CCW GROWER MANUAL

20th May 2014

Foreword

This grower manual is intended to provide grape growers contracted to CCW with a concise and definitive reference that can be used daily as a reference for their business. The manual is laid out with some general information available in the text, but with access to much more via links. It is intended as a guide and a central reference for growers to use to find some useful information. Having this manual in electronic form makes it easier for the user to access other links and information from a diverse range of sources. It also makes updating the information easier, and provides an effective, low-cost option to send useful information to a widespread grower base.

The links are written in blue, and in a different font as in the following: this is a link. Hovering the computer mouse over the link should give instructions how to access the new page – usually holding control and clicking on the link will work. Usually there will be a link to the CCW fact sheet or other CCW information. If there is additional material that may be of further interest, this will be included below the CCW link.

Disclaimer

The information contained within this manual is intended as a general guide only. Growers seeking more complete or detailed advice should seek specialised advice from a suitably qualified person.

INDEX

Roles and Responsibilities

CCW growers are in a different position from most other wine grape growers in Australia, in that their fruit is sold via an agreement to a grower-owned Co-operative. CCW Co-operative then on-sells the fruit to Accolade Wines under a Preferred Supplier Agreement. The key roles and responsibilities of the parties are outlined, but not limited to the points following:

Responsibilities of CCW Growers

- It is expected that CCW growers will be responsible for their own vineyard, and that they will carry out their business to the best of their ability;
- Produce fruit that is fit for the intended purpose, and as far as possible clean, sound and free from disease or defects;
- Abide by production and business standards as defined in the agreement to supply;
- Provide accurate and timely information when required by the wine company, including but not limited to crop production information, maturity information, etc;
- Attend meetings called by CCW Co-operative or Accolade Wines for the purpose of informing growers;
- Take measures to maintain or improve their skills and knowledge and keep abreast of changes to industry best practice for growing grapes;
- Work to maintain a positive portrayal of CCW Co-operative and its members.

Responsibilities of CCW Co-operative Staff and Board of Directors

- The Staff and Board will work to provide the best possible returns to CCW Growers. While it is recognised that each grower has responsibility for their own business; the staff and board of directors provide business and technical support that adds value to the business relationship;
- Provide accurate and timely information to CCW growers that can help them carry out their business;
- Represent growers in business communications with Accolade Wines;
- Communicate with Accolade Wines staff and provide, as far as possible, fruit from the grower group that matches that required by Accolade Wines;
- Staff will maintain a high level of professionalism in their business dealings with growers and with Accolade Wines staff. Staff will complete relevant personal training in order to better fulfil this role;
- CCW staff will attend industry meetings and where applicable take part in industry groups, to better represent the CCW grower group and to foster links throughout the industry. Such links will reinforce a positive perception of CCW and its members;
- Business negotiations with Accolade Wines will be conducted in good faith and in a timely manner as much as possible.

There can often be some confusion among growers about who to contact with questions or problems. CCW staff and Accolade Wines staff occupy different roles.

Contact CCW Co-operative Staff and Board of Directors about the following:

- Viticulture questions relating to problem solving, pest or disease control, nutrition or other viticultural issues (growers may alternatively contact Accolade Wines viticulture staff).
- Issues relating to business communications with Accolade Wines.
- Issues relating to payment for fruit under the conditions of the agreement.
- Application for changes to the supply contract, or planted area in the first instance. Further negotiations will need to involve Accolade Wines.
- Queries or disputes relating to fruit quality assessment.
- Grower meetings. CCW will hold growers meetings, and it is expected that growers make best endeavours to attend these meetings; and also respond to CCW correspondence promptly.
- Business negotiations with Accolade Wines will be conducted in good faith and in a timely manner as much as possible.

Contact Accolade Wines Staff about the following:

- Viticulture questions relating to problem solving, pest or disease control, nutrition or other viticultural issues (growers may alternatively contact CCW viticulture staff).
- Mapping of patches
- Permission to apply restricted or regulated agrochemicals
- Issues relating to the HACCP program
- Issues relating to intake of fruit including booking of fruit; harvest contractors and cartage contractors.
- Queries about patch quality or disease assessment

Other Grower Information

Farm Safety

General Workplace Safety

It is not within the scope of this manual to include extensive information about workplace safety, but more to remind growers of their obligation to take appropriate care and to provide a safe workplace. This is relevant for owner operators that do not employ other workers, and for those larger businesses that do employ others.

There are many sources of valuable information that can be accessed for further reading, including the following links:
Safework SA Horticulture Resources
Safework SA Horticulture Kit
Safework SA Kit Intro

Chemical Application

General principles of application of chemicals should be based around a minimalist approach. This not only minimises the potential off-target impact and has greatest

sustainability benefits, but also reduces potential problems with development of resistance (see later section about chemical resistance). When planning a chemical spray program ask the following questions:

- Is chemical application necessary?
- Are there methods other than chemical means to achieve the outcome I want?
- Am I choosing the best chemical for the job?
- Am I choosing the lowest toxicity chemical; or the option with the least potential off-target impact?
- Have I considered the chemical in relation to others I plan to use in this spray program? Have I considered chemical resistance guidelines?
- Have I considered the chemical withholding period stipulated in the Accolade Wines spray diary information? (Note – this may differ from industry withholding periods).
- What are the prices of the different chemical options?

For chemical spray application to be most effective it should have:

- The correct chemical
- Applied to the right target
- At the correct amount
- At the right time

Chemical Handling

Chemicals are potentially hazardous and should be treated with care. The SAFEGrapes requirements that Accolade Wines have for CCW growers stipulate that growers should have completed a chemcert accreditation. This should provide growers with appropriate training in chemical use, and it is not the intent of this manual to provide extensive information here.

There are some mandatory requirements that growers, as chemical users, should adhere to including but not limited to the following:

- Appropriate user training in the use of chemical (eg Chemcert)
- Possession of an MSDS for every chemical stored on the property (may be electronic or paper copy)
- Risk management assessment for chemical use on the property
- Appropriate safe chemical storage and signs
- Use of appropriate Personal Protective Equipment during handling and application of the chemical
- Avoidance of off-target chemical trespass (spray drift)

Accolade Wines have implemented an on property audit of food safety, to be conducted by Accolade viticultural staff. The link below indicate the critical requirements for the audit- Property Food Safety Inspection Requirements for Audits .

Note that the requirements for record keeping are constantly changing and growers should keep up to date with these changes. The chemical label is a legally binding document, and should be the first point of reference in regard to safety and handling issues for the chemical being used.

There is a growing requirement on **new** (eg Vivando) chemical labels and where chemical registrations are **renewed** for an increase in the number of records that must be kept; including recording the following:

- Chemical trade name and the rate applied
- Date, start and finish time of application
- Patch (location), crop type where the chemical is applied
- Wind speed and direction (measured at application site and 15m outside vineyard on the upwind side and between 3 and 10km/hr) , temperature and relative humidity during application
- Spray nozzle type, nozzle brand, flow rate, spray angle, nozzle capacity and pressure
- Name and address of applicator of chemical
- Name and address of the property owner
- Amount of product use per hectare and number of hectares applied to

The majority of these new records can be added in the "Comments" column in the Accolade Spray diary, however additional records may be required. The change in labels relates to reducing off-target spray drift. Accurate written records of the details of each spray application must be completed within 24 hours following application and kept for a minimum of 2 years.

Also on the **new** labels are other requirements:

- Do not apply chemical during surface temperature inversion conditions the application site
- Do not spray with droplets smaller than a medium spray droplet (refer manufacturers specifications)
- Do not direct spray above vine during airblast applications
- Mandatory no-spray zone, such as "aquatic and wetland areas, including rivers, surface streams, ponds, within 15m downwind from application area". The requirements will vary depending on the chemical.

Just as important as the spray diary is the recording of calibration of spray equipment, to show that equipment is operating within label parameters.

There are some valuable references to chemical safety here:

- PIRSA Chem Safety
- PIRSA Chem Storage
- Safework SA Chemical Links
- DPI Qld Chem Users' Manual
- Comcare Dangerous Goods info
- EPA Pesticide Guide

There are links to various chemical websites here:

- APVMA-permits
- Codex
- Cropcare
- Croplife Australia
- Dowagro
- Dupont
- AWRI-agrichemicals
- Nufarm
- APVMA
- Syngenta

- Farmoz
- Chemical Security
- Sumitomo
- UPL

The following websites offer search facility to find out about chemical information and MSDS for a range of chemicals, but may require subscription:

- MSDS
- Pestgenie

Another option if you have purchased a chemical and require the MSDS is to simply search the trade name of the chemical, add "MSDS" in the search pane on Google or a similar search engine. Growers are required to have a MSDS for every chemical that they have stored on their property. Electronic copies stored on the computer are usually acceptable, provided all chemical users have ready access to them.

Links for disposal of unwanted chemicals: Chemclear
or Phone 1800 008 182
Recycling of chemical drums: Drummuster
or Phone 1800 008 707

Information about AgSafe accreditation and training: AgSafe

Vineyard Management

The following section relates to general advice about vineyard management. A lot of the information can be found in the CCW fact sheets.

CCW Fact Sheets

These Fact Sheets can be found at the link:
CCW FACT SHEETS

Diseases

The main diseases found in the Riverland region include powdery mildew, downy mildew and botrytis. Excessive levels of these diseases can cause wine faults, or make the fruit totally unsuitable for making wine. Refer to your grape supply contract for the maximum disease threshold levels for these diseases.

It is the responsibility of a grower to control disease within their vineyard to the best of their ability.

Cultural Control Methods

Many diseases can be reduced by cultural methods. Most of the fungal diseases are favoured by conditions of high humidity, low air flow and low light within the canopy. Tight bunches are also more likely to have conditions that are conducive to berry splitting and disease growth as well; and anything that provides more open bunch architecture will be helpful in reducing the disease pressure.

Non-chemical methods that discourage these conditions inside the canopy include:

- Management of irrigation and nutrition to limit berry size (eg RDI)
- Canopy trimming
- Slashing to keep sward growth low
- Irrigating during the day to reduce humidity
- Pruning to manage the canopy and crop load

Usually successful disease control will entail the application of a successful spray program and use of as many cultural controls as possible to achieve the best outcome.

Downy Mildew

Downy mildew is a climate-driven disease. Unlike powdery mildew that will grow in any season, downy mildew requires specific conditions to grow. If it is left to grow unchecked it can devastate crops, especially when it starts early in the season. The earlier in the season downy mildew takes hold, the more severe the potential crop loss can be. This is primarily because the flowering stage of growth is very susceptible to damage from disease.

(Downy Mildew- A. Pietsch)

Downy mildew requires a primary infection to start, and secondary infections to continue growing. For information about the growth of the disease, see the CCW Fact Sheet Downy Mildew – "Development and Spread" CCW Fact Sheet - Downy Development and Spread. The level of disease increases, sometimes exponentially with each subsequent infection.

Management of the disease is only a consideration where there are suitable climatic conditions for the disease to spread. There are two approaches that are used:

- Pre-infection – application of "cover sprays" applied as close as possible prior to an infection event. This includes sprays of copper products, strobilurins, or other new chemistry groups to apply a protective layer over the plant tissue to prevent growth of the pathogen. If the plant growth is significant after the fungicide has been applied, there is likely to be some tissue that will not be protected from infection.
- Post – infection – this is usually in the form of metalaxyl products, but there are some other products (such as dimethomorph) that also offer post- infection control of downy mildew. At the time of writing this manual phosphorous acid (phos acid) is not permitted to be used.

For more information about spray programs for control of downy mildew, go to the CCW Downy Mildew Management Fact Sheet here: CCW Fact Sheet - Downy Management. There is some useful information from the GWRDC with a Q & A about Downy Mildew information with some good pictures here: GWRDC Downy Mildew Q&A

Powdery Mildew

As distinct from downy mildew, powdery mildew does not need specific climatic conditions to grow. It will grow more rapidly and become more of a problem when conditions are ideal, such as temperature at 27^0C, and high relative humidity. Control of powdery mildew usually involves cultural methods if possible, and application of sprays at regular intervals early in

the growth season. These are typically applied at 2, 4, 6 and 10 weeks after bud burst, with some sprays often required later in the season. If there are prolonged periods of humid weather, if the canopy of the vines in question is heavy, and with susceptible varieties a heavy spray program may be required to keep the disease in check. For more information about powdery mildew see the CCW Fact Sheet here: CCW Fact sheet Powdery Mildew Information, and control options here: CCW Fact sheet Powdery Mildew control

(Bunch Powdery- A. Pietsch)

(Leaf powdery – A. Pietsch)

Vitinotes with information about powdery mildew:

- Vitinotes - Powdery Mildew Characteristics
- Vitinotes - Powdery Mildew Management
- Vitinotes - Powdery Mildew Monitoring

GWRDC Q & A about powdery mildew with some very good pictures
GWRDC Powdery Mildew Q&A

Botrytis

(Botrytis- A. Pietsch)

Botrytis is the grey mould that grows on decaying fruit. It is present everywhere, so if the right conditions prevail it will grow. Botrytis has the following traits:

- It grows faster where plant sugars accumulate; so it is most common on ripe fruit and parts of the plant where there is a higher concentration of sugars.
- It is not a primary coloniser of plant tissue, and tends to grow on old or damaged tissue. For this reason plant tissue that has been previously damaged by other disease or insects can be readily colonised by botrytis.
- In the right conditions (warm and wet for long enough) botrytis can grow very rapidly, and if left unchecked, can decimate a crop in a matter of days.

- Botrytis manifests in the skin of the grape berry, and can produce the enzyme *laccase*. Laccase causes red wine to turn brown; and the rot leaves an unappealing musty odour to the wine. For this reason botrytis is more problematic with red varieties, as they are fermented on skins.
- Control of botrytis is extremely difficult if there are prolonged wet and warm conditions.
- It is also difficult to control late in the season when canopies are full, bunches are tight and achieving spray coverage of fungicides is almost impossible. The closer to harvest the infection sets in, the fewer chemical options there are.
- As the fungus has very rapid regeneration times the possibility of developing resistance to specific chemical controls is very high. Use of botryticides is subject to strict resistance management recommendations.
- A bad season of botrytis is likely to lead to high spore load and possible high disease pressure in the following season.

Note that botryticides are only active against botrytis. They are not active against other non-botrytis bunch rots. Iprodione, for example, will have no effect against sour rot. For further reading about botrytis bunch rot, see the following links:

Further Information

- Botrytis fact sheet : GWRDC Botrytis Fact Sheet
- GWRDC Botrytis Q&A fact sheet: Botrytis Q & A
- Botrytis Management Presentation GWRDC Botrytis Management Presentation
- Botrytis Control debrief: GWRDC Botrytis debrief
- Non-Botrytis bunch rots: Non Botrytis Rots Q&A
- Pre-harvest botrytis management: Botrytis Pre-harvest
- CCW Fact Sheet –No.2 Bunch Rot

Insect Pests

Light Brown Apple Moth

The most common insect pest is light brown apple moth (LBAM).
There is a link to the CCW LBAM fact sheet here:
CCW Fact Sheet - Light Brown Apple Moth

(Light Brown apple moth and webbing- A. Pietsch)

LBAM not only causes yield loss through damage to fruit, but importantly the feeding damage can lead to development of much greater damage from secondary rots. Like many other insect pests, control is not always necessary. If there are only small numbers of moths in a patch then the cost of control may not be warranted, and the cost of application of broad spectrum insecticides may outweigh the benefit. The minimum level of pests where control is warranted is referred to as the threshold level. It is difficult for a grower to make a decision about what the threshold level may be for their patch of vines; and in fact the threshold level will be different for different varieties. Varieties that command a higher price may have a lower threshold, as the cost of control may be justified at lower amounts and the

potential loss from insect damage is greater. Varieties with tight bunches where ensuing rots may develop (eg Sauvignon Blanc, Chardonnay) may also have a lower tolerance to the pest and therefore a lower control threshold. Typically 5% is used as an action threshold for LBAM, but each grower will have to make that decision for themselves.

Further information:
A project about monitoring LBAM in the Riverina is here: GWRDC LBAM monitoring
There is information about biological control of Light Brown Apple moth here:
GWRDC Biological Control LBAM
A GWRDC Innovators' Network presentation about pests in the vineyard:
GWRDC IPM in the vineyard
An extensive study about the cost of pest and disease management can be found here:
GWRDC Cost of P&D Management

Vitinotes have information about LBAM:

- Vitinotes - LBAM monitoring
- Vitinotes - LBAM management

Mites

Mites often go undetected in the vineyard, yet they may cause considerable problems. There are many types of mites, but most concern is with **bud mite** and also **rust mite**. There are often symptoms of **blister mite** in vineyards in the Riverland region; but this pest rarely causes economic damage unless it is present in plague proportions.

Mites are often difficult to control, as they usually can only be targeted at restricted times of the season, and using a restricted range of controls. Often mite populations are held in check by beneficial insects, and maintaining the balance of insect populations is desirable.

Bud Mites
Damage occurs from feeding of the mites within the developing bud, and symptoms include noticeable zigzag growth of shoots, often accompanied by damage to leaf margins and short internode length.

Vitinotes have information about bud mites here: Vitinotes - bud mites

Rust Mites
Also known as "bronzing mites" rust mites typically show symptoms of black or bronze-coloured leaf growth at the end of the growing season, shortly prior to harvest. The dark colour is caused by degradation of the chlorophyll within the leaf tissue, which can affect leaf function if the infestation is particularly bad. At these extreme levels leaf function may be compromised and the ripening of fruit may be delayed.
Rust mites are often problematic where hot, dry, dusty conditions may inhibit the action of beneficial insects that normally control the population of the pest. Other influences on the levels of rust mites include some fungicides and other chemicals which may also have a negative impact on the activity of beneficial insects.

Control of rust mites usually involves early application of wettable sulphur and spray oil (see link to rust mites "spring control" below).

This is usually applied during woolly bud stage early in the season. It is important when rust mite becomes a problem to record the affected patches so that they can be treated at the correct time in the following season.

(Rust Mite- A. Pietsch)

Further information :

- GWRDC Rust mites
- Vitinotes - rust mite control
- Vitinotes - rust mite monitoring
- Vitinotes - rust mite characteristics
- CCW Fact sheet- No. 8 Grapeleaf rust mite in the Riverland

Blister Mites

(Blister mite- A. Pietsch)

These mites typically form under blisters in the leaf surface, with white down growing profusely on the underside of the leaf. While there are marked differences to the appearance of downy mildew, the description has often caused confusion among growers with downy mildew growth. The blistering effect is caused by the plant response to the feeding action of the mites, whereby the plant generates hormone production at the feeding site that causes uneven growth and formation of the blister. The white down under the blister is thought to be plant leaf hairs that are growing profusely from the influence of the plant hormonal response.

Control of blister mite can usually be achieved by application of wettable sulphur close to bud burst at maximum label rates.

Further information:

- Use of wettable sulphur for control of mites: SARDI - Blister mite
- Biological control of blister mites: GWRDC Biocontrol Blister mite
- Control of mites in an IPM program: GWRDC IPM mite control
- Information about many insect pests: DPI NSW Vine Pests

Mealy Bug

Mealybugs are an occasional pest of winegrapes. They suck sap from the vine, releasing sticky honey dew that promote sooty mould. Mealybugs are also believed to be a vector of leafroll virus. Mealybugs over-winter beneath the bark of the trunk, crown and cordon and can have 3-4 generations in a year. Severe infestations are more likely in mild summers, late maturing varieties, where bunches touch the cordon and within dense, humid canopies. The use of some insecticides can disrupt beneficial insect populations, which can contribute to mealybug outbreaks. Control options are either applied in dormancy or prior to 80% cap fall.

Vine Scale

Vine scale is usually an innocuous pest, and does not cause problems until populations are at very high levels. When at high levels, however, it can severely retard vine growth. There can be additional problems with the possible transfer of diseases as the scale is a sucking insect; and the honeydew that is emitted by the insect encourages growth of mould. Control usually involves application of dormant sprays using a high volume of well-directed oil spray at the vine cordon.

(Vine scale- A. Pietsch)

Further Information

- CCW Fact Sheet - Vine scale

Earwigs

European Earwigs are only a problem in spring when they feed on new vegetative growth and populations are high in number. They also can hide in vine covers in newly established vineyards, and attack young vines. Earwigs can be found feeding on leaves and buds during the night, and sheltering under the bark during the day. They do have the benefit of being predatory insects, and feed on a wide range of mites and insects.

(European Earwig – A. Pietsch)

Further Information

- Agric. WA - European Earwig pest of viticulture
- CCW Fact sheet No.6 Earwigs

Snails

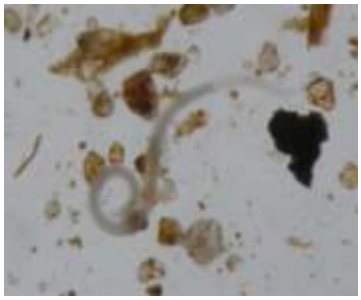
(common white snail- A. Pietsch) *(brown garden snail – A. Pietsch)*

The most significant species of snail affecting vineyards in the Riverland are the common white snail, the Italian white snail and the brown garden snail. Snails can contaminate loads, reduce sprinkler performance, and eat foliage. Damage is usually greatest on young vines and around budburst. If too many snails are in the canopy at harvest, loads can be rejected. Control snails early in the season. There are various forms of control options available; baiting, avoid providing an alternative host (weeds, covercrops), knock snails off vines, cultivation (to destroy eggs), and poultry (to eat snails).

Further Information

- Agric WA - snails
- CCW Fact Sheet No. 5 Snails
- Snail Monitoring in Vineyards

Nematodes



(Root Knot nematode- A. Pietsch)

Nematodes feed on the root system of grapevines. When infected, grapevines will have reduced vigour and yield. Damaged roots can then also become infected with root rot fungi. There are various types of nematodes that infect grapevines and each with a different life cycle, and different level of damage that they can cause to a vineyard. The most common nematodes to attack grapes are Citrus nematode, Root-knot nematode and the Root lesion nematode. To assess the levels of nematodes and to determine the type of nematodes in the soil a nematode test can be done. A soil sample is taken and sent off to a laboratory for assessment. Thresholds have been established for a number of nematodes and be used in conjunction with a visual assessment whether treatment is required. It is always a good idea to get a soil test before planting, as rootstocks can provide different levels of resistance to nematodes. There are chemical control options available, but will not eradicate the nematode populations but just temporarily reduce their numbers. There is also cultural management options available, such as cultivation in summer, adding manure/compost to encourage diversity in the soil ecology, and non-host cover crops.

Further information

- CCW Fact Sheet No.9- Nematodes
- CRCV- Nematodes in Australian Vineyard Soils
- Agri WA - Vine Nematodes
- CRCV - A sampling method for nematode monitoring

Phylloxera

Thankfully the Riverland region is free from phylloxera, so there will not be a great deal of information required in this manual. Growers should maintain awareness and vigilance in making sure that this pest is not introduced into the region. If phylloxera were to invade the Riverland, the impact would be negative and significant. For more information go to the Phylloxera and Grape Industry Board (PGIBSA) website here: PGIBSA Website.

There is extensive information about the nature of phylloxera, monitoring for the pest, and maps of the different exclusion, risk, and infestation zones in Australia.

Spray Application

Spray Drift Prevention

Avoidance of spray drift (or chemical trespass) is a common law duty-of-care that must be exercised by the applicator of chemicals. Regulations aimed at curbing spray drift are becoming more stringent around the globe, and growers should be aware of their responsibilities.

Aside from the clear legal and environmental benefits, it makes sense to avoid spray escaping from the target, from the viewpoint of reducing waste and increasing the effectiveness of pest and disease management. Some methods of reducing spray drift from occurring include:

- Adjusting the direction and strength of air streams from air blast sprayers so the chemical laden air hits the target, and is not excessively carried past it. Water and air volumes should be adjusted to match different canopy size at different stages of the season;
- Directing spray nozzles at the target and minimising and directing off-target;
- Selecting nozzle types that reduce drift;
- Adjusting pressure to reduce drift;
- Avoid spraying during unsuitable conditions. This includes unfavourable wind, or when inversion layers are present;
- Install buffer zones to intercept spray if possible.

As the size and density of the vine canopy increases during the growing season more spray volume (ie water rate per hectare) and usually more chemical is required. For further information on spray volumes see: CCW Appropriate Spray Volume Calculator.

See CCW "Spraying Principles" for further information about spray drift, here: CCW Spraying Principles

Further Information

- GWRDC Spray Application in Viticulture Notes
- GWRDC Spray Application Fact sheet
- APVMA-Operational Notice
- APVMA-spray drift principles

Resistance Management

Refer to CCW Fact Sheet 12 "Chemical Resistance" for an explanation about the concept of chemical resistance with this link. Essentially, repeatedly treating a pest or disease with the same type of chemical (Group), that controls a part of the population may no longer be effective after time. It is important that growers consider including resistance management plans as part of their pest and disease control strategy. A failure to control the development

(spray application- A.Weeks)

of resistance means that some chemical controls will no longer be effective; not only on the property where resistance develops but possibly throughout a region. For this reason there are recommendations about rotation of different chemical groups issues by CropLife Australia. In general, controlling diseases, weeds or pests by the widest range of control options is the best policy to prevent resistance developing. If a pest, disease or weed is not controlled after the application of a chemical, it does not necessarily mean that resistance has occurred, but every effort should be made to prevent those individuals from forming another generation. This is preferable by application of a chemical from a different group, or better still from use of another method of control. It is good practice to have a resistance management plan to prevent resistance from occurring.

An example of a herbicide rotation for control of couch grass in vines may be:

Order of herbicide in rotation:	Active Chemical	Herbicide Group
First	Glyphosate (eg Roundup®)– early season	Group M Herbicide
Next	Paraquat / Diquat (eg Sprayseed®) or paraquat on its own;	Group L Herbicide
Last	Haloxyfop (eg Verdict®) or Fluazifop (eg Fusilade®)	Group A Herbicide

Further Information:
Herbicide Resistant Weeds in Australia: List of herbicide resistant weeds
Herbicide resistance groups: GRDC Herbicide Resistance
AWRI – Links to resistance management sites: AWRI resistance management information

Canopy Spraying

Most spraying that is done in the vineyard involves applying chemical to the vine canopy, whether it is fungicide, insecticide or foliar fertilizers. The air that is contained within the vine canopy must be replaced with chemical-laden air in a way that effectively covers the target tissue.

Canopy spraying of fungicides or other pest control agents is one of the most important tasks that a grower will do in a vineyard. It is too often viewed by growers as a task that must be endured rather than a job that must be completed correctly.

Refer to CCW fact sheets with some suggested spray programs CCW Fact Sheet - Downy Mildew Management
Refer to "CCW Spraying Principles" for some more extensive information in regard to canopy spraying: CCW Spraying Principles
More information can be found about problems with fungicide control here:
GWRDC Fungicide Control Chemistry Update

Ground (Weed) Spraying

Usually the aim of ground spraying is to control weeds by applying herbicides. Depending on which herbicide is being applied, this usually requires application in a manner that avoids the herbicide contacting the foliage or green tissue of the vines. Care must be taken in the calibration process, as herbicides will have limited effect if the applied rate is too low, and applying at an excessive rate may waste money and risk off-target damage.

Herbicides may be either knock down (broad spectrum) which kill a wide range of weeds, (eg glyphosate) or selective, where they are effective against only one type of weed (eg fluazifop). Knock down herbicides require special care, as they are likely to cause off-target damage to vines within the vineyard where they are being used or on adjacent property if they are subject to drift.

Herbicides commonly work with one of three modes of action; either

- ***Systemic*** – the herbicide is absorbed into the plant and moves within plant tissue to kill the plant. Glyphosate works in this way.
- ***Dessicant*** – the herbicide only kills the plant tissue where it contacts the plant. Paraquat and diquat work in this way.
- ***Residual*** – the herbicide is applied directly to bare soil and the herbicide is absorbed by the germinating weed seed. Simazine works in this way.

The type of herbicide will have an influence on the amount of water that is required to apply the herbicide to cover the plant. Generally speaking, higher water rates are needed to achieve adequate coverage with dessicant herbicides than for systemic herbicides. If excessive water rates are used, it is likely that much of the herbicide will be washed off, and effectiveness of kill will be reduced. This may also cause environmental concerns.

The product label will give recommended water rates, and these recommendations should be followed. The label may also specify recommended application methods and guidelines for mixing chemicals. The label is a legal document, and the instructions must be followed.

Some herbicides are subject to withholding period considerations, and there are also some that may be prone to leaching. This is especially the case in lighter soils, and where full cover irrigation is applied or it rains soon after herbicide application. This should be avoided at all costs to prevent environmental damage.

The age of the vine also influences the type of herbicide used. Younger vines are generally more sensitive to herbicide applications.

Some residual herbicides also need rain or irrigation to push the herbicide into the weed seed bank, and bind it the soil. Again read the label if this is required.
It is important that the right herbicide is used at the correct rate for the weed in question. Information about weed identification can be found here: Weed ID

Some information about glyphosate resistance can be found here:
GWRDC Glyphosate Resistance
Strategies for reducing herbicide use in vineyards:
GWRDC Herbicide reduction
Some general information about herbicide application can be found here:

- CCW Fact Sheet- No.14 Herbicide Application and Resistance Management

Spray Calibration

All spray plants should be calibrated as specified in the Accolade Wines Spray Diary. It is good practice to calibrate a spray plant every time the spray application rate changes, and to calibrate the spray plant at the start of each season. Spray nozzles and other parts of the sprayer may become worn, and this will affect the application rate of the control agent being used, and possibly its efficacy.

Use of adjuvants

Some products may benefit from the addition of adjuvants. This is covered briefly in the "Spray Principles" document. Many agrochemicals contain their own adjuvants, but in some cases addition of another adjuvant may enhance the action of a herbicide or fungicide.

Further information about the use of adjuvants here: Vitinotes - selecting adjuvants

Spraying insect pests

Note that use of some insecticides is limited, and may require permission from Accolade Wines staff prior to use. Check the recommendations in the Accolade Wines spray diary prior to applying insecticides. Generally when dealing with control of insect pests the following rules of thumb apply:

- Use non-chemical methods if possible;
- If a chemical option is used, select the "softest" (least damaging off target insects) option available that controls the pest;
- Consider a range of options rather than reliance only on chemical controls;
- Adhere to resistance management guidelines to avoid resistance problems developing;
- Consider spray drift issues as discussed earlier in the manual
- Target the spray at the correct part of the canopy, and at the right stage of the insect life cycle to get the best result.

Further information:

- PGIBSA Phylloxera information
- PGIBSA Regulations
- PGIBSA Phylloxera Management Zones
- PGIBSA Inspecting vineyards
- PGIBSA FAQ's

Nutrition

Vines need nutrition to allow the vine to function. When fruit is harvested, nutrients that have been used to produce the crop are exported into the fruit. Conventional viticulture dictates that these nutrients are replaced in a nutrition program. The nutritional requirement will depend on many factors including:

- Production need – ie lower yielding, high quality fruit for high quality wine or high production fruit for bulk or neutral production;
- Rootstock type
- Variety
- Vine and site vigour
- Irrigation system and irrigation regime

Nutrients have different functions within the vine, and are categorised into two main types depending on the vine need. These are Macronutrients and Micronutrients.

Macronutrients are required in larger quantities, and include

- Nitrogen N
- Potassium K
- Phosphorus P
- Magnesium Mg
- Calcium Ca
- Sulphur S

The main functions of the macronutrients are as follows:

Nitrogen

Main functions
Important for plant structure, vigour, and metabolism
Related to plant yield and production
Chlorophyll function
Amino acid synthesis

Deficiency Symptoms
Poor growth, short or stunted shoots
Overall yellowing of leaves
Loss of green colour – reddening of shoots

Toxicity Symptoms
Extremely dark leaves
Dead sections in leaves, "burning" of leaves
Excess vigour; long internode length
Excess vegetative growth, often at the expense of fruitfulness

Phosphorus

Main Functions
Energy transfer, development of plant growth
Development of plant sugars and proteins
Important for root and shoot growth

Deficiency Symptoms
Reduced shoot and root growth
Decreased fruit set
Reddening or yellowing in older leaves
Red dots forming near the edge of lower leaves
Severe symptoms can resemble leaf roll virus

Toxicity Symptoms
Excess phosphorous can lead to zinc and iron deficiency
Yellow inteveinal chrlorosis or "little leaf" zinc deficiency symptoms may result

Potassium

Function
Strengthens plant tissue and increases fruit size
Plays an important role in stomatal function, regulating water movement in and out of the leaf
Carbohydrate metabolism and transport within the plant
Protein synthesis

Deficiency Symptoms
Marginal and interveinal chlorosis on older leaves
Leaves may rolls upward at margins; in severe cases defoliation can follow
Leaf blackening or strong purple colour
Small tight bunches that may ripen unevenly
Potassium deficiency may resemble water or salt stress in some cases. Care must be taken with the diagnosis.

Toxicity Symptoms
Excess potassium can cause antagonism with magnesium, and therefore symptoms of magnesium deficiency will be evident
Excess potassium can lead to higher juice pH and increased instability of colour in wine.

Sulphur

Function
An important component of essential amino acids in the plant
Formation of chlorophyll, proteins and plant metabolites

Deficiency Symptoms
General yellowing of young leaves
Necrosis & translucent appearance of young leaves
Reduced of stunted growth
Toxicity Symptoms
None Noted

Calcium

Function
Cell integrity
Skin and cell wall strength
Aids metabolic processes

Deficiency Symptoms
(In soils) – poor soil structure
Thin skins, possible increase in susceptibility to rot type diseases
Dieback of shoot tips, dead patches in leaves;
Dieback of root tips

Toxicity Symptoms
"Waterberry"
Early bunch stem necrosis

Although micronutrients are required in smaller amounts, they are still essential for vine growth and function. These include:

- Zinc Zn
- Manganese Mn
- Molybdenum Mo
- Iron Fe
- Boron Bo
- Copper Cu

The availability of nutrients can be influenced by the soil.

There is a GWRDC Nutrition Technical presentation here:
CRCV-Nitrogen Fertilisation
CRCV-Phosphorous Fertilisation-
CRCV-Potassium Fertilisation
CRCV-Molybdenum
CRCV-Trace elements

Assessing Vine Nutrient Status

The use of petiole samples and soil tests can help determine the nutritional requirements from season to season. The petiole sample, being a tissue test that indicates what the plant is taking up at the time, whilst a soil test will determine what nutrients are available to be taken up by the roots. Petiole samples are taken at 80% capfall. Contact a CCW viticulturist when one is required. Visual assessment of vine health is also just as important.

Further Information:
AWRI- soil sampling
CCW- Petiole Sampling

Fertiliser Application

Fertiliser can be applied in various ways, fertigation, banded into soil, broadcast on soil surface, or sprayed on to the foliage.

Generally, prior to planting, phosphorous fertilisers (Super) are banded into soil prior to planting. If fertigation is not an option, then nitrogen is generally applied in a broad cast application into rootzone area.

Fertigation gives greater flexibility in the types and amounts of nutrients supplied. It also allows for a more efficient use of fertiliser, ie. there is less waste as it is applied to the wetted zone, which contains the majority of the feeder roots. More information can be found at
DPI NSW - fertigation

Foliar Nutrients come in two forms, granular and liquid. Micro-nutrients are generally applied as foliar applications (except iron can be applied via the soil also). The granular fertilisers are generally cheaper than the liquid forms, but not as compatible with other products in the spray tank. Liquid foliar nutrients are generally chelated (always check with reseller), which means they are more compatible with other products in the tank, but also are more expensive. The other benefit of using chelated products is that they are more readily absorbed by the plant.

Organic fertilisers generally need to be incorporated into the soil to allow microbial breakdown and release of nutrients into forms that the vine roots can use, and this can take various amounts of time depending on temperature and soil moisture. Organic fertilisers generally have a variable and often low content of macronutrients (N, P, K). The benefits of organic fertilisers is that organic carbon is added to the soils, and general soil health improves.

Contains information about nutrition, soil health, inorganic and organic fertilisers and their nutrient contents. GWRDC- Fact sheet nutrition
Information on post-harvest nutrition of Grape vines can be found here:
Post harvest Care of Grapevines: irrigation, nutrition and salinity

Fertiliser Calculations

When calculating the nutrient requirement, here are some calculations that may be helpful.

(a) Price per kg of nutrient = Price per tonne ÷ 10 ÷ % nutrient
(b) Cost/ Ha = cost per tonne x rate (kg/ha) ÷ 1000
(c) Amount of nutrient (kg/ha) = Amount of fertiliser (Kg/ha) x %nutrient in fertiliser ÷100

For further information on fertiliser calculations refer to the fertiliser calculator at Fertiliser Calculator on the CCW website.

Cover Cropping

There are many reasons that growers choose to plant cover crops. These include:

- ***Increasing soil fertility*** – legumes such as peas, beans and medic legumes can add nitrogen and increase soil fertility.
- ***Improving soil structure*** – plants such as radish, rape and brassica species have strong tap roots that can increase porosity of soil. When the root breaks down after the cover crop is finished, the result is preferred pathways for water, nutrients and air to be allowed into the soil. Soils that have a severe hardpan may require ripping prior to sowing these plants.
- ***Biofumigation*** – some Brassica species can accumulate compounds that are antagonistic to nematodes. It is imperative that these crops are slashed just prior to flowering in order to gain the benefit from the biofumigant properties.
- ***Preserving soil structure*** – as the cover crop decomposes it adds organic matter to the soil. This offers improvement of the very long term. There are also benefits from the cover crop preventing rain and wind erosion. Planting cover crops in the wheel tracks may reduce soil compaction.
- ***Biodiversity*** – some cover crops are deliberately planted to encourage a diverse population of insects to combat light brown apple moth, and other insect pests. Note that some broadleaf cover crops may encourage populations of light brown apple moth.

- ***Creating symbiotic relationships with crop plants*** – Some plants (particularly grasses) have the ability to increase beneficial organisms such as mycorrhizae within the soil, which can improve the ability of the vines to access soil nutrients.
- ***Weed control*** – Some cover crops may have an allelopathic[1] effect, and prevent other weeds growing in the vineyard. The cover crop can be grown in the mid row and either slashed with a side-throw mower so that the vine row is mulched; or the cover crop can be mulched or rolled in the mid row to control weed growth.
- ***Altering vineyard floor temperature*** – Cover crops may reduce the reflected heat during summer, and can also be used to manipulate vineyard floor temperature. There is a link to some of this information here: GWRDC Vineyard Floor Temperature

Further information about cover crops:
Cover crops and vine nutrition: GWRDC Cover crops and Vine Nutrition
GWRDC Vineyard Resilience and Vineyard Floor
There are some seeding guidelines for cover crops at the following link: GWRDC Cover crop seeding guidelines
Cover crops for weed control: Cover Crops for weed control
Cover crop selection tool: cover crop selection tool
Cover crop info on natives: Native cover crops in Viticulture

Irrigation

(dripper- driptips.toro.com)

Irrigation types have been changing from high output to lower output, higher efficiency systems over recent years. Most CCW growers have drip irrigated vineyards now, in particular following the recent droughts and the associated high price of water. There have been some state and federal government-funded assistance programs to help growers convert to more efficient irrigation systems. If growers are considering an irrigation conversion it would be worth enquiring if there are any assistance programs available.

Different approaches to irrigation can have different results. A heavy irrigation will usually result in higher yields and encourage vigorous shoot growth. More conservative irrigation regimes will usually result in shorter shoot growth, smaller berry size, and lower yields. The irrigation regime that is chosen for a particular patch will depend on the desired outcome for the variety and end use of the fruit.

Some different approaches for irrigation include:

- **Sustained deficit irrigation** – irrigation is applied at amounts below the optimum level over a large amount of the growing season or the whole season. This approach usually greatly restricts canopy growth and yield. This approach was common during the drought due to high cost of water. The water stress that this irrigation approach imparts may cause problems with vine health and bud fruitfulness in future seasons.
- **Regulated deficit irrigation** – this is the approach where an irrigation deficit is applied during a strategic time of the growth cycle to restrict berry size, shoot growth, or both. Usually the deficit is managed – hence the word "regulated".

[1] Allelopathic effect – in this context means that the cover crop prevents the growth of other plants

- The idea is to impose a mild stress and reduce the growth below the maximum level in order to improve the quality of fruit. Use of this irrigation approach is extremely risky without use of good soil moisture monitoring equipment.
- **Partial root zone drying** – is a highly intensive method of increasing fruit and the resulting wine quality. The method involves installing drip lines either side of a vine row, and irrigating different parts of the root zone to impart mild stress. There is a higher capital requirement than most conventional drip systems due to the extra irrigation lines required.
- **Nil deficit irrigation** – where vines receive the same amount of water that is required for balanced growth
- **Heavy irrigation** – where vines receive high amounts of water to boost growth. This approach is typical with low value varieties that may require higher yields to meet the cost of growing.

Details about timing of irrigation and effects of irrigation levels can be found on the CCW Fact Sheet 11 here: Water Supply and Vine Response Summary Table

Some information about Partial Root Zone Drying (PRD) can be found here:
GWRDC PRD Notes

Irrigation Scheduling

Scheduling irrigation is essentially applying the right amount of water at the right time. There are many ways of doing this, and there is no single "best method" that can be recommended at the expense of all others. Many proficient irrigators use a combination of methods. Some common irrigation scheduling approaches and positive and negative points about them are shown in the following table.

Method	Positive	Negative
Dig stick – check soil to ascertain irrigation performance and water requirement	Testing the actual soil moisture – not reliant on a model Low (or no) cost	Requires experience and judgement Does not provide quantitative assessment of irrigation Labour intensive
ET_0 Method (Evapotranspiration)	Easy – relatively low cost Reflects plant water use Provides grower with indicator of irrigation need	Not reliable in all situations – should be backed by other methods Potential for errors to be magnified
Tensiometers	Moderate cost Indicative of water use in the root zone Modern versions can be logged	Some maintenance requirement; calibration needed Not accurate in water tensions where RDI is practiced

Method	Positive	Negative
Capacitance probes (eg Enviroscan, Sentek)	Accurate tracking of soil moisture in the rootzone Useful computer program – user friendly High degree of automation – can be remote downloaded Works across wide range of soil moisture content – suitable with RDI Can track soil water use at different depths, or as an average Some work with other monitoring probes – eg soil salinity	Relatively expensive A very small volume of soil is monitored, so selecting the sensor site is vital Portable types have high labour component
Resistance (gypsum) blocks	Relatively low cost Monitoring can be automated Low maintenance	Blocks dissolve over time Less accurate in sandier soils
Observation of plant symptoms	Accurate anticipation of stress Irrigation decisions are made in reference to vine growth	Experience required Often when symptoms appear it is too late to deal with them High labour requirement

Further information about irrigation scheduling:

- Shiraz Irrigation Trial
- Vitinotes - Irrigating with less water
- Vitinotes - RDI
- SARDI irrigation efficiency report

Converting to Drip Irrigation

If growers are considering converting from sprinkler to drip irrigation, there are a number of factors that should be considered; including

- Timing – Post Harvest
- Pump needs; changes to system pressure
- Filtration needs
- Irrigation design
- Nutrition program required during the conversion

Note that changing from a full-cover irrigation system to a drip system results in the same *number* of vine roots being irrigated in a greatly reduced total *volume* of soil. This means that irrigation regimes and fertilizer programs during the conversion phase are important in encouraging a "relocation" of the root system across to a smaller volume of soil. For these reasons it is wise to consult an accredited irrigation expert to ensure that irrigation design and the ensuing nutrition and irrigation program allows the best result in vine growth.

There are some informative links about drip conversion here:
Some extensive notes about conversion to drip GWRDC drip conversion notes

Sub Surface Drip Irrigation

There has been some success with irrigating vines with sub surface drip irrigation. This can lead to highly efficient irrigation regimes due to reduced evaporative losses. There have been some concerns, however, with root intrusion in some installations. This is especially

the case with red varieties, where water is withheld during RDI. This tends to encourage root proliferation "in search of" water. Prevention of root intrusion can be achieved through various physical barriers or with the use of chemical treatments. This problem may cause enough concern for some growers to favour conventional above surface drip irrigation.

When trying to budget water across the property and through the season refer to CCW Water Budgeting Tool. The tool will assist in making decisions on where water should go and, at what time of the year (depending on growth stage and weather conditions), with the water available.

After budgeting and assessing the irrigation requirements for the property, a deficit may result. If this occurs water can be leased or purchased depending on requirements. Or if a surplus, water could be leased or sold.

Rootstocks and Irrigation Regime

Different rootstocks will have different requirements for water. The different rootstock traits may be seen in the rootstock section. There is a link to rootstock requirements for irrigation here: GWRDC Rootstock and Water Use
Rootstock selection and management: GWRDC Rootstock Information
Yalumba Nursery have a very good source of information and a decision support tool to help in the selection of rootstocks here: Yalumba Nursery rootstock selector
The Riverland Vine Improvement Committee: RVIC website
Phylloxera & Grape Industry Board website: PGIBSA Rootstock information

Salinity Management

During the drought the effect of irrigating with minimal amounts of water became very clear. Some growers encountered problems with accumulation of salts in the root zone, and in turn in fruit. While many of these affected patches had obvious symptoms of salt burn, many did not. Unfortunately for some growers, the level of salts accumulated in the fruit was in excess of the legal limit permitted in wine, and some fruit was rejected.

The main cause of this accumulation of salts in the root zone was the fact that many (if not most) growers did not have sufficient irrigation water available to leach the salt away from the root zone. Recent research has shown that leaching irrigations work most effectively when they are applied at the end of the winter rainfall period. During the drought period there was little rain; so little rain and little or no leaching irrigations meant that many growers were effectively storing irrigation salinity in the root zones of their vineyards.

There was a clear relationship between rootstocks and the likelihood of high levels of salt in fruit. K51-40 and K51-32 rootstocks figured prominently in the list of patches with high levels of salt accumulation. This was followed by vines on their own roots.

While it was not exclusively the rootstock type that led to root zone salinity problems; it was a significant factor. It is strongly suggested that growers who are selecting a rootstock think carefully about their growing situation. After witnessing the extensive problems with salt accumulation with the K51-40 and K51-32 rootstocks, planting vines grafted to these stocks cannot be recommended; in particular with red varieties. The salt accumulation with reds is potentially a much bigger problem, due in part to the common practice of controlled deficit irrigation, but also due to the fact that salts accumulate in the berry skins, and as such, are more likely to affect red wines than white wines.

Salt Tolerance of some common rootstocks:

Relatively tolerant ***Relatively sensitive***

Ruggeri 140, Schwarzmann	**110 Richter, 99 Richter**	**Own Roots**
Ramsey, 101-14, 1103 Paulsen	**Teleki 5C**	**K51-40 K51-32**

(Note: The above diagram is a generalisation and cannot be used for specific recommendation of a rootstock. For more detailed information visit one of the rootstock websites listed above under "Rootstocks and irrigation regime.)

Further Information:
GWRDC Notes - Sustainable Salinity Management : GWRDC Salinity Management
Overview of rootstocks in other countries: GWRDC Rootstock evaluation and breeding
Rootstock information Yalumba Nusery-Roostocks

References and further reading
"Soil Irrigation and Nutrition", Grape Production Series number 2, Phil Nicholas (Ed.), 2004. South Australian Research and Development Institute (SARDI).

Soil Health

Given the emphasis that is often placed on addition of nutrients and water, soil health in vineyards is often overlooked. The way that soil properties may either enhance or reduce the growth of vines is determined by the *physical*, *biological* and *chemical* properties of that soil. Factors that related directly to the fertility of the soil were addressed in the nutrition section of the manual, and will not be covered here.

Soil Physical Properties

Physical properties can be loosely referred to as the mechanical properties, or the way the soil "holds together" and the influence that this has on water and root growth. One of the most serious impediments to vine root growth is caused by soil compaction.

Soil compaction may be caused by cultivation of the soil causing a hard pan, but is more commonly related to continual passage of tractors compacting soil under the wheel tracks. Compaction may occur at any time, but it will be greatly worsened if tractors are driven in a vineyard when the soil is wet. It is a good idea to avoid using heavy machinery in vineyards immediately following heavy rain, or more precisely when the soil is wetter than field capacity. A compact soil will not only resist root growth; it is also unlikely to have good air and water flow at the root zone, therefore further debilitating root growth.

Wheel track compaction can reduce or totally stop root growth. It may also cause pooling of irrigation and rainfall over the wheel tracks, making compaction worse in successive machinery passes through the vineyard. Some sandy soils can be naturally compact to the point where root growth is limited.

Remediation of compaction can usually only be redressed by ripping the wheel tracks; and possibly followed by application of gypsum or sowing a cover crop with a deep and solid tap root to encourage the new "preferred pathways" that have just been ripped into that soil to

remain open for as long as possible. Traffic should be avoided on newly-ripped soil, and in some cases soil is re-compacted after only a few passes. In some soils the wheel track compaction may be corrected simply by sowing a deep-rooted cover crop (eg Fodder radish, rape seed, chicory) over the affected soils to open up the soils. In many cases the soil compaction is so bad that even deep-rooted plants such as these will have trouble penetrating through soil. These crops also require considerable water to germinate and become established, so they may not be overly reliable to grow in drip-irrigated vineyards in the absence of irrigation or rain.

Addition of gypsum can also help maintain soil structure; but too often gypsum is credited with being able to "open up" soil. Gypsum can prevent or delay *further* deterioration of soil, but it is not likely to be able to remediate a badly compacted soil without accompanying physical remediation.

Soil Chemical Properties

Soil slaking and dispersion is where the soil seals and will not readily allow infiltration of water.

Slaking is rapid breakdown of soil aggregates, usually due to addition of fresh water to a cation-rich soil. The term slaking usually refers to a layer that forms on the soil surface that is resistant to further infiltration of water, and may be worsened by raindrop impact.
Dispersion usually refers to clay soils, and is when the soil loses its structure due to addition of fresh water – eg. rain. In the Riverland region these soil properties are often seen in the sticky grey river clays. Often the problem is associated with excess sodium, as found with the clay floodplain soils. When this soil, which is typically rich in sodium, (and possibly also magnesium), is subject to rain, the cations are mobilised in the soil and repel, causing the soil to disperse.

Chemical properties will also strongly influence the ability of the soil to "hold" and "release" nutrients in the soil. Many soils in the Riverland region have pH levels above 8, which can lead to lower availability of Zinc, Manganese, Iron, Nitrogen and Phosphorus.

Soil Biological Properties

The ability of a soil to sustain biological activity is closely related to the amount of water in the soil, as well as soil organic carbon and decaying plant matter. Dry, wind-blown mallee sands, for example, are often regarded as "dead" soils. There is a stark contrast with dark coloured – moist and fertile soils often found in cooler, wet areas.

Riverland soils are very often low in organic carbon content and plant matter. Typically organic carbon levels of 3% - 8% are desirable; but many sands in the region typically have organic carbon levels below 1%. Low carbon levels in soils usually allows more leaching of nutrients, less aggregation of soils, less support for biological growth (such as mycorrhyzae and bacteria) and a less hospitable environment for plant roots to grow. This can be amended in several ways – by addition of carbon – containing mulches or soil ameliorants, and by planting cover crops that are slashed and worked into the soil. Remediating low soil carbon levels is a long term issue to repair and will often require a combination of methods such as those above.

See Vitinote 5 (link below) for further information.
A very good overview of soil properties and health: GWRDC Soil Health and Properties

Vitinotes with information about measuring soil properties:

- Vitinote 1 - Soil Sampling
- Vitinote 2 Measuring Soil pH
- Vitinote 3 - Soil Salinity
- Vitinote 4 - Measuring Organic Carbon
- Vitinote 5 - Soil Structure
- Vitinote 6 - Soil porosity
- Vitinote 7 - Soil Strength
- Vitinote 9 - Examining Vine Roots
- Vitinote 10 - Measuring soil moisture

Weather

Many growers call CCW and ask questions about weather forecasts. There are a number of different weather sites that can be used, and are very handy for planning disease control options.

Weather forecast and information sites:

- BOM
- Elders Weather
- Silo

Interactive weather site: BOM interactive weather
Forecast explorer: Murrayland forecast

Rainfall forecast web pages that may be useful:

- AWN rainfall forecast
- Weatherzone rainfall forecast
- BOM rainfall forecast
- Vertical Velocity rainfall forecast

Local weather stations can be accessed here: NRM board-weather stations

Frost

The temperature at which frost damage occurs is dependent on growth stage. However, the most critical stages are between woolly bud (below -2.5°C) and shoots no longer than 150mm (0°C). Frost injury occurs when the water in the plant cells freeze and rupture, causing cell death.
At the time of planting, consider the environment (eg. natural depression, near a water mass and surrounding scrub) and variety (early budburst varieties more susceptible), to limit the impact of frost on production.
A delay in pruning can delay budburst, and possibly reduce the impact of frost. Other management options available to minimise the impact of frost are to maintain weed free vineyards, slash or work-in covercrops and try to maintain good soil moisture.
If sprinkler irrigation is available, it can be used to increase the air temperature and reduce the potential damage from frost. Sprinkler irrigation should start before the air temperature falls below 0°C.

Further information on frost:

- AGRIC WA-Frosts
- GWRDC- Arming against Frost

Heatwave Management

Irrigation is the most significant management tool to mitigate the effects of a heatwave. The rootzone should be at full capacity prior to the heatwave occurring and maintained during the heatwave. It is essential also that the canopy ensure enough coverage of bunches without causing excessive shading. Where possible retain groundcover to reduce the amount of reflective heat going back into the canopy. Rows that are orientated east-west limit the amount of exposure bunches have to afternoon sun. Sunscreens (Surround® and Screen®) can limit the effects of heatwave, but must be used in-conjunction with good irrigation practices.

Further information on heatwave management:

- GWRDC-Managing grapevines during heatwaves

Baume Sampling

Baume samples are used to schedule fruit for harvest. The baume sample should be representative of the patch ie not just in one area of the patch but from across the whole patch. Generally, bunch sampling is a better technique to get a representative sample than berry sampling. 20 bunches is a good sample size for most patches.

During the season maintain consistency in your sampling technique. Samples should be taken at the same time of the day each time and preferably in the cool of the morning.
As stated in the Accolade Wines 2012 Vintage Requirements "Growers should start testing the fruit maturity of each patch on a weekly basis as soon as berry softening is complete" (ie. at approximately 9 baume). Sampling should be performed at least twice a week when fruit is ripening and nearing harvest. Once a patch is booked, growers should continue to sample and submit baume results, including a final sample within 48 hours prior to picking to confirm bookings. Failure to provide regular baume results will likely hinder the booking of the patch.
Refractometers can become inaccurate over time. Prior to each vintage refractometers should be calibrated. Calibration solutions and instructions are available from Berri Estates. Calibration solutions from previous seasons should not be used.

Further Information

- CRCV- Grape Maturity 1.- Importance of sampling for baume correctly.

Harvest (MOG)

When the harvester arrives at your property make sure the machinery is clean and free from foreign material, and that there are no oil or fuel leaks. Take the time with the harvester operator to set up the harvester to avoid MOG (material other than grapes), as this could save problems at the weighbridge. Other things to consider when trying avoid MOG is trying to avoid harvesting in wet conditions as it is hard to remove leaf matter. Also, poor pruning techniques in the vineyard, especially where hand clean-up following machine pruning has been inadequate, can add excess wood to the harvest load. Control snails during the growing season, so as not to become a problem at harvest. Make sure vine rows are clear of foreign objects. Continue to inspect the load and harvester, during the picking of the fruit.

Further Information:
"Australian Winegrape Load Assessment" –Allen, W ; 1998
Viti Notes- Grape Maturity 3. Matter other than grapes