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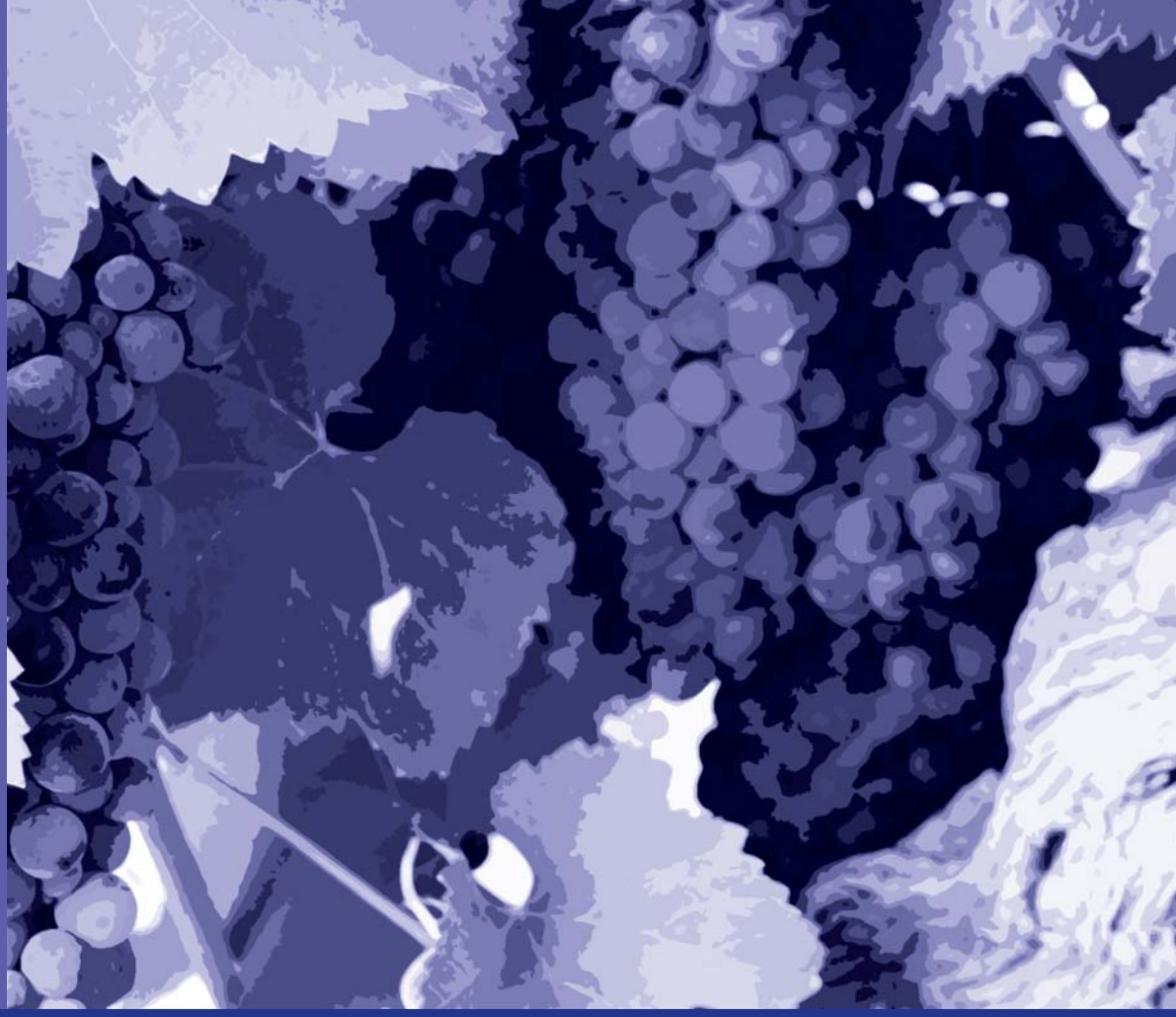

VITICARE ON FARM TRIALS

Manual 3.3 - Vine Health

Vine growth stage

Shoot growth

Pruning weight

Canopy density assessment

Petiole analysis

Measuring weed cover under vines

Botrytis assessment

Nematode assessment

Rust mite

Cooperative
Research Centre
for
Viticulture

Core Participants

About the CRCV

The Cooperative Research Centre for Viticulture is a joint venture between Australia's viticulture industry and leading research and education organisations. It promotes cooperative scientific research to accelerate quality viticultural management from vine to palate. Australian grapegrowers and winemakers are key stakeholders in the CRCV, contributing levies matched by the Commonwealth Government and invested by the Grape and Wine Research and Development Corporation in the Centre.

For more information about the CRCV, please visit www.crcv.com.au.

Disclaimer

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Introduction

Introduction

The Cooperative Research Centre for Viticulture has conducted On Farm Trials since 1999. The initial trials were conducted in eight regions (Port Phillip, North East Victoria, Central Victoria, Adelaide Hills, Riverland, South West Slopes, Riverina and Hunter Valley) and provided Australian growers with the ability to formally assess and validate new science and technology. The trials were conducted over four growing seasons and helped growers to solve problems in their vineyards and improve their management practices.

In 2004 the On Farm Trials project expanded to cover more than 20 viticultural trials primarily in the Riverina, Riverland and Sunraysia regions. Rather than focusing on individual grower issues, the CRCV team has worked with regional grower groups to determine regional issues. The trials are still conducted on a participant growers' property but a team of people are involved to learn from the trial and to share the workload.

This booklet is part of a series that draws on knowledge gained from this experience in developing and delivering On Farm Trials.

Conducting a trial in your vineyard is not easy and is not a decision that should be made lightly. Although trials can be an excellent method for refining management practices, improving quality or looking for solutions to problems, there are many practical considerations involved in conducting a trial.

On Farm Trials can lead to management improvements in a number of areas. The information in this booklet will guide you through the various protocols involved with setting up On Farm Trials that aim to look measure vine health by vine growth stage, shoot growth, pruning weight, canopy density assessment, petiole analysis, weed cover under vines, botrytis assessment, nematode assessment and rust mite.

Vine Growth Stage

Aim

This trial aims to measure vine health by assessment of vine growth stage.

Important Points to Know

It is critical to recognise the different vine growth stages as this affects the management of various pests and diseases, nutrition and irrigation. Likewise it is important to recognise that vineyard management can impact on the timing of growth stages. For example, spring pruning of spurs can delay bud burst and flowering compared to mid winter pruning. Likewise, water stress can shorten the interval from bud burst to flowering, and from flowering to véraison (McIntyre et al. 1982).

The degree of accuracy for measuring vine growth stage will depend on the system used. Many growers will simply use a general observation to give the time of certain vine growth stages, eg woolly bud. However, using the modified Eichhorn and Lorenz (E-L) system (Coombe 1995) to assess vine growth stages, a grower can more accurately define the timing of a vine growth stage. The modified E-L chart can be found below.

The major growth stages define by the modified E-L system that could be assessed are:

Stage	Modified E-L number	Description
Budburst	4	Green tip; first leaf tissue visible
Full bloom	23	17-20 leaves separated; 50% caps off
Veraison	35	Berries begin to colour and enlarge
Harvest	38	Berries harvest ripe

Before You Get Started

The following requirements will help you prepare for this trial:

- Modified E-L chart
- Recording sheet

Trial Timelines

Trial monitoring commences when the first evidence of the particular growth stage appears.

The time spent at each vine would is 1 minute to complete the count and assess if 50% of buds/shoots/bunches are at the measured stage. Consequently, this measurement would take approximately 1 hour. You may have to return to the block on 2-3 consecutive days to make an accurate measurement of the vine growth stage.

Trial Method

1. Two buds per cordon or cane are tagged and observed on two vines in each treatment plot. The buds should be the most apical on the spur (i.e. closest to spur end). For cane punned vines, use the 2nd and 3rd bud excluding the most basal bud.

2. Make regular observations and record the date of your observations and the number of buds/shoots/bunches within the treatment plot at each growth stage. Convert this number to a percentage of the total.

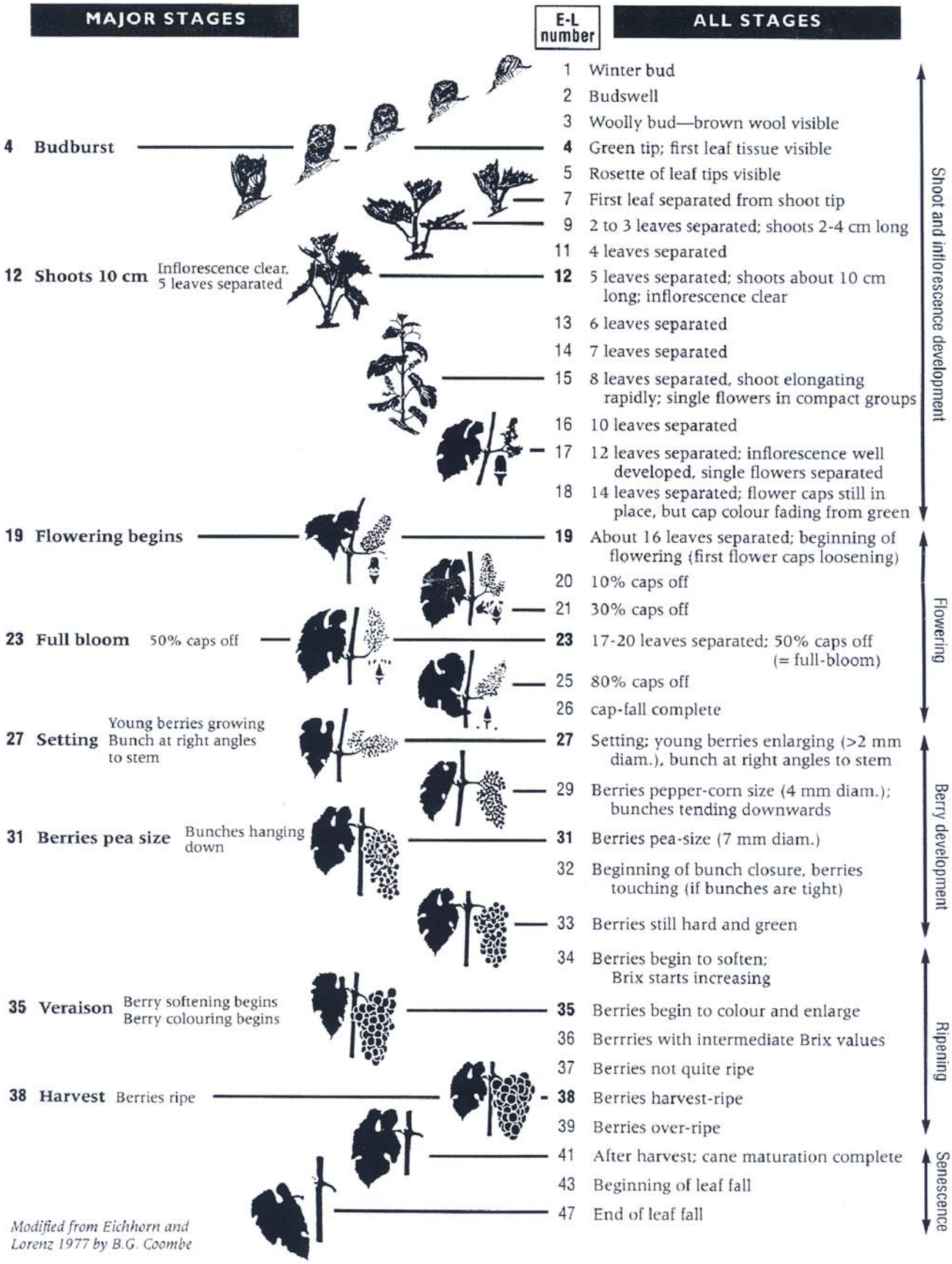
3. If the tagged shoot becomes vigorous or is weak, re-select a shoot that is more typical.

4. Note the dates when 50% of the tagged buds/shoots reach each of the growth stages. E.g. When 50% of buds (5 out of 10) are at growth stage E-L 4, this is recognised as the date of bud burst.

Example
An inflorescence has reached Stage 23 (full bloom) when 50% of the individual flowers have pushed off their caps. Therefore, the date recorded for this stage is when 50% of the flowers on the tagged buds have pushed their caps off.

At some stages, you will need to record observations every two or three days to pinpoint the date at which a particular developmental stage is reached.

Grapevine growth stages – The modified E-L system



Modified from Eichhorn and Lorenz 1977 by B.G. Coombe

Shoot Growth

Aim

This trial aims to assess vine health by assessment of vine shoot growth.

Important Points to Know

Shoots start to grow from budburst in early spring, drawing on the stored carbohydrate reserve, before there are sufficient leaves for photosynthesis to supply growth requirements. Shoots grow slowly at first because of the cool temperatures. This slow period of vegetative growth is followed by a massive spurt during late spring, termed the grand period of growth. Lateral shoots may also form at this time, adding to the general leafiness of the vine.

Shoot growth can help describe the formation of canopy leaf area and is a useful index of vine vigour. Shoot growth will be highly dependant on vine management, particularly irrigation and nutrition early in the season particularly during the grand period of growth.

Before You Get Started

The following requirements will help you prepare for this trial:

- Dressmakers
- Measuring tape
- Recording sheet
- Fluorescent flagging tape
- Marker pens

Trial Timelines

The timing of measurements is dependent on what results you would like to produce and how much time you have available.

a. Growth rate: if you are looking at the rate of shoot growth, measurements will have to be made every 1-2 weeks

b. Total growth: If you are interested in the total growth then it is possible to make just one measurement in the season, probably post harvest

c. Intermediate: Select critical times of the season when shoot growth may be important to measure eg flowering, veraison, pre-harvest and post harvest

The standards for assessing vigour from measurements of shoot growth have been developed for shoots just before harvest (see table below).

The time taken to measure and record the length and node number of six shoots should be approximately 10 minutes.

Trial Method

1. Select six shoots from the middle vines in each treatment plot (If there are 6 vines per plot then tag six randomly chosen shoots from the middle 4 vines). Tag these shoots with fluorescent flagging tape and number each shoot from 1 to 6 so shoots can be re-measured.

2. Select shoots on the basis of their developmental stage and appearance that is representative of the whole vine. Avoid particularly short, undeveloped shoots.

3. Measure the length of the tagged shoot from its base (where it joins onto the spur or cordon) to its tip.

4. Count the number of nodes from the base of the shoot (the first leaf that emerged at bud burst) to the tip (the most recent leaf that emerged and unfolded from the growing tip of the shoot).

5. Record identity of treatment plot and shoot, the length of the shoot and the number of nodes.

Trial Calculations

Mean shoot length (cm)	= sum of shoot length for six shoots / 6
Shoot growth rate (cm/week)	= current shoot length - previous shoot length / interval between measurements in weeks
Mean node number	= sum of nodes for six shoots / 6
Mean internode length (cm)	= Mean shoot length / Mean node number

Optimal values

It is difficult to define optimal values since these can vary greatly with variety and climate. The following table has been taken from Smart and Robinson (1991) for measurements taken just before harvest.

	Low Vigour	Moderate Vigour	High Vigour
Shoot length (cm)	50	100	>200
Shoot node number	<10	15-20	>25
Internode length (cm)	<5	6-8	>8

There are no ideal values for shoot growth rate as it is highly variable and can only be used to compare between different treatments or managements.

Pruning Weight

Aim

This trial aims to assess vine health by pruning weight.

Important Points to Know

Pruning weight gives a good indication of the vegetative growth of the vine during the season and is proportional to shoot length and the leaf area carried in that season. The calculation of mean cane weight (pruning weight/cane number) gives a useful indication of shoot vigour.

The measurement of pruning weight in relationship to yield is an informative measure of vine balance. The ratio of yield to pruning weight gives a good indication of the balance between the fruit and vegetative growth. Vineyards with high vigour have low yield pruning weight values and overcropped vines have high values.

If a vine is vigorous, hedging removes a certain amount of material, but the relative vigour remains. In other words, if it is vigorous when topped, it remains vigorous after it has been topped (short of some major event like the absence of water).

Before You Get Started

The following requirements will help you prepare for this trial:

- Secateurs
- Spring scales with hook or top loading portable field scales (that weigh items up to 20 kg and are accurate to 0.1 kg)
- Item to bundle canes together (string, bucket or hessian bag)

Trial Timelines

Pruning weights and cane number measurements should be carried out at pruning. Conduct pruning to company specification. When pruning treatment plots, ensure each vine is pruned to a similar bud number.

If a pre-pruner is used in the trial block it is important to hand-prune the measured vines before the pre-pruner has been through.

The time taken to prune, count and weigh canes from one vine will be approximately 20 minutes.

Trial Method

1. Hand-prune the middle vines in each treatment plot (eg. If there are 6 vines per plot then prune the middle 4 vines) according to company specification.
2. Remove and discard old wood from the current season's canes
3. Count pruned canes of the middle vines per treatment plot.
4. Do not count or weigh small canes less than 5 nodes.
5. Record the identity of the treatment plot and the number of canes.
6. Bundle canes together so that they can be easily weighed.
7. Record the treatment plot and the total pruning weight (kg) of the middle vines in the field using scales.

Trial Calculations

Mean cane weight (grams)= total pruning weight x 1000 / cane number

Pruning weight per vine (kg) = total pruning weight / number of vines pruned in each plot

Yield to pruning weight ratio = Yield per vine (kg) / Pruning weight per vine (kg)

Optimal values
From Smart and Robinson (1991).

	Low Vigour	Moderate Vigour	High Vigour
Mean cane weight (grams)	<10	20-40	>60
Yield to pruning weight ratio	>12	5-10	<3

Canopy Density Assessment

Aim

This trial aims to measure vine health by canopy density assessment.

Important Points to Know

The assessment of canopy density by the Point Quadrat method was developed by Dr Richard Smart (see Smart and Robinson 1991) as a measure of leaf and fruit exposure to the sun. A high degree of shading within a canopy can decrease bud fruitfulness, delay berry growth and ripening, reduce colour development, and encourage fungal diseases. Various management techniques can be used to improve canopy density including trellis and training systems, rootstock selection and irrigation.

Before You Get Started

The following requirements will help you prepare for this trial:

- Point quadrat: thin metal rod that can be made from a welding rod with a sharpened tip; 1 m long and 2 mm in diameter. The rod must be rigid.
- A guiding board. One metre wooded rulers with at least 10 cm increments work well.

Trial Timelines

The assessment should be carried out when the canopy is fully developed, usually between veraison and harvest

Approximately 200 insertions can be done per hour with two people; one recording while the other inserts the rod.

Trial Method

1. Insert the rod into the canopy at fruit zone level. Insert the rod horizontally for vertical canopies. For sloping canopies insert perpendicular to canopy wall. Insert the rod at random. Do not look at the canopy before inserting the rod.

2. Insert the rod through the entire canopy. If the canopy is too dense or large, insert the rod only half way. The calculations are modified when inserting half way.

3. Insert the rod 50 times per treatment plot using only the middle vines (eg. If there are 6 vines per plot, then randomly insert rod 50 times in the middle 4 vines). Inserted the rod into the canopy either randomly or at 10 cm intervals (using guiding board).

4. Record sequentially the parts touched by the rod while inserting it. When the rod passes through the canopy without touching bunches or leaves, it is recorded as a gap. Use the letters L for leaf, B for bunch and G for gap.

Recording data
Record " L" every time the rod touches a leaf, "B" for bunch and "G" for gap

Example:
- Insertion #1: first touch: leaf (L), second touch leaf (L), third touch cluster (C), etc.
- Insertion #2: gap (G), the rod touch nothing
- Insertion #3 …Continue for 50 insertions

The record sheet will look like this:

Vine number	Insertion number	Data
1	1	LLB
1	2	G

The first and the last L or B recorded are considered as exterior for calculation purposes

Trial Calculations

The calculations are based on 50 insertions through the whole canopy. Some adjustments are necessary when the insertions are done only through half the canopy.

- Percent gaps: total G divided by the number of insertion and multiply by 100 to obtain the percentage.
  Example: (10 gaps/ 50 insertions) x 100 = 20% gaps

- Leaf layer number (LLN): total leaves touched, L divided by the number of insertions
  Example: 75/50=1.5

- Percent interior leaves: Total leaves touched minus the first and last leaf touched at each insertion divided by the total number of leaves touched by the rod multiplied by 100 to obtain the percentage.
  Example: [(75 L - 68 exterior L)/75 L] x 100 = 9%

- Percent interior bunches: Total bunches touched minus the first and last bunches touched at each insertion divided by the total number of leaves touched by the rod multiplied by 100 to obtain the percentage.
  Example: [(20 - 15 exterior)/20] x 100 = 25%

Modifications when inserting rod from one side to the centre
Insert the rod 25 times on each side of the canopy, so that readings 1 to 25 are from one side and readings 26-50 are from the other side. To simplify calculating the data, have the column for readings 1 to 25 next to the column for readings 26 to 50. The first row of data will then contain readings 1 and 26.

- Percent gaps: total G divided by the number of insertion and multiply by 100 to obtain the percentage.
  Example: (10 gaps/ 50 insertions) x 100 = 20% gaps

- Leaf layer number (LLN): total leaves touched, L divided by the number of insertions
  Example: (75/25 + 62/25) =5.48

- Percent interior leaves: Total leaves touched minus the first leaf touched for readings 1 to 25 and the last leaf touched for readings 26 to 50 divided by the total number of leaves touched by the rod multiplied by 100 to obtain the percentage.
  Example: [(137 L - {30 +38 exterior L})/137 L] x 100 = 50%

- Percent interior bunches: Total bunches touched minus the first bunch touched for readings 1 to 25 and the last bunch touched for readings 26 to 50 divided by the total number of bunches touched by the rod multiplied by 100 to obtain the percentage.
  Example: [(38 - {11 + 8 exterior})/38] x 100 = 50%

Interpreting Results

Optimum values:
- Percent gaps should be 20-40%,
- LLn should be 1.0-1.5 or less,
- Percent interior leaves less than 10%,
- Percent interior bunches less than 40%

Petiole Analysis

Aim

This trial aims to measure vine health by petiole analysis.

Important Points to Know

The petiole is the stem of the leaf. Petioles have been found to be sensitive to the changes in nutritional status of the grapevine. Standards have been published for the concentration of nutrients in petioles at flowering when inflorescences have discarded 80% of their caps (E-L stage 25, Coombe (1995) - refer to the measurement technique in this series - vine growth stage).

Before You Get Started

The following requirements will help you prepare for this trial:

- Paper bags with labels
- Razor blade or sharp knife
- Instructions from laboratory

Trial Timelines

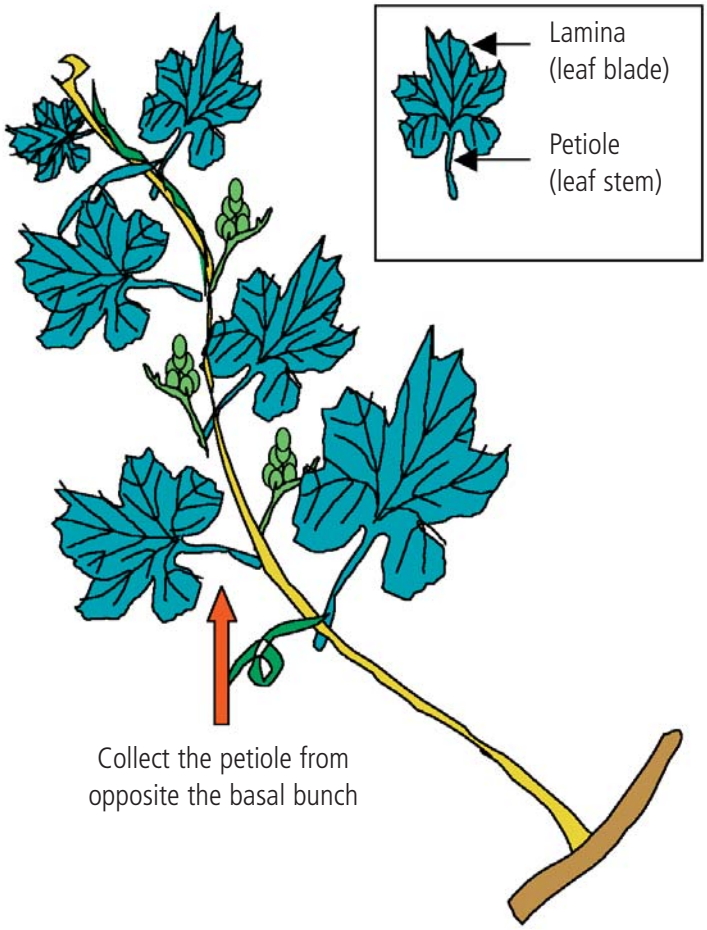
Petioles are sampled once per season. The sample is collected at 80% cap-fall.

As a conservative estimate, allow 10 minutes per treatment plot (i.e. 30 petioles).

Trial Method

No 'one' part of the vine, or 'one' collection method will provide you with all the answers to the vine nutrient status, however, as a comparison of treatments, petiole sampling will provide you with a suitable way to compare vine nutrient status.

The petiole should be collected from a leaf opposite the basal bunch at flowering (80% cap-fall).



How many samples do I take?
When determining the number of samples that should be sent to the laboratory for analysis, or the number of analyses that you carry out, there is always a balance between the time, cost and statistical accuracy.

Method 1:
Most statistically accurate, most time and cost
Take 30 petiole samples from the middle vines of each treatment plot and send those individual samples to the laboratory (e.g. If there are 6 vines per treatment plot, select samples from the middle 4 vines).

For example, if you have a trial that had 2 treatments replicated 4 times, giving a total number of 8 treatment plots then you would send 8 samples for analysis.

Method 2:
Less accurate, minimal time and cost
Take 30 petiole samples from the middle vines of each treatment plot, and then group the same treatments together from all replicates. In the example above this will reduce the number of samples for analysis down to 2.

Handling and sending samples

1. Place petioles into paper bags
2. Label sample bags and fill in laboratory forms
3. Check with laboratory to make sure sample(s) can legally be sent. If you are within a Phylloxera Risk Zone (PRZ) or Phylloxera Infested Zone (PIZ) then consult the National Phylloxera Management Protocol (http://www.phylloxera.org.au/regulation/preventionprotocol.html) before sending samples
4. Do not send samples at the end of the week. Store in a refrigerator and post at the beginning of the following week

Analysis

The analysis of plant nutrient status will have to be carried out in a laboratory. [For example in Victoria, State Chemistry Laboratory, Cnr. Sneydes & South Rds, Werribee, Vic, 3030. Ph. (03) 9742 8755]

Optimal values

Table 1 was taken from Goldspink (2000). It was developed from initial research in California on Sultana, and modified by trials in Eastern and Western Australia.

Note: The data in the table only relates to petioles collected opposite the basal bunch at flowering.

Table 1: Petiole analysis guide for diagnosing the nutrient status of the vine (Goldspink 2000)

Nutrient	Petiole Concentration	
Total nitrogen	<0.7%	Deficient
	0.7-0.89%	Low to marginal
	0.9-1.2%	Adequate
	>1.2%	Excessive
Nitrate Nitrogen	<600mg/kg	Deficient
	600-1500mg/kg	Adequate
	1500-2500mg/kg	High
	>2500mg/kg	Excessive
Phosphorus	<0.15%	Extremely deficient
	0.15-0.19%	Deficient
	0.2-0.29%	Low to marginal
	0.3-0.49%	Adequate
	>0.5%	Excessive
Phosphorus (Pinot Noir only)	<0.12%	Extremely deficient
	0.12-0.14%	Deficient
	0.15-0.19%	Low to marginal
	0.2-0.39%	Adequate
	0.40%	Excessive
Potassium (adequate nitrogen)	<0.79%	Deficient
	0.8-0.99%	Low
	1.0-1.29%	Marginal
	1.3-2.99%	Adequate
	>3.0%	Excessive
Calcium	<1.2%	Deficient
	1.2-2.5%	Adequate
Magnesium	>0.4%	Adequate
Sodium	>0.5%	Excessive
Copper	<3mg/kg	Deficient
	3-6mg/kg	Low to marginal
	>6mg/kg	Adequate
Zinc	<15mg/kg	Deficient
	15-25mg/kg	Low to marginal
	>25mg/kg	Adequate
Manganese	<25mg/kg	Deficient
	25-500mg/kg	Adequate
	>500mg/kg	High
Boron	<25mg/kg	Deficient
	25-30mg/kg	Low to marginal
	30-70mg/kg	Adequate
	70-100mg/kg	High
	>100mg/kg	Toxic
Chloride	>1.0%	Toxic

Measuring Weed Cover Under Vines

Aim

This trial aims to assess vine health by measuring weed cover under vines.

Important Points to Know

A plant is a weed if it is growing where it isn't wanted and it creates a problem for grape production. Weeds compete for water and nutrients, and when vines are young, for light. Many weed species can host populations of pests and diseases, which may attack or infest vines, and some species encourage nematodes. If very large, prickly or noxious, they can obscure access by vineyard workers for monitoring and harvesting activities, or foul machinery.

Weeds are often annual species that grow vigorously, occur in large numbers and spread rapidly. They can be any plant type (succulent, broadleaf, ground cover, grass, herb, vine, woody shrub or tree).

Many weeds are very hardy and advantaged by disturbance to soils, changes in light levels and moisture availability. They therefore, make efficient colonisers under and between vine rows.

Why is it important to measure weed cover?
Under vine management will impact on weed species and populations. Practices such as mulching, growing an inter-row and/or under vine cover crop or cultivation will influence weed species and populations. Weed populations can be modified as some weed species develop herbicide resistance.

Measuring weed cover, as part of particular On Farm Trials (OFT) will help determine which, if any, weed management is needed. How much impact weeds have on your grape production will determine whether or not to apply control measures or to investigate other methods as part of an OFT.

When monitoring weed cover as part of an OFT it is wise to maintain an inventory of existing weeds and results of control measures from season to season, as some weed management needs to be undertaken over the long term. This will also indicate what weeds have 'escaped' the management strategy.

Before You Get Started

The following requirements will help you prepare for this trial:

- Pasture square (usually 0.1m2) or metal grid (eg. concrete re-enforcement)
- Recording sheet

Trial Timelines

You should monitor in spring and autumn, when weeds are the biggest problem. If you are measuring reductions in herbicide use in an OFT, you should monitor just before herbicide application.

In a trial, you may not need to apply your standard weed control protocol to every plot. You should take note of any changes in your standard protocol (including time and resources). This will help if you want to quantify (in terms of dollars) the difference between the treatments.

However, for managing your trial efficiently, it may be easier to apply your standard weed control protocol to the whole trial area (if you usually spray once in spring and once in autumn with glyphosate, do this to the whole trial area). Before applying the herbicide, you should walk through the trial and, for each treatment plot, assess the weed cover.

The time to estimate the weed cover 3 times in a treatment plot will take approximately 5-10 minutes.

Trial Method

The two ways of measuring weed cover are 'eyeballing' and using a grid.

'Eyeballing'
For each treatment plot, look on the ground and estimate the percentage of the ground that is covered by weeds. If the weeds are sparse, try to visualise how much area they would take up if they were all next to each other.

Using a 'Grid'
This method is more accurate than the 'eyeballing' method. Place a grid or quadrat on the ground in a random position within the treatment plot (Figure 1). The grid will usually be made from strips of aluminium or steel welded into a rectangular shape. One piece of concreting re-enforcement mesh is ideal. The inside of the quadrat should be divided into equal segments (e.g. 4 or 8) to make it easier to estimate how much of the ground is covered by weeds (Figure 1).

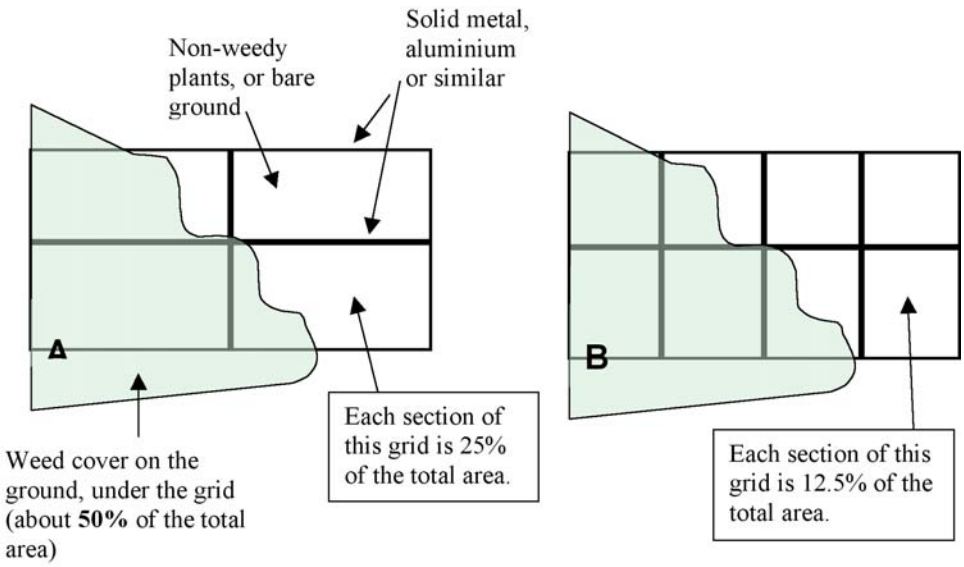


Figure 1: Two possible grid designs for measuring weed cover between vines. A: Divided into 4 sections, each section is 25% of the total area. B: Divided into 8 sections, each section is 12.5% of the total area.

How many samples should I take?

The number of measurements to take within a treatment plot will depend on the size of the plot. However, for weed cover, you should take no less than 3 samples per plot.

For example, if your treatment plot is one panel (~8m long) then you'll need to take 3 samples in each panel. Take your measurements between the vines in the middle of the panel. For example, if there were 4 vines in a panel, you'd take your measurements between the 1st and 2rd vines, the 2rd and 3rd vines, the 3rd and 4th vines. (see Fig. 2).

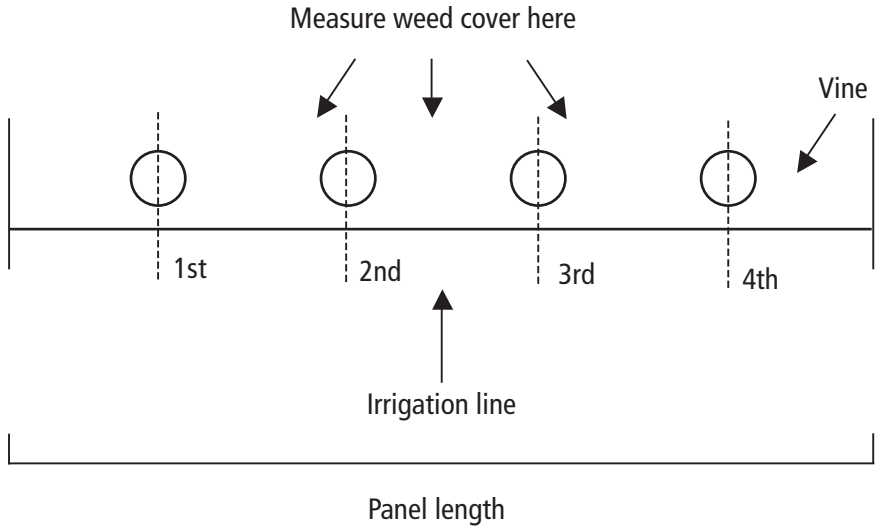


Figure 2: Example of weed cover protocol (if one panel is one plot in the trial design).

The grid will need to fit in the area you're going to measure under the vines. Up to 0.5m2 (eg. 100 cm x 50 cm) would be suitable in most situations. To reduce error, it would be best if the same person carried out all the measurements at each assessment. This reduces 'human' error, as each person's estimation may be slightly different.

Trial Calculations

The most effective treatments will be:

- The treatment with the least percentage of ground covered by weeds
- The treatment where you used the least amount of herbicide (or other method of weed control)

Your results may be clearer if you graph them (Fig. 3). This may help you to compare the results from different treatments.

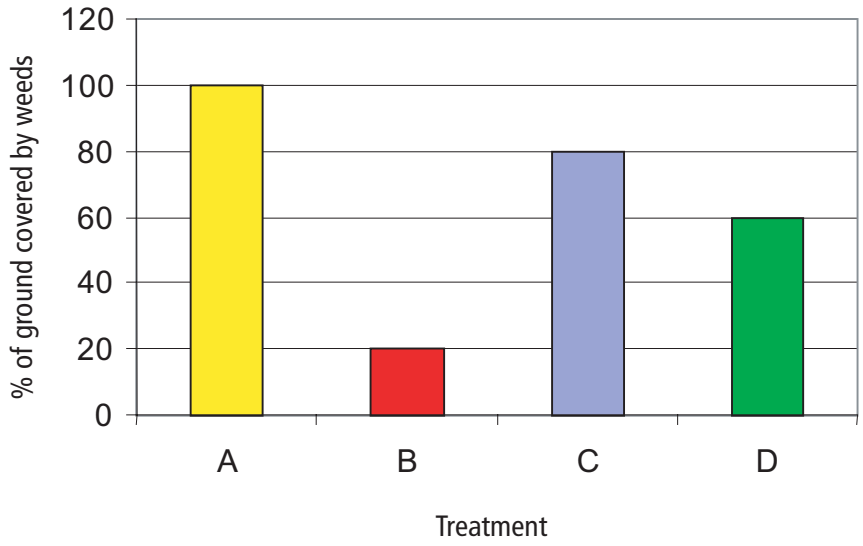


Figure 3: Graphing the percentage of the ground covered by weeds (vertical axes), against the treatment (horizontal axes).

Your management strategy will also depend on the type of weed present, rather than just the weed cover on the ground. For example, 50% cover by clover may not require management, but 50% cover by thistles would need some attention. If you would like to take note of the type of weed, some useful books are listed in the references at the end of this booklet. The relative amount of each weed species can also be estimated using the grid method.

Botrytis Assessment

Aim

This trial aims to measure vine health by botrytis assessment at harvest.

Important Points to Know

The fungal disease Botrytis rot or grey mould, Botrytis cinerea, is wide spread, although less common in dry inland winegrape vineyards of Australia. Generally, grapes infected with botrytis rot are undesirable for winemaking.

Berries with slippery skin and bunches with grey mouldy growth are the most obvious symptoms of Botrytis.

Bunch rots other than Botrytis have become increasingly significant in warm-climate vineyards. Colletotrichum sp. and Greenaria sp. appear to be the most common fungi isolated, and are undesirable for winemaking. Identification of bunch rots other than Botrytis is critical in determining a spray program. This protocol can be adapted for bunch rots other than Botrytis.

Before You Get Started

The following requirements will help you prepare for this trial:

- Assessment key
- Recording sheet

Trial Timelines

The assessment of Botrytis (and other rots) using the assessment key should be carried out at harvest. For assessment of Botrytis incidence at other growth stages, different techniques are required.

Trial Method

1. Select at least 10 bunches from each treatment plot.
2. Select the bunches from the middle two vines of the treatment plot, from both sides of the canopy, and from the top, middle and bottom areas of the canopy.
3. Take the bunch in hand, rotate it and look for disease symptoms.
4. Assess the side of the bunch that has the average level of disease for the bunch.
5. Assess the level of bunch rots with the assessment key below.

Trial Calculations

Bunch rot infections are assessed as severity and incidence. Severity identifies the average amount of infection on a bunch, while incidence is a measure of the number of bunches infected as a percentage of the total bunches assessed. Use the equations below to calculate the severity and incidence of bunch rots for each treatment. To do this, first replace the category number with the mean score (see table below), if category, not percent area of bunch infected, was recorded in the field (for example, if the category number was 3, the mean score is 4.5).

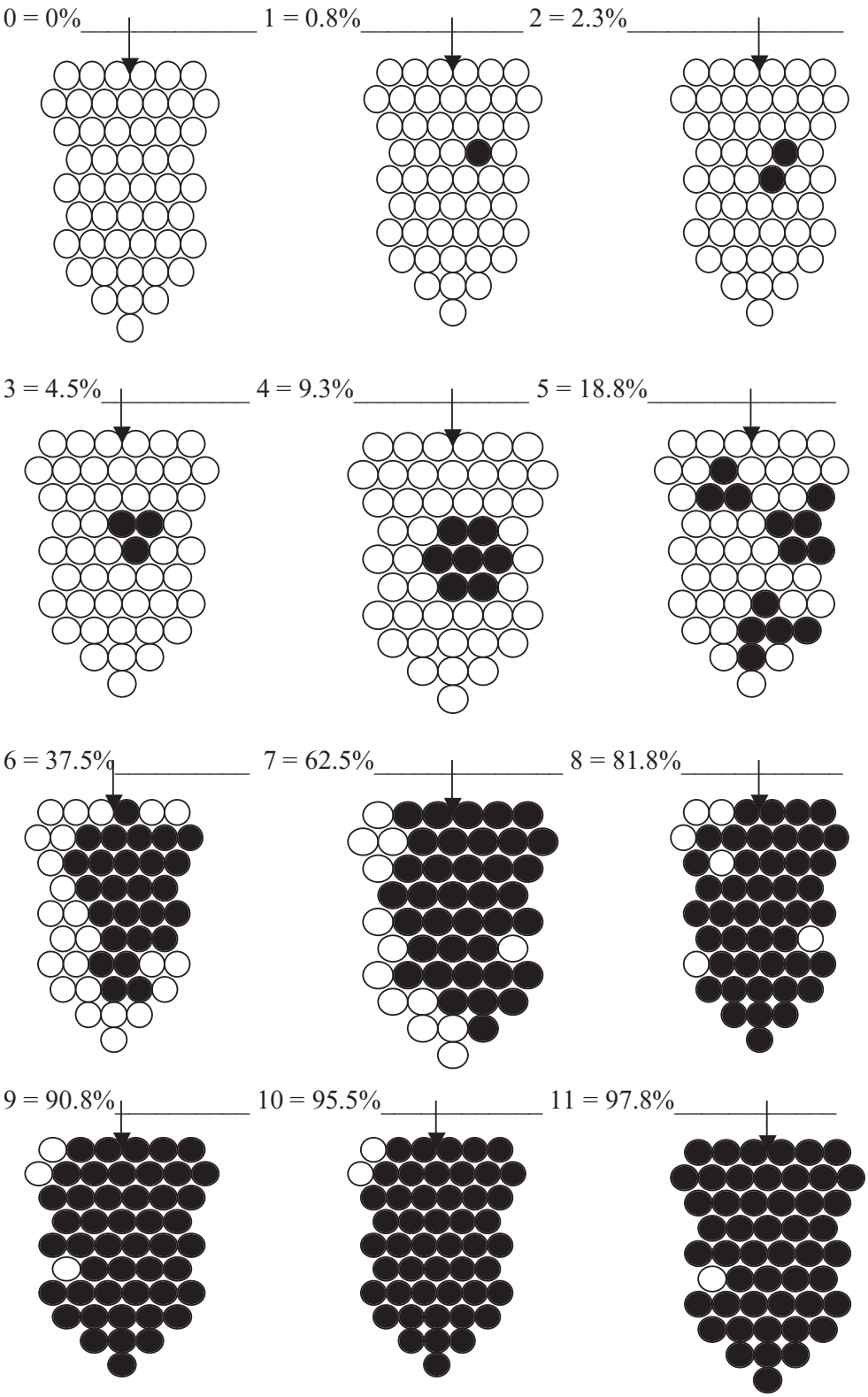
Compare the severity and incidence of infection with vines under other management treatments.

Severity
= Sum of mean scores ÷ number of bunches assessed

Incidence
= Number of bunches with severity > 0 ÷ number of bunches assessed

Category	Mean Score(% area diseased)
0	0
1	0.8
2	2.3
3	4.5
4	9.3
5	18.8
6	37.5
7	62.5
8	81.3
9	90.8
10	95.5
11	97.8
12	99.3
13	100

Botrytis Assessment Key



Note: Shaded area on diagrams represents diseased area (category = % area diseased).

Nematode Assessment

Aim

This trial aims to measure vine health by assessment of nematodes.

Important Points to Know

Nematodes, also known as eelworms, are mostly microscopic in size and have translucent, slender, wormlike bodies that taper toward the head and tail (McKenry 1992). They are hard to see with the naked eye, but can be extracted from the soil using specialised techniques. Plant-parasitic nematodes feed on plant roots and can decrease their production substantially (Rhaman et al. 2000).

Therefore, it is important that nematode pressure is assessed pre-planting, and also when management inadvertently promotes the lifecycle of nematodes (Quader et al. 2001). Legume cover crops are ideal hosts for nematodes, whilst others can provide a biofumigant effect (refer to trial protocol 'Pathogenic Nematode Management').

Before You Get Started

The following requirements will help you prepare for this trial:

- Shovel
- Bucket
- Plastic bags

Trial Timelines

Conduct the trial from spring to winter, when there is an active host present.
A minimum of 10 minutes to collect each sample is required.

Trial Method

1. Sample when soil is humid but not too damp, preferably after rain or irrigation.
2. Discard the surface soil to minimise the influence of dried topsoil, weeds and cover crop.
3. Collect three soil samples from the middle vines from each treatment plot at 30 50 cm from the trunk, at 10-30 cm depth.
4. For each treatment plot, alternate the side of the vine from which samples are collected.
5. Approximately 1kg of soil is necessary from each treatment plot. Each sample must contain soil and/or feeder roots.
6. Place each sample in a separate labelled bag and tie off.

Store bags in a cool place until they can be sent to a recognised nematological testing service. All soil and/or root samples need to be assessed as soon as possible after collection.

For a recognised nematological testing service in Victoria contact:

Crop Health Services
Institute for Horticultural Development

Postal address
Private Bag 15
Scoresby Business Centre
Victoria Australia 3176

Location Address
621 Burwood Highway
Knoxfield Victoria 3180
Telephone (03) 9210 9356
Facsimile (03) 9800 3521
Email: Lila.Nambiar@nre.vic.gov.au
www.nre.vic.gov.au/agvic/ihd/services/chs.htm

Rust Mite

Aim

This trial aims to measure vine health by assessment of rust mite damage in spring.

Important Points to Know

The grapevine rust mite is specific to grapevines. It is found throughout the grape growing regions of the world, including Australia and New Zealand. It was first reported to be associated with grapevine abnormalities in 1906 in Europe. It is a microscopic pest 0.2-mm in length, too small to be seen with the naked eye. Rust mites feed on the upper and lower surface of grapevine leaves from spring to mid-late summer, causing the typical late summer foliage bronzing. In early spring they migrate from winter shelters to the swelling buds and give rise to the first generation of the new growing season. For this reason it is recommended that sprays be applied at woolly bud stage (Bernard et al. 2001).

Trial Timelines

Assessments should be carried out at 5 leaves separated, shoots at 10cm (E-L growth stage 12 when inflorescences are clear).

Trial Method

1. Sample at 5 leaves separated; shoots about 10 cm in length; inflorescence clear (Growth stage 12, Coombes, 1995).
2. Assess 25 shoots per treatment replicate.
3. Score each shoot based upon the visual symptoms of rust mite damage (0, 1 or 2 as identified in the below diagram)

Visual Appearance

Flat and smooth	Some distortion	Crinkled and
		
		
		
Score 0	Score 1	Score 2

Visual Score

Resources

Some useful resources for evaluating vine growth stage

Coombe, B.G. (1995) Adoption of a system for identifying grapevine growth stages. Australian Journal of Grape and Wine Research. 1(2), 104-110.
McIntyre, G.N., Lider, L.A., Ferrari, N.L. (1982) The chronological classification of grapevine phenology. American Journal of Enology and Viticulture. 33, 80-85.

Some useful resources for evaluating shoot growth

Smart, R. and Robinson, M. (1991) Sunlight into Wine: A handbook for winegrape canopy management. (Winetitles: Adelaide, Australia).

Some useful resources for evaluating pruning weight

Smart, R. and Robinson, M. (1991) Sunlight into Wine: A handbook for winegrape canopy management. (Winetitles: Adelaide, Australia)
Some useful resources for canopy density assessment

Smart, R. and Robinson, M. (1991) Sunlight into Wine: a handbook for winegrape canopy management. (Winetitles. Adelaide Australia)

Some useful resources for petiole analysis

Goldspink B.H. (2000) Assessing the vine nutrient status. In: 'Fertilisers for wine grapes: An information package to promote efficient fertiliser practices.' 3rd Edn. Eds, B.H Goldspink and K.M. Howes (Chief Exectuive Officer of Department of Agriculture: Western Australia) pp 12.1 - 12.19.

Some useful resources for measuring weed cover under vines

Felfoldi, E. (1993) Identifying the weeds around you. (Department of Agriculture Victoria: Melbourne).
Lamp, C., and Collet, F. (1989) Weeds in Australia. 3rd Edn. (Inkata Press Pty Ltd: Melbourne.)
Wilking, J.L., Barnett, A.G., and Amor, R L. (1986) Crop Weeds. Victorian Crops Research Institute. (Inkata Press Pty Ltd: Melbourne

Resources

Some useful resources for nematode assessment

Quader, M., Riley, I.T. and Walker, G.E. (2001). Distribution pattern of root-knot nematodes (Meloidogyne spp.) in South Australian vineyards. Australian Plant Pathology 30, 357-360.

Rhaman, L., Somers, T. and Creecy, H. (2000). Distribution of nematodes in vineyards and relationship of root knot nematode (Meloidogyne spp.) to vine growth and yield. The Australian Grapegrower and Winemaker, Annual Technical issue 2000, pp 53-57.

McKenry, M.V. (1992) Nematodes. In: Grape Pest Management, Second Edition. Eds D.L. Flaherty, L.P. Christensen, W.T. Lanini, J.J. Marois, P.A. Philips and L.T. Wilson (University of California: Oakland), pp 281-293.

Some useful resources for evaluating rust mite

Bernard M., Horne P. and Hoffmann A. 2001. Preventing restricted spring growth. The Australian Grpaegrower and Winemaker 452: 16 - 22; 453: 26.