2

VITICARE ON FARM TRIALS

Manual 2.2 - Improving Soils 2

Managing soil moisture using mulches
Managing soil using cover crops

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 can help manage soil moisture using mulches and managing competition with cover crops.

Managing Soil Moisture Using Mulches

Aims

This trial aims to evaluate alternative vineyard floor treatments for:

- Managing soil moisture
- Managing weed cover
- Improving soil structure, pH, nutrients, etc
- Reducing herbicide usage
- Converting to organic growing
- Improving vineyard environment
- Using irrigation water more efficiently

Important Points to Know

Mulches conserve soil water by shading the soil surface and reducing evaporation. Mulches are placed on the soil surface, and can be made from cover crops, volunteer weeds, plastic and other inorganic materials. However, the most common and readily available type of mulch is baled straw or hay. Recently, compost has been promoted as another effective mulch alternative. Mulches are usually placed under vine and sometimes in the inter row.

- Sites at risk of water-logging should not be covered by mulches
- Mulches and cover crops should be avoided in frost prone areas
- Mulching is particularly beneficial where soil water reserves are limiting vine vigour and/or crop yields. Mulches are most effective in hot, dry climates and non irrigated settings, but may also be useful where it is necessary to limit the use of irrigation water because of lack of supply or where water quality is an issue. In addition, the use of mulches under young vines can be beneficial in maximising vigour and achieving an earlier first harvest.

Positive and Negative Aspects

It is important to determine the risks associated with vineyard floor treatments at the proposed site. These risks must be weighed up against the potential benefits that a particular treatment may impart. Some risks may preclude trialing treatments on a particular site (eg: mulches on soils at risk of water-logging). At other sites, it may be sufficient to monitor a potential risk and have a contingency plan in place to deal with it if it occurs. The advantages and disadvantages of mulch application are listed below. These may be used as a guide to risks that may develop.

Advantages include:

- Conserves soil moisture;
- Reduces irrigation requirements;
- Controls weeds;
- Reduces need for herbicides;
- Adds organic matter to soil (for organic mulches);
- Improves soil structure and soil biological activity;
- Moderates soil temperatures (ie less extremes between highs and lows);
- Improves grape yields;
- Improves infiltration and reduces possibility of erosion; and
- Can provide nutrients for crop growth.

Disadvantages include:

- Can harbour pests such as crickets;
- Increases vine vigour;
- Can increase frost risk in frost-prone areas;
- Can increase risk of fires until mulch consolidates; and
- Can result in a nitrogen deficit in the first year.

In light of these advantages and disadvantages, some questions worth considering are:

- Which risks are important at your site?
- Which risks would not prevent the trial proceeding but should be monitored?
- What plans need to be put in place to reduce the impact of any risks occurring?

Cost Benefit Analysis

In order to determine the financial viability of a mulching program, a cost/benefit analysis should be completed, to relate the monetary requirement of mulching to a production basis. However, it must also be remembered that by increasing soil pH the soil is being protected from degradation and measurements of soil loss over the longer period will justify the commitment to soil protection through a mulching program.

Before You Get Started

The following points will help you prepare for this trial:

- Organise mulch and labour for mulch application;
- Have a slasher that throws mulch under the vines;
- If cover crop is to be used, fertiliser will be required for its establishment;
- A seeder will be required to sow the cover crop; and
- Know how to use and install soil moisture monitoring equipment.

Site Suitability

One or more of the following site characteristics will make your site highly suitable for conducting a vineyard floor trial.

Climate:

- Low frost risk
- Extremes in temperature during growing season

Water/Irrigation:

- Insufficient water supply
- Declining quality of irrigation water
- Declining performance of irrigation system
- High rates of surface evaporation
- Poor infiltration of water into soil

Vines:

- Young vines slow to establish
- Poor vine vigour

Potential Treatments

1) Bare soil: involves keeping the soil free from all vegetation, except for the vines. The advantage of this approach is that it minimises the risk of frost. Bare soil may not be the favoured approach in areas where soil moisture is limiting. Bare soil can also result in higher risks of erosion, waterlogging and poorer root growth due to a reduction in soil organic matter over time.

2) Baled straw or hay: the most common straw or hay used is wheaten or oaten hay. The main advantages of baled straw are its relative abundance and the availability of machinery and experienced contractors to apply it under-vine. This type of mulch usually has a relatively high carbon to nitrogen ratio, which increases the chances of causing a nitrogen deficiency in the first year. In addition, straw tends to collect in machinery and is highly combustible.

3) Cover crops: can be purposefully sown in the inter-row for use as mulches when mown and thrown under-vine. They can be grasses, legumes or mixed species. Advantages of cover crops include increased organic matter, higher nutrient levels, better water infiltration and drainage, improved vineyard environment and suppressed volunteer weed growth. Some disadvantages include increased competition between the crop and vine for water, they may harbour pests and diseases, and can increase the risk of frost damage (CRCV 1999)

4) Plastic film: can also be used under vine, but mainly for weed control. It has been found to be particularly useful in accelerating vine growth in new plantings. Disposal of plastic film can be a major problem.

5) Volunteer weeds: can protect the soil surface and provide organic matter without adversely affecting vine growth or crop yields. These weeds can act as a 'living mulch' or can be mown and thrown under vine. The success of this strategy depends on finding a balance between weed control and maintaining adequate soil mulch cover. The types of weeds present are a major consideration because some can harbour pests and diseases of the grapevine.

6) Composted mulches: are becoming increasingly available as an alternative-mulching product. The most suitable type of composted mulch is made from green waste (eg: garden prunings, leaves and grass clippings). This material is shredded and composted under controlled conditions to eliminate plant pathogens and weed seeds. These composts are a valuable source of stabilised organic matter that can be used as mulch or incorporated into the soil at planting. Care should be taken to select a compost produced according to the Australian Standard for Composts, Soil Conditioners and Mulches (AS 4454-1999) to ensure that it is safe to use and free of contaminants. Apply to a depth of 5 cm in a 0.5-m bandwidth under the vine. Applying compost too thickly (> 10 cm) can be counter productive because it can prevent the free movement of water through the mulch into the soil.

Measurements and Monitoring

There are numerous measurements that are applicable to a mulch application trial. Unfortunately there is no single set of measurements that are applicable to all trials. The correct measurements can only be selected once the trial's objectives have been clearly defined. Following is a list of potential measurements.

The following table includes potential measurements for this type of trial, their time involvement and difficulty.

Measurements	Time*	Difficulty*
Plant/soil nutrient status	1	C
Vine vigour/shoot length	3	A
Soil temperature	1	A
Daily evaporation and rainfall	1	A/B
Soil moisture/infiltration	2	B/C
Weed incidence	1	A/B
Baumé	1	A
pH	1	B
Titratable acidity	1	C
Colour	2	C
Root density	1/2	A/B
Disease visual assessment	1	A
Yield	2	A
Earthworms	1	A
Soil biology/organic matter	1	C
Soil sample	1	A
Vine growth stages (phenology)	1	A

**Time is where 1 = few minutes per replicate, 2 = 15 minutes per replicate, 3 = >30 minutes per replicate; Difficulty is where A = easy, no laboratory skills and/or measurement equipment required, B = some laboratory skills and/or measurement equipment required, and C = laboratory skills and/or sophisticated measurement equipment required. Refer to complete Table 2.2 in Section #2: Trial Design and Variability.*

Trial Timelines

Trials involving mulches should be run for a minimum of three years. The impact of increasing soil organic matter with the addition of mulches, for example, is difficult to measure in short term trials. In addition, the initial high cost of mulch application may be justified by showing benefits occurring for successive seasons after a single application in the first year. In general, mulches should remain effective for at least three years.

Mulches can be applied in spring or autumn and cover crops are usually sown in autumn. The time required to carry out the treatments e.g. mulch application would be approximately one day. The time required for taking soil samples and other soil measurements would be approximately 0.5 day per week per measurements. Also take into account 0.5 day for shoot length and pruning weights. The time required for measurements at harvest would be approximately 0.5 day for bunch sampling for quality parameters.

Shaded areas in the following table indicate when measurements or samples suggested above are to be taken. See the measurement manual in this series for more information about measurement protocols.

	Dormancy	Bud burst	Shoots 10 cm	Flowering	50% capfall	Berry set	Berries pea-size	Bunch closure	Veraison	Harvest	Post-harvesty
Trunk size											
Shoot length											
Pruning weights											
Petiole analysis											
Weed cover											
Soil sample											
Soil OM											
Soil pH											
Soil structure											
Infiltration											
Soil Salinity											
Soil moisture											
Earthworms											
Root											
Grape yield											
pH											
Baumé											
Titratable acidity											
Colour											

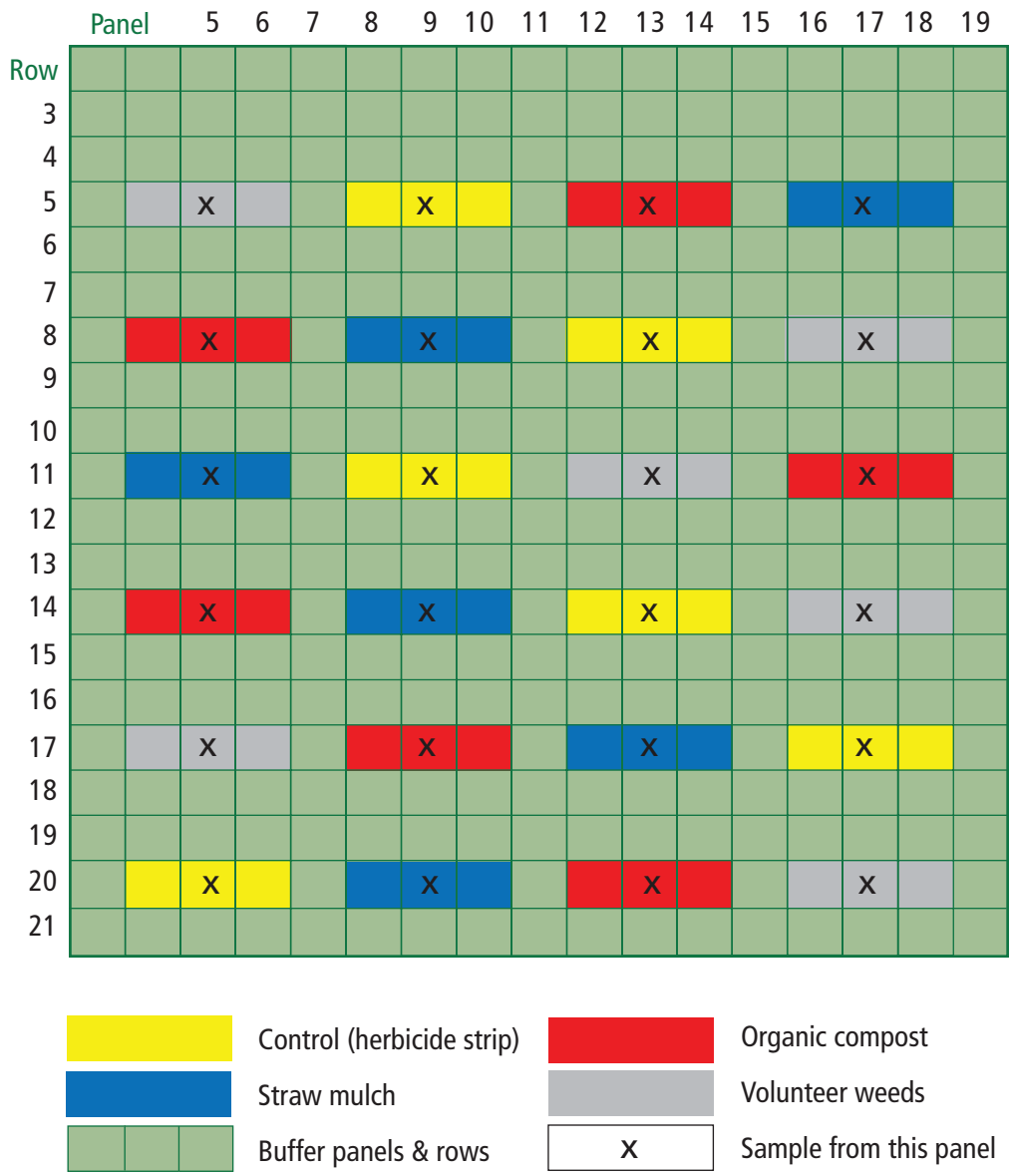
Mulching Trial Designs

Treatments will need to be replicated within the trial area at least six to eight times, more if the area is not very uniform. One of the treatments should be a control, which will often be current practice. It is advised not to have more than three or four treatments, to allow enough time for management of the trial.

Plots (or experimental units) can be different shapes and sizes, but a common plot in a mulching trial consists of three rows by three panels of vines. The middle panel is used for taking measurements (for example, Row 5 Panel 5).

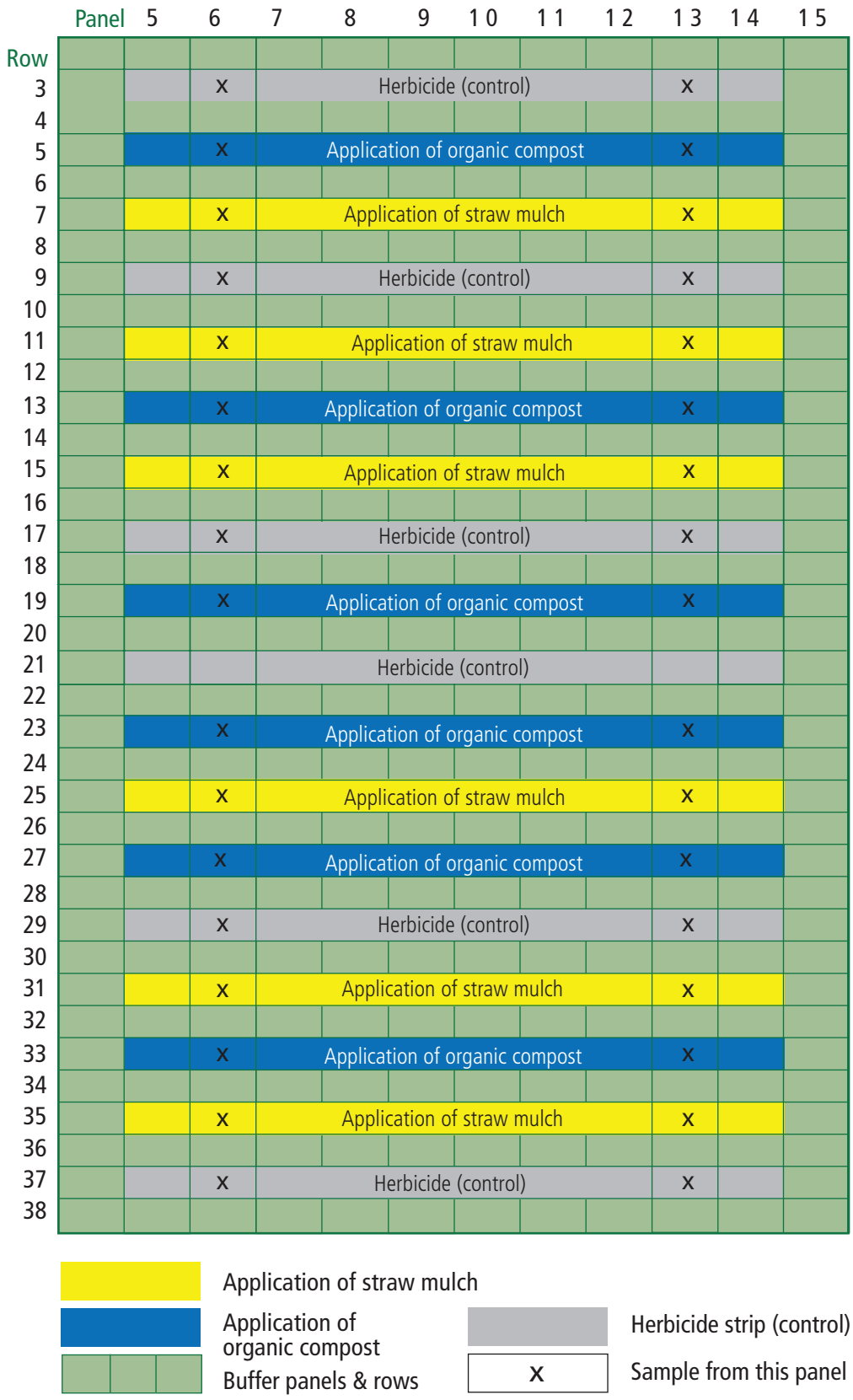
Buffering is important to identify clear treatment areas and to avoid contamination between treatment areas. Buffer zones are marked as panels with grid-lines in the following designs.

Design 1: An example of a randomised block design that could be used to test different mulches (for example, straw mulch and organic compost).



Design 1 gives an example of a trial layout in which the treatments are three different mulches plus a control (herbicide strip). The trial has four treatments and six replications, arranged in a randomised block design, with the blocks being rows (or, more strictly, groups of three adjacent rows).

Design 2: An example of a trial design to test different mulches (for example, straw mulch, organic compost) using rows as experimental units.



Design 2 gives an example of a trial layout in which the treatments are two different mulches plus a control. It uses rows as experimental units as opposed to panels. This can make management of the trial (i.e. mulch application) a little easier.

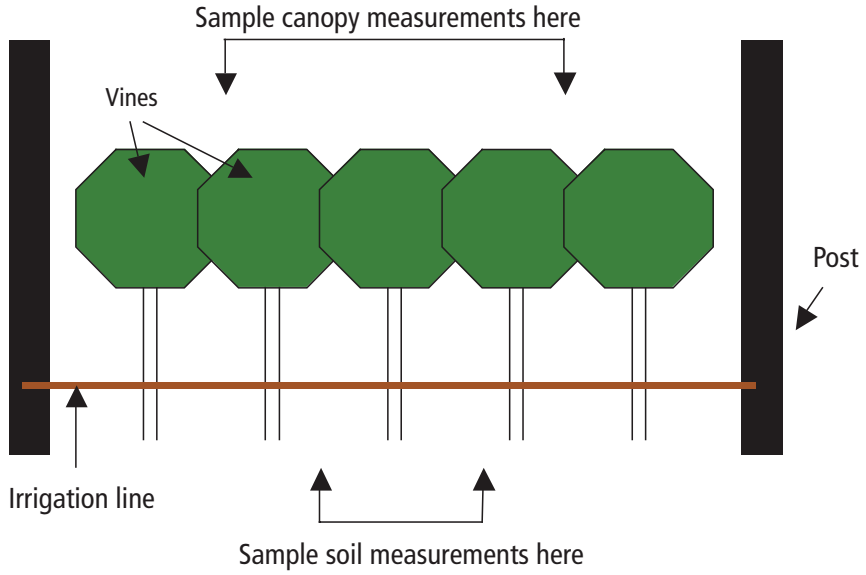
When using rows as experimental units, it is normally anticipated that a maximum of three treatments are trialed due to the potential workload expected. This trial has three treatments and six replications, again arranged in a randomised block design, with the blocks being groups of three adjacent experimental units.

It is recommended to only sample the middle vine in panels marked with an X (Designs 1 and 2) when taking vine measurements. If there are more than three vines per panel, only sample from the middle vines of the panels mentioned above (see Figure 1).

When taking soil measurements always sample from between two vines in the middle of each middle panel.

These recommendations will ensure that there is no contamination between plots; in some situations they may be waived provided that contamination is not a possibility. The approach described here also guarantees objectivity in the sampling, which will prevent the experimenter's bias from jeopardizing the results.

Figure 1: A diagrammatic explanation of where, within a panel, measurements can be taken.



Managing Competition With Cover Crops

Aims

This trial aims to manage competition with cover crops by:

- Evaluating alternative vineyard treatments for managing competition under the vine
- Controlling and reducing the canopy vigour while retaining yields and fruit quality to appropriate levels
- Reducing herbicide usage
- Converting to organic growing
- Improving vineyard environment
- Using irrigation water more efficiently

Important Points to Know

Cover crops include sown plant species used singly or in a mixture. In viticulture, cover crops can be used for the control of the vigour of the vine and in irrigation and soil fertility management.

Not all species make beneficial cover crops. Thus, it is important to choose the species and variety that best suits the particular site and management program. The information gathered in the pre-trial assessment, such as climate, topography and soil type will assist in choosing the most appropriate cover crop for the proposed site.

Cover crops, when used to reduce vine vigour, are in competition with the vine for water, nutrients and soil atmosphere. Sometimes, excess vigour is the result of plentiful supply of soil water. Cover crops can utilise excess water and reduce vine growth into the inter row. At sites at risk of waterlogging, cover crops can be sown to use excess soil moisture. Cover crops are to be avoided in frost prone areas because they increase the risk of frost.

Cover crops can also be used as mulches when mown or sprayed. The mulch from cover crops breaks down quickly, but cover crops can also regenerate quickly providing continued supply of organic matter.

Positive and Negative Aspects

It is important to determine the risks associated with vineyard floor treatments at the proposed site. These risks must be weighed up against the potential benefits that a particular treatment may impart. Some risks may preclude trialing treatments on a particular site whilst at other sites, it may be sufficient to monitor a potential risk and have a contingency plan in place if it occurs. The advantages and disadvantages of using cover crops in vineyards are listed below. These may be used as a guide to risks that may develop.

Advantages include:

- Increased competition between crop and vine for water
- Improved soil moisture
- Increased organic matter
- Increased water infiltration and drainage
- Reduced erosion
- Improved vineyard environment
- Cooler surface temperatures
- Reduced evaporation losses
- Reduced sunburn damage
- Increased wind protection
- Better weed and pest control
- Suppresses volunteer weed growth Improved trafficability

Disadvantages include:

- Creates plough pan and wheel track compaction
- Increased levels of nutrients
- Harbours pests and diseases
- Increased humidity Increased frost risk
- Soil preparation prior to sowing if not direct drilling
- Costs of implementation and maintenance
- Nitrogen cost of legume cover crop may be more expensive

In light of these issues, some questions worth considering are:

- Which risks are important at your site?
- Which risks would not prevent the trial proceeding but should be monitored?
- What plans need to be put in place to reduce the impact of any risks occurring?

Cost Benefit Analysis

In order to determine the financial viability of a cover crop program, a cost/benefit analysis should be completed, to relate the monetary requirements of cover crops to a production basis. However, it must also be remembered that by increasing soil organic matter and stability, it is protected from degradation and measurements of soil loss over the longer period will justify the commitment to soil protection through a cover crop program.

Before You Get Started

The following points will help you prepare for this trial:

- Organise the appropriate equipment; secateurs, mowers, slasher to throw cover crop under the vine-row, fertiliser for the establishment of the cover crop;
- Have suitable herbicide applicators available and a seeder to sow the cover crop.

Site Suitability

The following site characteristics make a site highly suitable for conducting a competition management trial.

Climate

- Low frost risk
- Low annual rain fall
- High annual rain fall

Water/Irrigation

- Insufficient water supply
- Declining quality of irrigation water
- Declining performance of irrigation system
- High rates of surface evaporation
- Poor infiltration of water into soil

Vines

- High vine vigour (eg. strong vegetative growth)
- Poor vine vigour
- Young vines slow to establish
- Declining productivity/quality
- Quality issues (e.g. excess vigour, poor colour)

Soils

- Poor soil water holding capacity
- High soil temperatures

Potential Treatments

Potential treatments could include:

1) Cover crop management
a) Mow only
b) Nil mow
c) Mow with herbicide under vine
d) Nil mow with herbicide under vine

2) Various cover crop- sowing rates
a) Manufacturer sowing rate
b) 2 times the manufacturer sowing rate
c) Half the manufacturer sowing rate
d) Usual cover crop in the vineyard (control)

3) Various species / mixture
a) Actual cover crop or bare soil (see table below)
b) Species / mixture #1
c) Species / mixture #2
d) Species / mixture #3

The following table lists a range of cover crops and sward species for vineyards

Cover Crops	Mown sward
Cereal rye	Soft broome
Barley	Wimmera ryegrass
Oats	Rose clover
Italian ryegrass	Sub clover
Rape/Canola	White clover
Faba beans	Cocksfoot
Field peas	Fescue
Vetch	Perennial ryegrass
Triticale	
Mustard	
Legume crops	

Measurements and Monitoring

There are many potential measurements that could be made in a vineyard floor trial, depending on the site and the treatments imposed. Unfortunately there is no single set of measurements that are applicable to all trials. The correct measurements can only be selected once the trial's objectives have been clearly defined. The following is a list of potential measurements.

The following table includes potential measurements for a cover crop trial, their time involvement and difficulty.

Measurements	Time*	Difficulty*
Plant nutrient status	1	C
Pest and disease incidence	1	A
Vine vigour - shoot length	3	A
Soil moisture	2	B/C
Soil temperature	1	A
Weed incidence	1/2	A
Baumé	1	A
pH	1	B
Titratable acidity	1	C
Colour (anthocyanins)	2	C
Soil physical parameters	1	B/C
Soil pH		
Root density	1/2	A/B
Yield	2	A
Bunch number	1	A
Earthworms	1	A
Soil biology/organic matter	1	C
Vine growth stage (phenology)	1	A

**Time is where 1 = few minutes per replicate, 2 = 15 minutes per replicate, 3 = >30 minutes per replicate; Difficulty is where A = easy, no laboratory skills and/or measurement equipment required, B = some laboratory skills and/or measurement equipment required, and C = laboratory skills and/or sophisticated measurement equipment required. Refer to complete Table 2.2 in Section #2: Trial Design and Variability.*

Trial Timelines

Trials involving the use of cover crops should be run for a minimum of three years to see the full benefits of the treatments. The effect on soil biology may not be observed in the first year of cover cropping. It is advisable that cover crops be sown in autumn to allow a good soaking rain to germinate seeds. Yield and quality measurements will take about 0.5 day to take samples and readings. The time required to carry out soil moisture and earthworm counts is also approximately 0.5 day.

Shaded areas in the following table indicate when measurements or samples suggested above are to be taken. See the measurement manual in this series for more information about measurement protocols.

	Dormancy	Bud burst	Shoots 10 cm	Flowering	50% capfall	Berry set	Berries pea-size	Bunch closure	Veraison	Harvest	Post-harvesty
Soil moisture											
Earthworms											
Trunk diameter											
Shoot length											
Vine growth stage (phenology)											
Grape yield											
Bunch number											
Grape yield											
pH											
Baumé											
Titratable acidity											
Colour											

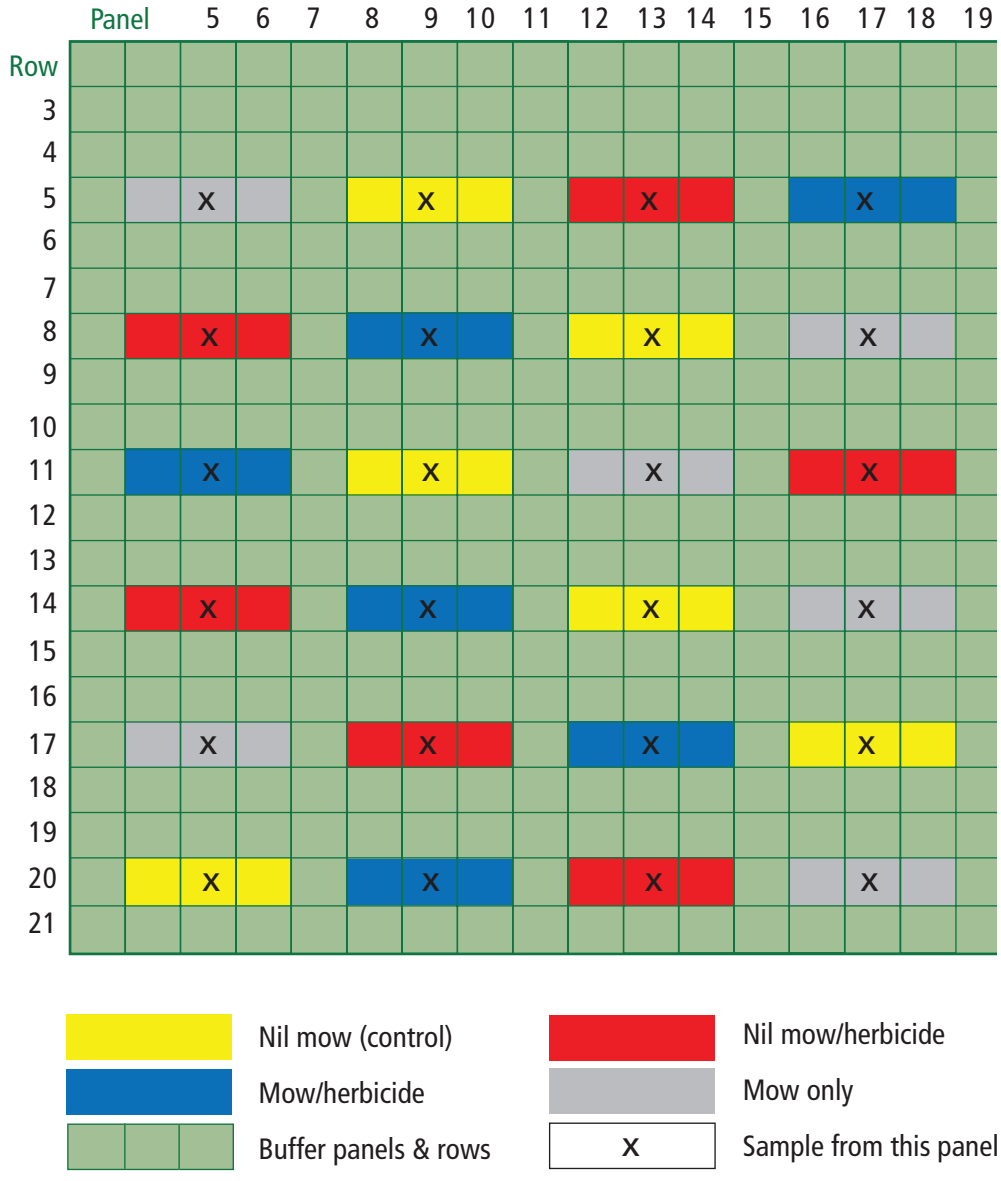
Trial Designs for Cover Cropping

Treatments will need to be replicated within the trial area at least six to eight times, more if the area is not very uniform. One of the treatments should be a control, which will often be current practice. It is advised not to have more than three or four treatments, to allow enough time for management of the trial.

Plots (or experimental units) can be different shapes and sizes, but a common plot in a cover crop trial consists of three rows by three panels of vines.

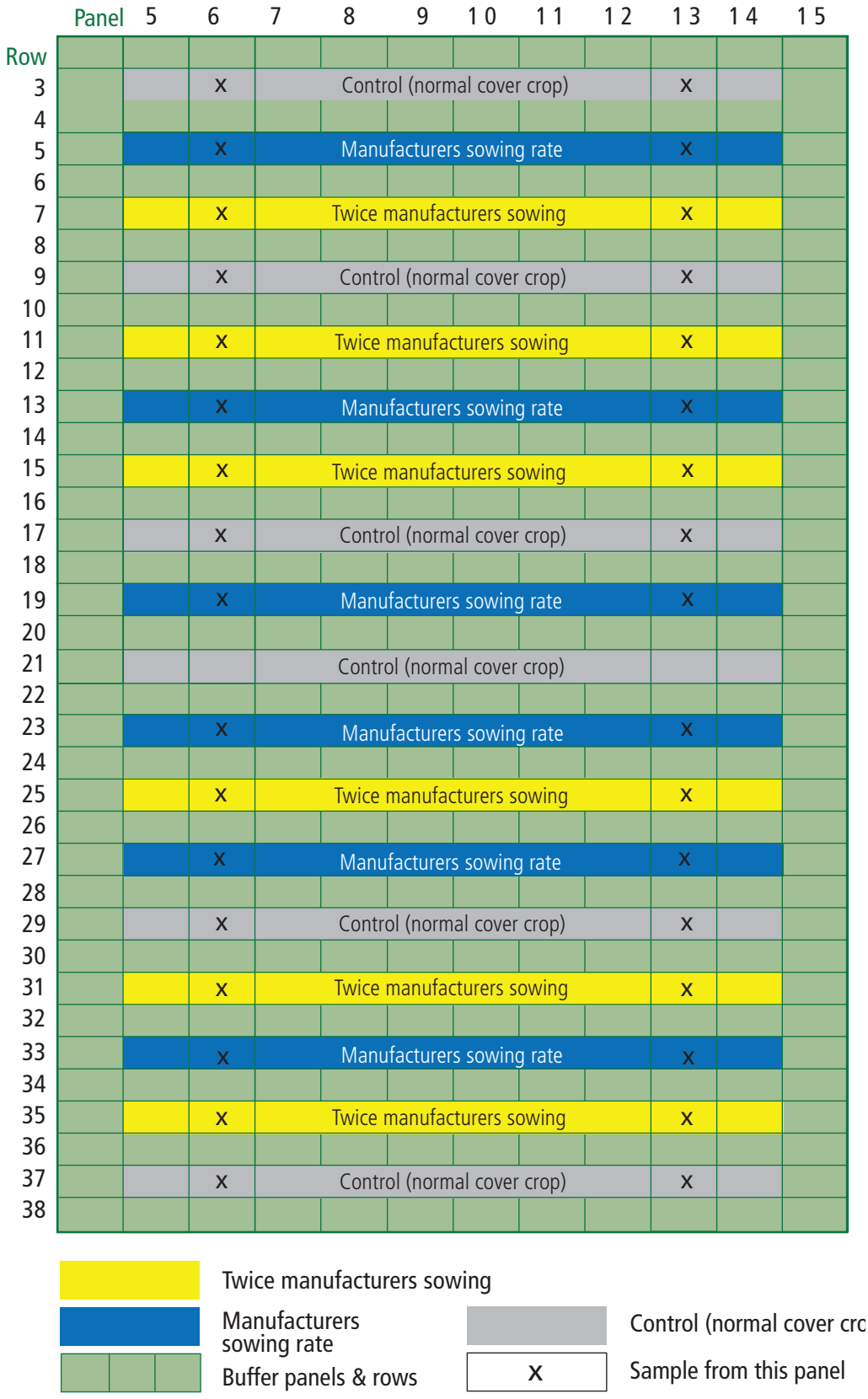
The middle panel is used for taking measurements (for example, Row 5 Panel 5). Buffering is important to identify clear treatment areas and to avoid contamination between treatment areas. Buffer zones are marked as panels with grid-lines in following the designs.

Design 1: An example of a randomised block design that could be used to assess management of cover crops (for example, mowing, use of herbicides)



Design 1 gives an example of a trial layout in which the treatments are three different methods of cover crop management plus a control (nil mowing). The trial has four treatments and six replications, arranged in a randomised block design, with the blocks being rows (or, more strictly, groups of three adjacent rows).

Design 2: An example of a trial design to test different rates of cover crops (manufacturers sowing rate, double the rate, and half the rate) using rows as experimental units.



Design 2: gives an example of a trial layout in which the treatments are two cover crop sowing rates plus a control.

It uses rows as experimental units as opposed to panels. This can make management of the trial (ie sowing of crops) a little easier.

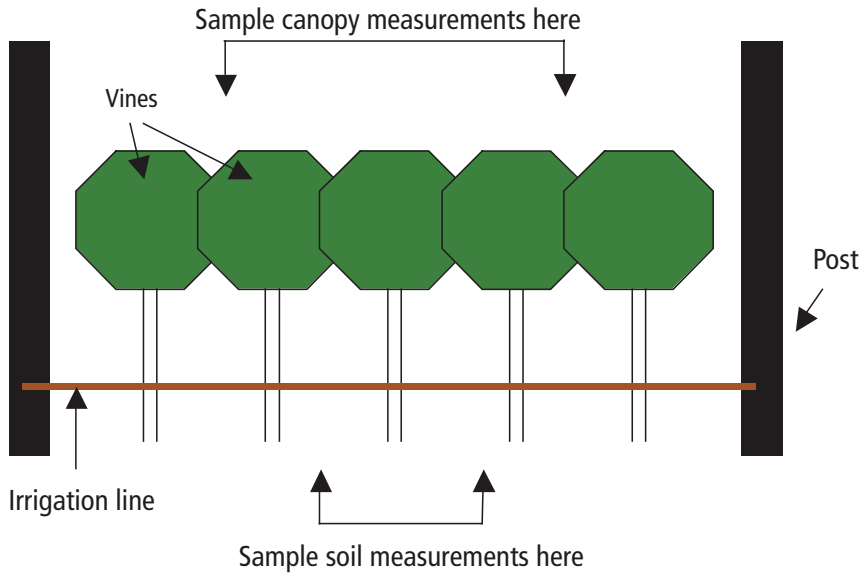
When using rows as experimental units, it is normally anticipated that a maximum of three treatments are trialed due to the potential workload expected. This trial has three treatments and six applications, again arranged in a randomised block design, with the blocks being groups of three adjacent experimental units.

It is recommended to only sample the middle vine in panels marked with an X (Designs 1 and 2) when taking vine measurements. If there are more than three vines per panel, only sample from the middle vines of the panels mentioned above (see Figure 1).

When taking soil measurements always sample from between two vines in the middle of each middle panel.

These recommendations will ensure that there is no contamination between plots; in some situations they may be waived provided that contamination is not a possibility. The approach described here also guarantees objectivity in the sampling, which will prevent the experimenter's bias from jeopardizing the results.

Figure 1: A diagrammatic explanation of where, within a panel, measurements can be taken.



Resources

Some useful resources for mulching trials include:

- Buckerfield J.C. and Webster K.A. (2000) Vermicompost - more than a mulch. Vineyard trials to evaluate worm-worked wastes. The Australian and New Zealand Grapegrower and Winemaker Annual Technical Issue 438a: 160 - 166
- Buckerfield J.C. and Webster K.A. (2000) Vineyard trials show value of mulches. Organic matter for management of young vines. The Australian and New Zealand Grapegrower and Winemaker 441: 33 - 39
- Kingson C. (2001) Waste management and sustainable grapegrowing. The Australian and New Zealand Grapegrower and Winemaker 444: 29 - 31
- Schefe C. (2000) Composts in viticulture. The Australian and New Zealand Grapegrower and Winemaker 442: 31
- Wheaton A.D. and Everett M. (2003) Managing hard-setting and crusting of under-vine soil surface In: Laukart N. and Joyce D.C. (edts) 'Participatory On-Farm Trials for Viticulture Manual.' (Cooperative Research Centre for Viticulture, Adelaide, S.A.)
- Wilkinson K. (2000) Promoting the use of recycled organic material (ROM) in viticulture - second progress report for Natural Heritage Trust. Natural Heritage Trust 6
- Wilkinson K., Sicard S. and Hackett S. (2003) Managing competition with cover crops In: Laukart N. and Joyce D.C. (edts) 'Participatory On-Farm Trials for Viticulture Manual.' (Cooperative Research Centre for Viticulture, Adelaide, S.A.)

Some useful resources for cover cropping trials include:

- Armstrong J. (2000) Sustainable permanent mid-row management in vineyards. The Australian Grapegrower and Winemaker 434: 36 - 39.
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