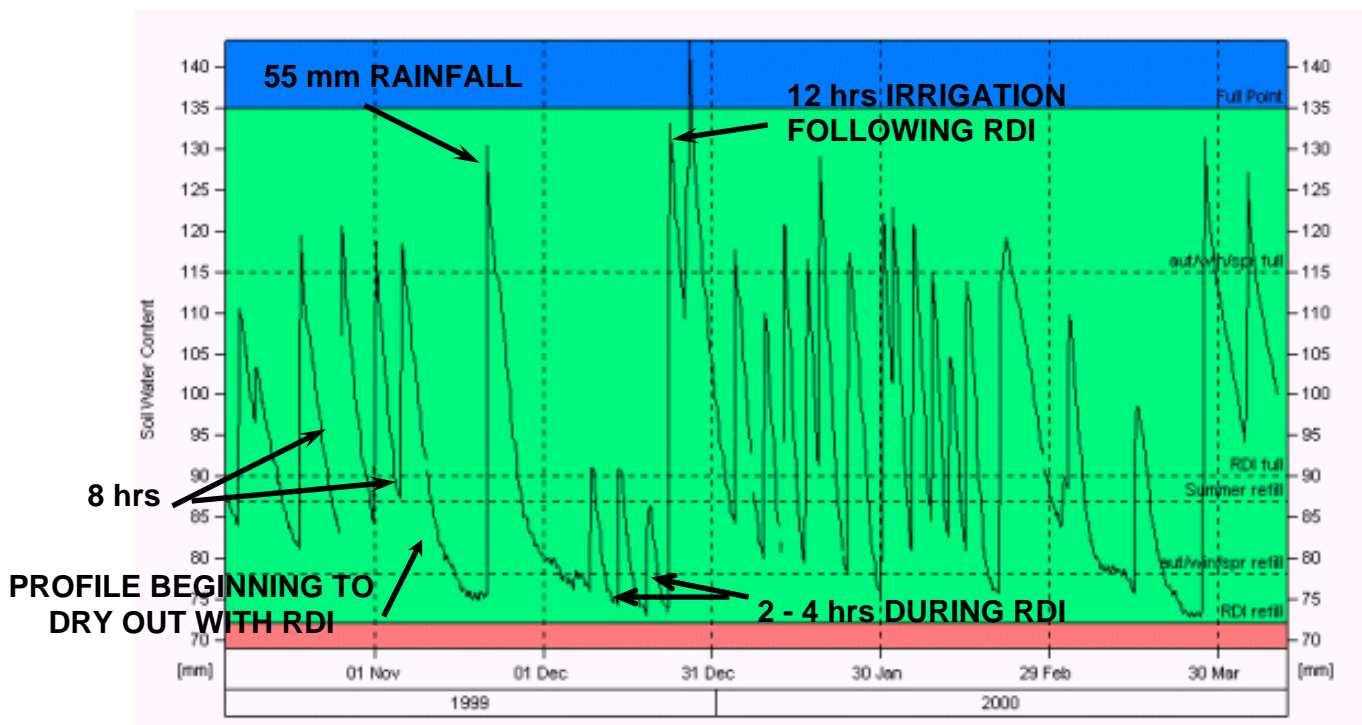


Figure 1. Example of an RDI program with monitoring by EnviroSCAN (summed graph 20-80cm).

This example shows how quickly the soil can be dried out for RDI with drip irrigation. The profile initially took seven days to dry out (early November), and then only 5 days following 55 mm rainfall, putting the vine back under stress relatively quickly. Also note that 12 hours of irrigation following RDI did not push water above the full point. A follow-up irrigation a few days later was necessary to fully re-wet the profile and provide some leaching while at the same time avoid excessive irrigation which can create vigour problems.

Full Cover Irrigation

Full cover sprinkler systems result in greater rootzone volumes, and therefore require more time to dry the profile out. Vineyards irrigated with full cover irrigation need to begin drying out

earlier in the season in order to apply stress by the time fruit set is completed. Often 12-15 days is required to completely dry out the profile with full cover systems. This means planning for RDI should begin prior to fruit set. In some instances profiles should not be full at budburst, particularly on heavy ground, in order to dry the profile to a desired level following fruit set.

SOIL TYPE

Uneven soil types within a patch being subjected to RDI is a major problem in Sunraysia. Soil variability becomes readily highlighted once RDI is applied as uneven amount of water are made available to the crop. A common example is when light and/or shallow soil types dry out earlier than the rest of the patch placing these vines under a greater level of stress than necessary. Soil surveys are ideal in identifying soil types prior to irrigation design or re-development. They have become a standard practice in Sunraysia as the need for consistent soil types within each irrigation unit is very important in order to produce crops of even growth, yield, quality and maturity.

Clay soils often present difficulties in applying RDI to vineyards in Sunraysia. Clays tend to have shallower rootzones, and therefore precise irrigation management is required. If the profile is too wet or too dry serious problems can result.

All soil types are difficult to wet back up following RDI. At least double the normal amount of water is usually needed to fully re-wet the profile. Often 3-4 close irrigations are needed to re-wet the profile. Runoff will determine the duration of these irrigations.

SALINITY

As RDI involves the drying out of the soil profile followed by relatively small, well controlled water applications, soil salinity can become a problem if not closely monitored. Regular soil sampling is recommended to ensure rootzone salinity levels are below 2 dS/m. Soil sampling should occur well below the 'normal' active rootzone as water will be extracted from these depths when stress is applied. If drip irrigating sampling should also occur to the side of the wetted strip. If high soil salinities exist, leaching irrigations are required. Post veraison or preferably post harvest leaching is the only option, particularly for full cover systems as early season leaching adds subsoil moisture and may not allow enough time to dry the profile out by the time fruit set is completed.

NUTRITION

Nutrition must be adjusted accordingly if applying RDI. This usually involves a reduction in fertiliser application, or changing the timing of application. Very early season applications, and post harvest applications in particular become more important to maintain crop health while at the same time having little impact on fruit quality.

RDI has been known to induce Calcium, Zinc and Magnesium deficiency. Some micro nutrient applications, prior to the RDI period, may be necessary.

OTHER MANAGEMENT ISSUES

Growers practicing RDI often comment on the reduction in powdery mildew infections, as well as other diseases. As no new growth is being produced during the RDI period little incidence of new powdery infections tend to occur at this time. Reduced incidence of disease continues later in the season as a result of the reduction in vine vigour and a more balanced canopy. Humidity inside the canopy is reduced and better spray penetration is achieved. Less weed growth in the vineyard is also observed.

It is generally considered that RDI should not be carried out on vines less than 3-4 years old. Young vines in Sunraysia often, but not always, produce good quality fruit without applying any water deficit and canopies are generally not excessively vigorous at this stage. In any case young vines should be allowed to continue to develop their framework. The uneven nature of immature patches also makes RDI difficult to apply. Re-plants or weaker vines struggle to develop if subjected to RDI. Poor lignification of canes has resulted when RDI is applied to young vines.

COMMON MISTAKES

Undoubtedly the most common mistake with RDI is the belief that it involves completely turning off the irrigation over the recommended stress period. RDI stands for regulated deficit irrigation. Soil moisture is regulated to an acceptable level, usually through smaller, well controlled irrigation applications. An acceptable level of stress is applied to slow down growth, but usually not stop it all together.

The other major mistake growers make is that the stress is applied at the wrong growth stage. This usually occurs due to a lack of understanding and identification of growth stages, and inadequate soil moisture monitoring. Continuing to apply stress post veraison is a common mistake which can result in major fruit quality problems. At the same time, applying excessive amounts of water following veraison, particularly with Shiraz, can result in large canopies developing.

Planning for RDI must also begin early in the season, not only from fruit set onwards, to ensure an adequate level of stress is actually achieved following fruit set. This is particularly important for full cover irrigation systems and/or heavy soils. As mentioned excessive subsoil moisture early in the season can stop profiles from being dried out to an adequate level. For this reason it can be difficult to achieve the desired results from RDI at the first attempt due to the irrigation management practices adopted in previous seasons. Many growers comment that once soil moisture monitoring equipment has been installed, and subsoil moisture levels monitored and managed throughout this initial season, as well as over winter, excessive subsoil moisture is avoided in the following spring, and RDI achieves the desired results in subsequent seasons.

RE-WETTING THE PROFILE AT VERAISON

A common question growers ask relates to the irrigation management required at veraison. Should you fully re-wet the profile at veraison? Do you begin applying larger amounts of water when bunches begin colouring, are at full colour, or somewhere in between?

This is a particular problem in seasons when flowering and subsequent growth stages are uneven throughout a patch. Practices throughout the district vary in regard to irrigation management at veraison, and at this stage there is no clear answer. In reality this may not be a problem as we know that it takes a significant amount of water to fully re-wet the profile. As it is difficult to re-wet the whole profile straight away, rootzones do not become fully re-wetted until the third or fourth irrigation. By this stage the vines may be well into veraison. This means that in most instances it is impossible to change the moisture status of the total rootzone at exactly the desired growth stage anyway. The main concern should be to not allow stress to continue too long after veraison, particularly if warmer weather is approaching. Continuing stress after veraison can slow colour development. Many growers find that once the heavier, more frequent irrigations take place colour development is hastened.

ROOTSTOCK SELECTION

Rootstocks vary in their response to RDI. The depth and density of rootzones has a big influence on the stocks ability to tolerate or avoid water stress. Rootstock selection is important if planning to apply RDI.

Ramsey

RDI is often necessary to control vigour and cropping levels with this rootstock. Often higher levels of stress are required to have an effect. May need to begin drying out the profile earlier in the season than with other stocks. Varied results found on marginal soils.

Swarzmann, Kober 5BB (clone Teleki 5A) and K5132

Not as tolerant of heat and drought conditions, particularly in marginal ground. Induced nutritional problems also found on marginal ground when subjected to RDI. Good results found on better soil. *K5140* is highly sensitive to salinity and therefore may not be suitable.

Ruggeri & Paulsen

Much easier stock to apply stress compared to Ramsey.

WINEGRAPE VARIETY

It is becoming increasingly evident that all grapevine varieties have their own water requirements. It is standard practice now when designing an irrigation system to have each variety isolated into individual irrigation valve units. RDI practices will likewise be unique for different varieties. Based on grower experiences throughout Sunraysia the following varietal effects have been observed.

SHIRAZ

Shiraz is the variety on which most RDI research has been conducted, and is the most successful variety to which RDI has been applied. The early vigour in this variety requires RDI to control or even shut down canopy growth. Tendrils drop first when applying RDI, indicating that sufficient stress has been achieved. Moisture levels are critical after veraison and stress at this time can shut down sugar accumulation.

Continuing lighter crops have been observed when RDI has been applied over a number of seasons. As a result some growers are reducing the severity of RDI, or allowing unrestricted growth to occur occasionally (say one season in four) to re-establish vine vigour. Good quality fruit has been produced at up to 35 t/ha with successful RDI.

CABERNET SAUVIGNON

Cabernet Sauvignon gives the appearance of maintaining vegetative growth under stressed conditions, tolerating drought stress. It is often difficult to determine if adequate stress is being applied based on visual symptoms. Therefore accurate soil moisture monitoring equipment is of even greater importance with this variety. Stress does not need to be applied to the same degree as Shiraz in order to reduce berry size. If berry shrivel occurs in most cases it will not recover.

Cabernet does not tend to drop its tendrils as readily as Shiraz. Basal leaves and tendrils have been known to drop, but it is thought that this is an indication that stress has gone too far. Fruit set can be up to 10 days later than Shiraz, meaning that RDI should be applied over a different time period. Cabernet Sauvignon canopies often appear to be self regulating once fully developed, with relatively smaller canopies produced. RDI may not be required in this situation. High temperatures have been known to reduce fruit colour and flavours late in the season.

Shoot topping and tipping should be done as little and as late as possible to avoid lateral growth and second crops. Many growers find that if their irrigation management and RDI is done correctly, then there is little need for shoot trimming, avoiding the problem of lateral growth altogether.

Applying RDI to Cabernet Sauvignon appears difficult on deep soils as it tends to be very good at scavenging water. This may be a problem if wet weather occurs during winter and spring, leaving ample sub soil moisture in the profile.

Uneven bud burst and subsequent uneven growth stages, particularly with relatively young vines, has resulted in some growers applying growth regulators to try to even up budburst. This has allowed RDI to be applied to more uniform growth stages over the whole patch.

Many growers prefer not to attempt RDI on Cabernet Sauvignon.

RUBY CABERNET

Ruby Cabernet is a high yielding variety. RDI has been used as a method to help reduce crop loads. RDI has also encouraged earlier ripening, bringing harvest into line with other varieties.

MERLOT

Often found to be a weaker variety in warm climates such as Sunraysia, and in this situation not requiring any stress to control vigour. When RDI has been applied to Merlot it has been found that when the tendrils drop stress had gone too far. Moisture levels are critical after veraison.

Many growers prefer not to attempt RDI on Merlot.

GRENACHE

RDI has resulted in bunch stem necrosis and a large amount of berry drop. In the following seasons it has been found that canes fail to lignify and eventually die. Not recommended for RDI.

ACKNOWLEDGMENTS

Thankyou to the various growers and irrigation agronomists in Sunraysia who have been willing to share their experience and knowledge of RDI. Thanks also to the researches and advisers from the various Departments of Agriculture (NSW, Victoria and South Australia), and CSIRO.

Funding was provided by the Grape and Wine Research and Development Corporation, the Victorian and Murray Valley Winegrape Growers Council and the Murray Valley Industry Development Committee.

RDI BEST MANAGEMENT PRACTICES

The following is based on those common responses received from the interviewed growers. It is aimed at providing an overview of the management practices required to successfully carry out RDI in Sunraysia. Individual growers are encouraged to develop their own management practices based around these principles.

1. Irrigation scheduling

Moisture monitoring is compulsory in order to carry out RDI properly. In Sunraysia's hot climate, together with sandy soils and often deep rootzones, continuous, multi depth soil moisture monitoring is recommended. Four to five sensors are recommended throughout and below the rootzone to monitor where the water is being applied, and from where it is being extracted. This often means that the more sophisticated (and expensive) tools are necessary to do this properly. Testwells also recommended to monitor the presence of watertables.

2. Obtain feedback from winery regarding fruit quality

In many instances RDI may not be warranted. This may be because soil types, rootstock or vine age may already be successfully restricting vine vigour. Wineries may already be happy with the fruit quality you are producing. Returns for quality fruit must also warrant RDI and the likely reduction in crop load. It must also be remembered that RDI is only part of producing good grapes. Nutrition, canopy management and disease control are all important management aspects which need to be considered. RDI by itself will not guarantee quality fruit.

3. Know your soils

An understanding of soil types and rootzones, as well as their variation within a patch is very important for efficient irrigation management, and especially important if practicing RDI. For example deep soils with well developed rootzones will need to begin drying out earlier in the season (possibly from budburst) in order to have the vines under some level of stress after fruit set. Soil surveys are highly recommended.

4. Have a well designed and maintained irrigation system.

Even applications of water must be applied and the system must have an acceptable DU. The irrigation system and water supply must also be flexible in order to supply small amounts of water at short notice. Each winegrape variety must have its own individual valve in order to receive their individual water requirements.

5. Understand the vine growth processes

Identifying the growth stages, particularly fruit set and veraison, is critical in determining the appropriate timing of RDI. These growth stages are property and season specific. One of the main challenges of RDI is to understand the growth processes and adopt correct irrigation management.

6. Use as many tools as possible

This includes petiole and soil salinity testing, as well as auguring holes to confirm readings from soil moisture monitoring equipment. Visual symptoms of the vine are also important. Weather forecasts should also be used where possible.

7. Be brave

For experienced growers RDI goes against everything that was once normal practice. Reducing canopy growth and crop levels by reducing soil moisture can initially be hard to come to terms with. It is often found that RDI is not applied too hard in the first season, both for the managers peace of mind, as well as vine health.

8. Be open to new information

Being willing to practice RDI suggests you are already open to new ideas and information. RDI is still a new practice in Sunraysia, and understanding grapevine growth processes and their response to drought and heat stress is far from complete. Therefore, now more than ever, you will need to remain open to new information. In time your RDI practices will likely be adjusted as more information and experience becomes available.