Viticare Trials

FLOOR MANAGEMENT FOR SUSTAINABILITY

Mudgee, New South Wales

Cooperative Research Centre for Viticulture

Viticare Trials is a national Cooperative Research Centre for Viticulture (CRCV) project involving groups of regional growers, industry providers and researchers working together on demonstration trials that focus on topics which will benefit the regional winegrape industry. The aim of the trials is to accelerate the adoption of improved practices, new technologies or outcomes arising from viticultural research and to demonstrate and assess their suitability for your vineyard. There has been one Viticare demonstration trial in the Mudgee winegrape producing region from spring of 2004 to autumn of 2006 that has been examining important regional viticultural issues associated with under vine floor management.

This factsheet will concentrate on the outcomes achieved during the two seasons of the Viticare demonstration trial **Floor Management For Sustainability** in the Mudgee Region for two growing seasons, 2004/05 and 2005/06.

AIM

- Improve environmental performance in the under vine floor management.

OBJECTIVES

- To identify under vine floor management practices that can improve water use efficiency, provide effective options to conventional under vine floor management
- To develop an economic appraisal of under vine floor management options
- To develop awareness and knowledge of soil health measurement, monitoring and improvement in vineyards using soil chemical, physical and environmental characteristics.

BACKGROUND

Winegrape growers in the Mudgee Region were initially surveyed in 2004 to identify regional priorities for a CRCV Viticare Trial topic. A range of priorities including nutrition, irrigation, pests, canopy management and sustainability were proposed.

There was a strong message from the survey that conserving natural resources in the region was the highest priority, closely followed by nutrition, and then irrigation. The trial that commenced in 2004 has had a strong focus on good stewardship of natural resources, particularly irrigation water use efficiency and soil management.

Mulches have not been widely accepted but have the potential to assist with moisture conservation, control of weeds, minimise temperature fluctuations and improve soil health. Interest in composting winery wastes for mulching purposes is also developing. The Wine Industry already has a good environmental record and this trial shows how it can be further improved.

ABOUT THE DEMONSTRATION TRIAL SITE

The demonstration trial was located on the Gelland Vines Cabernet Sauvignon vineyard, 20km north of Mudgee and approximately 220 km North West of Sydney. The vineyard is part of the New South Wales Central Ranges GI and was planted in 2000 in a flat area with uniform sandy clay soils. There are 2222 vines per hectare, drip irrigation and a single wire non positioned canopy.

TREATMENTS

Five under-vine treatments were compared to identify practices that could improve water use efficiency, minimise herbicide use and/or improve soil management.

Treatment 1: Conventional herbicide; using 4 - 5 post emergent sprays

Treatment 2: Cultivation; using mechanical vertical rotavator. This treatment was abandoned in the second season due to equipment problems.

Treatment 3: No till slashing; under vine area slashed 3 - 4 times per season to suppress weed growth.

Treatment 4: ANL Vine Mulch; a commercially available compost product comprised of recycled organic products was applied to the under vine bank in a strip 50cm wide and 10cm deep.

Treatment 5: Straw Mulch; cereal stubble was applied as a continuous mulch at a rate of $2M^2$ per 100 meters – the straw was initially 30cm high before settling to 10 -15cm.

Each of the treatments was replicated five times for a total of 25 plots. Each plot was laid out in the winter of 2004 and covered 9 panels or 36 vines

An economic study was undertaken to determine the impact on profitability.

Weather: Spring each year was moist and cool, summers warm to hot with some thunderstorm activity. Weather leading into harvest on each occasion was favourable.

ASSESSMENT

The trial assessed the under vine treatments using the following parameters:

- Soil moisture (Diviner moisture probe)
- Yield - Bunch numbers, bunch weights, tonnes per hectare
- Fruit quality - pH, sugar, TA, colour
- Vine growth
- Soil temperature, earthworms
- Weed coverage
- Records of irrigation scheduling and rainfall
- Economics

The trial also investigated the Precision Viticulture technologies, aerial vigour mapping and EM 38 soil survey.

WHO WAS INVOLVED?

The trial has been an important cooperative effort involving local, state and national agencies, local growers and consultants as well as wineries and suppliers of mulching products; in particular,

Mr Warren and Mrs Stephanie Gelland (Grower Co-operators)
Ms Sheri Robinson formerly, National Coordinator Viticare Trials (Trial Advisor) CRCV
Mr Shayne Hackett, National Coordinator Viticare Trials (post December 2005) CRCV
Mr Clarrie Beckingham, Regional Coordinator CRCV)
Mr Bernard Blackley (Grower Co-operator & Graphs)
Dr Neil Coombes, (Biometrician)
Mr Ben Bryant, Orlando Wyndham, Poets Corner Wines (Fruit Analysis)
Mr Mark Roth (Straw Mulch Application)
Mr Phil Murray (Vine Mulch Application)
Australian Native Landscapes (Composted Vine Mulch)
Ms Thea Ridley, PB Ag Consulting (Irrigation data and reporting)
Mudgee Wine Grape Growers Assoc Viticulture Sub Committee
Mr Richard Plummer NSW DPI (Trial Management)
Terrabyte Services (Multispectral Imaging & Electromagnetic Survey)
Jammel Environmental & Planning Services (EM 38 Survey)
Mr Peter Hedberg (Excel Economics)
Mr Michael Porteus (Project Promotion)

ACTIVITIES AT THE SITE

- A "Getting Started in Environmental Management Systems" (incorporating VERA) workshop held in Mudgee, 25th June 2004.
- Field Day 16th July 2004 to present sward species for vineyard interrow area.
- Results presented at National Sustainable Viticulture Seminar, Mudgee, 23rd June 2005
- Soil Health, Mulches and Composts, Soil Variability Mapping and Case studies presented at a "Vineyard Soil Management Field Day", Mudgee, 8th December 2005
- "Vine Mulch Benefits", article in the state wide newspaper, Agriculture Today April 2006.

RESULTS

Fruit Yield and Quality

The Straw Mulch and Vine Mulch treatments produced the highest yield over both seasons. The Conventional Herbicide treatment also performed well while the Slashed treatment produced the lowest yields and appeared to be suffering from lack of soil moisture due to the presence of other plant species in the under-vine row.

Table 1: Harvest Data

	Ave. Bunch No.		Ave. Bunch Wt. (g)		°Brix		Titratable Acidity		pH	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
T1 - Herbicide	40	134	59	63	23.60	24.96	5.56	5.87	3.39	3.35
T2 - Cultivation	37	145	60	62	23.38	24.57	5.72	5.86	3.39	3.36
T3 - Slashed	37	121	49	53	23.97	25.06	4.89	5.60	3.45	3.44
T4 - ANL Mulch	33	158	75	90	22.88	24.20	6.03	5.92	3.39	3.38
T5 - Straw Mulch	43	178	80	81	22.85	23.93	5.68	6.11	3.37	3.35

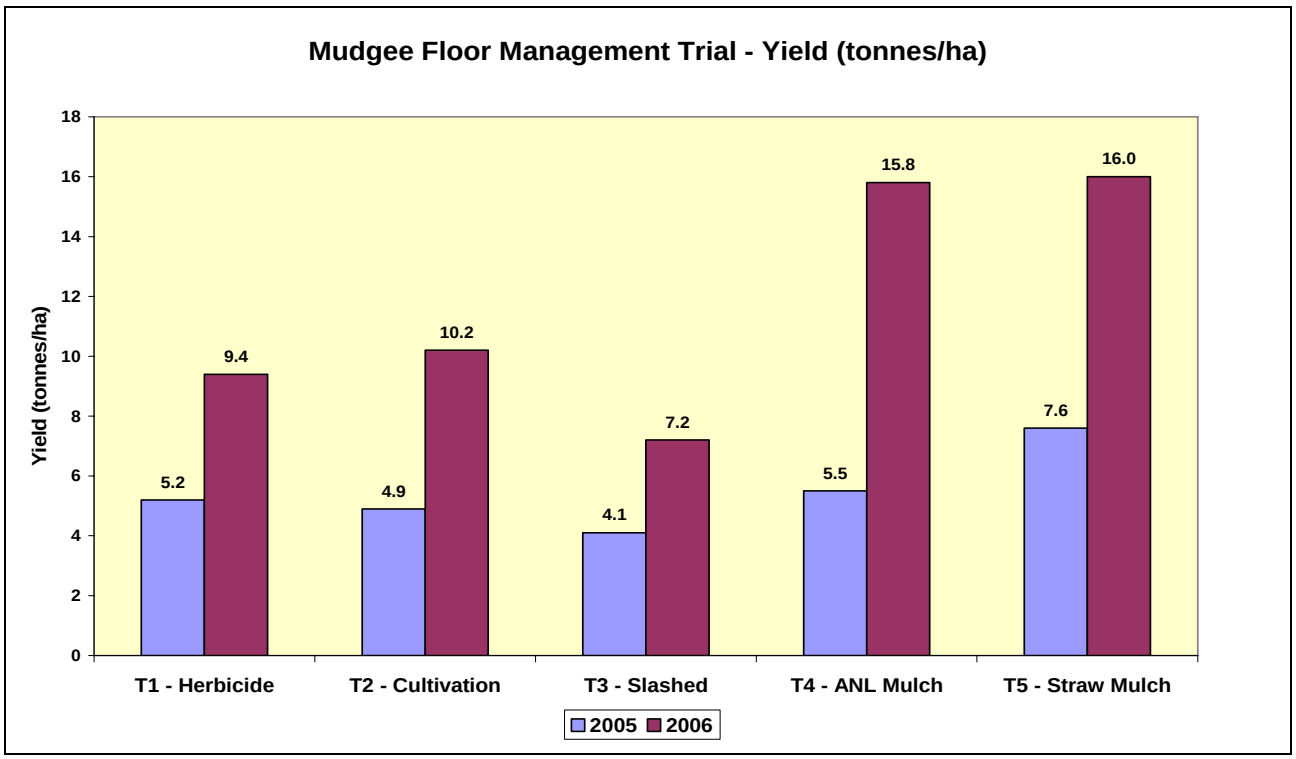

Figure 1: Yield data for the 2005 and 2006 seasons

The higher yields in 2006 were thought to be a result of vines being one year older. They had significantly higher bunch numbers and slightly increased bunch weights. Both of the mulch treatments had far superior yields in 2006 which was due to the higher bunch numbers and larger bunch weights (Table 1).

For wine making purposes, all treatments met quality specifications for sugar, pH and titratable acidity in both seasons. Both mulch treatments had the lowest Brix levels in both seasons but were considered negligible. The mulch treatments had the highest titratable acidity in both seasons compared to all other treatments. The juice pH levels were similar across all treatments for all seasons.

Colour tests are becoming more popular and depending on the winery more or less importance is given to fruit colour. Colour samples were taken for the 2006 harvest only and results are displayed in Table 2. The conventional treatments showed the highest colour whilst both mulched treatments were the lowest. However, all treatments met minimum winery colour specifications. Flavour sampling by tasting berries is considered important by wineries but was not assessed here.

Table 2: Colour Assessment

Treatment	Anthocyanin (mg/g.f.w)
T1 - Herbicide	1.99
T2 - Cultivation	2.05
T3 - Slashed	2.07
T4 - ANL Mulch	1.41
T5 - Straw Mulch	1.86

NB. 1.4 was the minimum level desired by the winery

Shoot Length

All treatments had acceptable vine balance and open canopies for good light utilisation and pest management. The mulch treatments had the largest canopies but did not require summer pruning. Shoot growth on these treatments was not considered excessive.

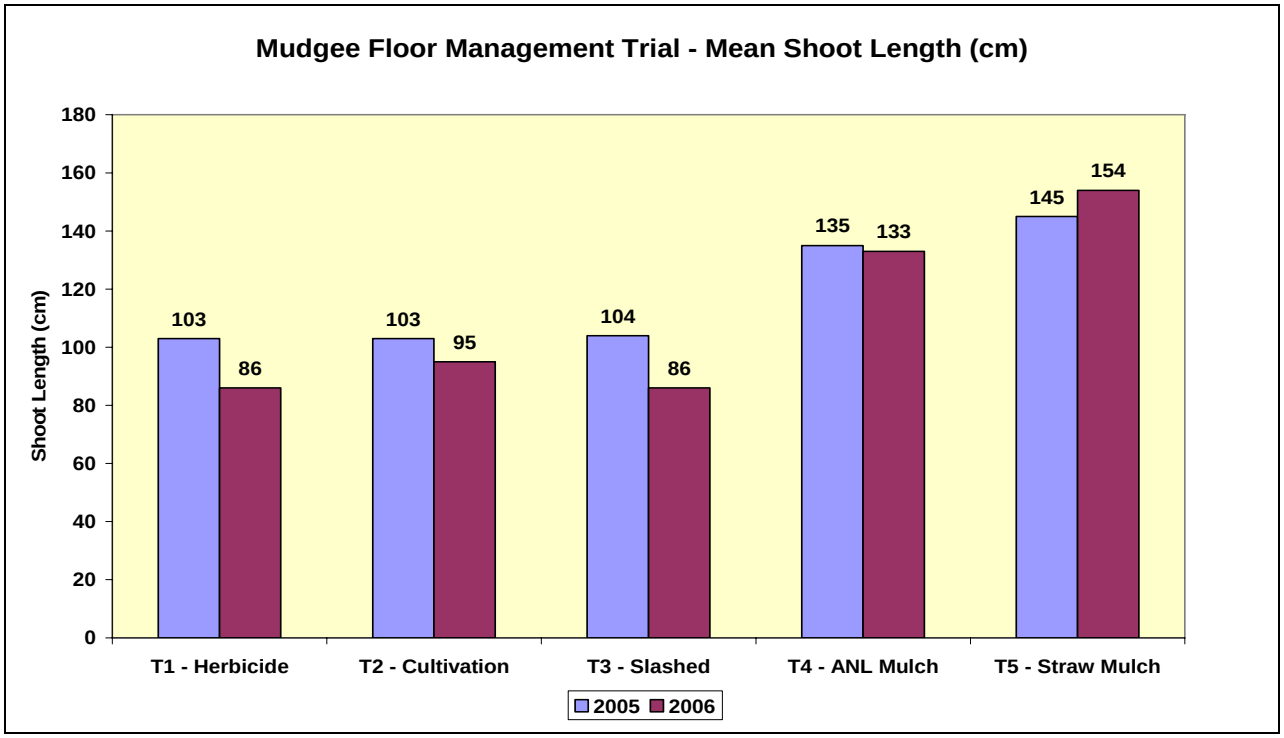

Figure 2: Mean Shoot Lengths

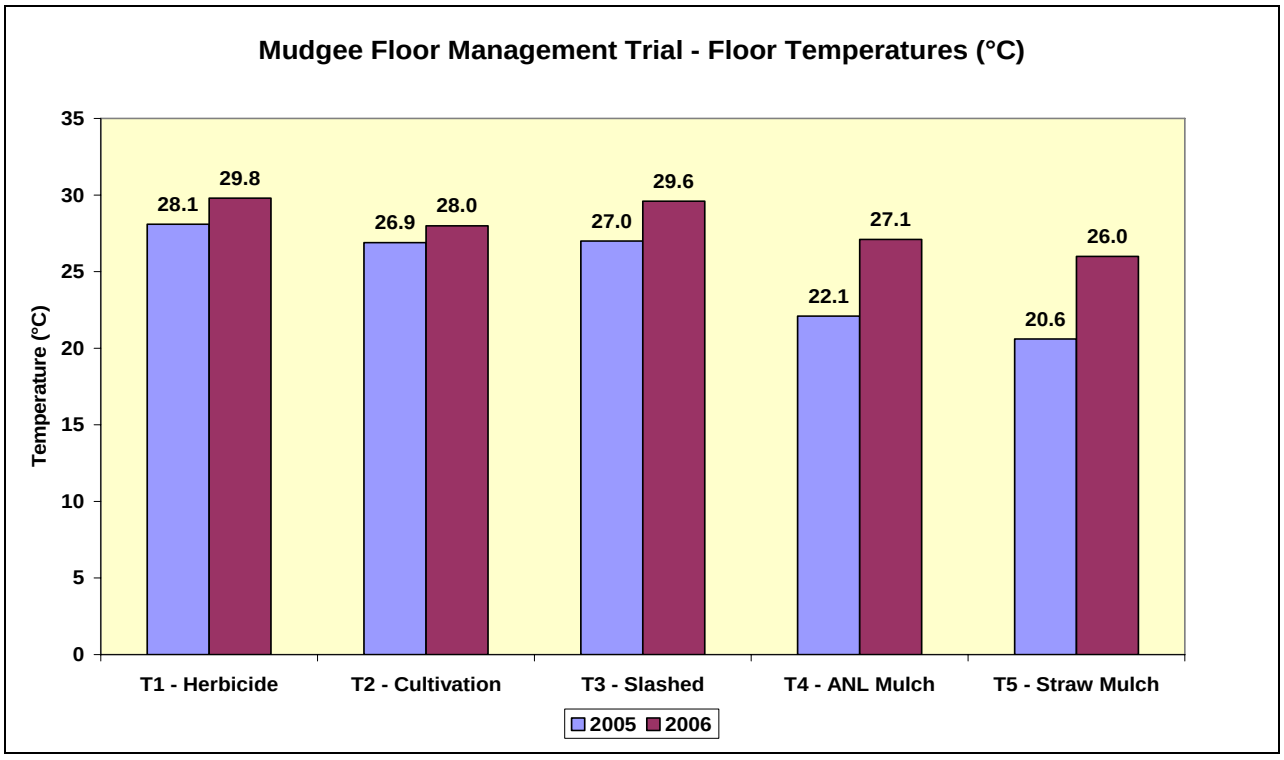

Figure 3: Mean Vineyard Floor Temperatures

Soil Temperatures

All readings of soil temperature were taken 10cm below the soil surface. The summer cooling effect of the mulch treatments appeared to be reduced by the second season, this

may have been a result of the declining depth of mulch. Any warming effect of the mulch treatments in early spring was not measured and could not be considered.

Weeds

Figure 4 provides an indication of weed pressure throughout the two years of the trial. The Herbicide treatment was considered to have provided adequate control of weeds. The ANL Mulch treatment remained weed free throughout requiring only one cleanup spray in winter of 2005. The Straw Mulch treatment produced self sown cereal plants that did not regrow after spot spraying. The Slash Only treatment had the greatest weed coverage at both assessment times and appeared to be having a negative impact on vine performance.

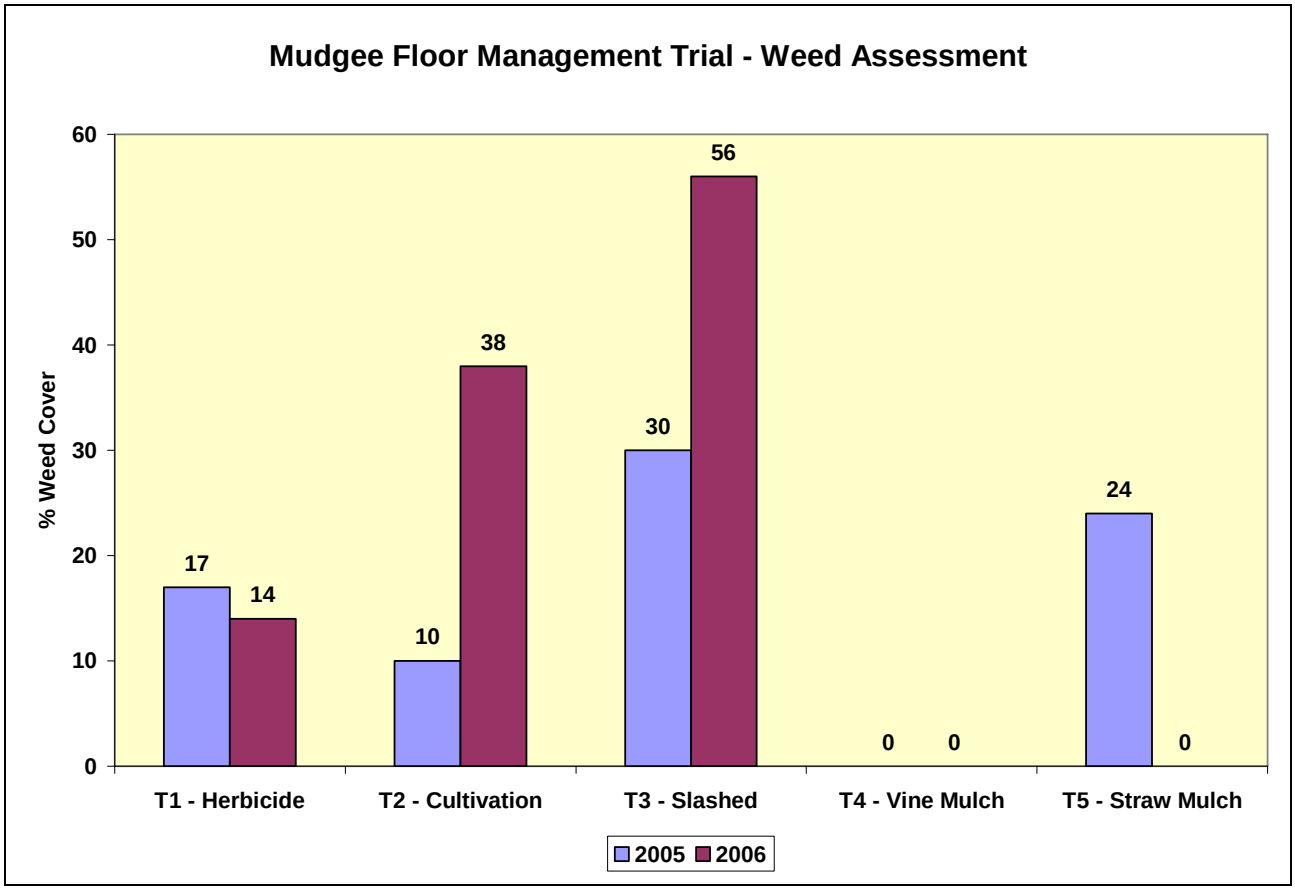

Figure 4: Percent weed cover of under vine area

Soil Health

Soil health is the continued capacity of a soil to function as a vital living system. A range of indicators are used including organic matter/carbon, soil chemistry, soil biology (soil microbial activity/biomass), soil biodiversity, % groundcover, plant growth and health and soil physical characteristics. Aspects investigated here included the presence of worms and percent organic matter (%OM).

Worms

12 months after establishing the trial, no worms could be found under any treatments.

Table 3: % Organic Matter Results at two sampling times (Optimum level 2%)

Treatment	Herbicide	Cultivate	Slash only	ANL Mulch	Straw Mulch
2004	1.2	1.4	1.2	1.3	1.3
2006	1.2	1.5	1.8	2.5	1.5

The %OM results shows that the ANL Mulch treatment provided the greatest increase in soil organic matter over the two years. The Slash Only treatment was the next highest as would be expected where plant material was maintained on the soil surface. The Straw Mulch treatment, surprising provided little increase in the organic matter levels. All other treatments remained relatively unchanged over the trial period.

Soil Moisture

The 0 – 80cm soil moisture profile in four replicates of the five treatments was monitored using a Deviner soil probe**.** Whilst there were some differences in actual values (due to minor differences in soil types), the patterns of soil moisture readings were similar between all replicates in each treatment. Figures 5 and 6 average together the four replicates in each treatment to show average summed diviner readings over each season.

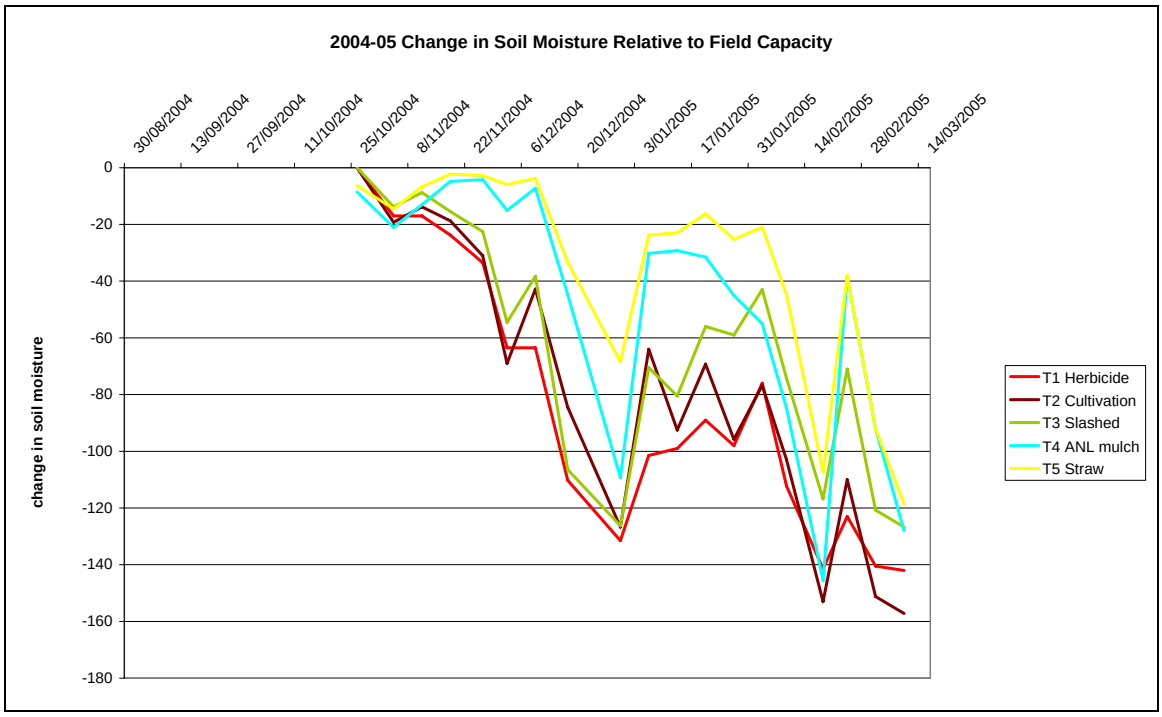

Figure 5: 2004/05 Soil Moisture Data

2004/05 Season

All 5 treatments commenced the 2004/05 season at similar soil moisture levels.

Through November and early December, the ANL and Straw mulch treatments maintained higher moisture levels for longer than all other treatments. The difference between the mulch treatments and other treatments at this time was possibly due to evaporation at the soil surface and transpiration from other plant species in the under vine row.

By mid-December all treatments showed a rapid decrease in soil moisture as temperatures and vine water use increased. Despite this high demand, the mulched treatments did not become as dry as the other treatments. This may be attributed to the higher soil moisture content in these treatments entering into the January period. This would have provided a greater initial moisture level from which the vines could draw from.

Following a summer storm experienced in late February, the ANL and Straw mulch treatments and to a lesser extent; the Slashed treatment increased their soil moisture to a higher level. This was not evident in the Cultivated and Herbicide treatments as water

infiltration was far lower under both of these treatments. This may have been a result of soil surface sealing or through lack of macro-pores as a result of low organic.

The ANL Mulch, Straw Mulch and the Slash Only treatments ended the season at higher moisture contents than the Herbicide and Cultivated treatments. The higher moisture levels in the Slash Only treatment was possibly due to the smaller canopy associated with this treatment.

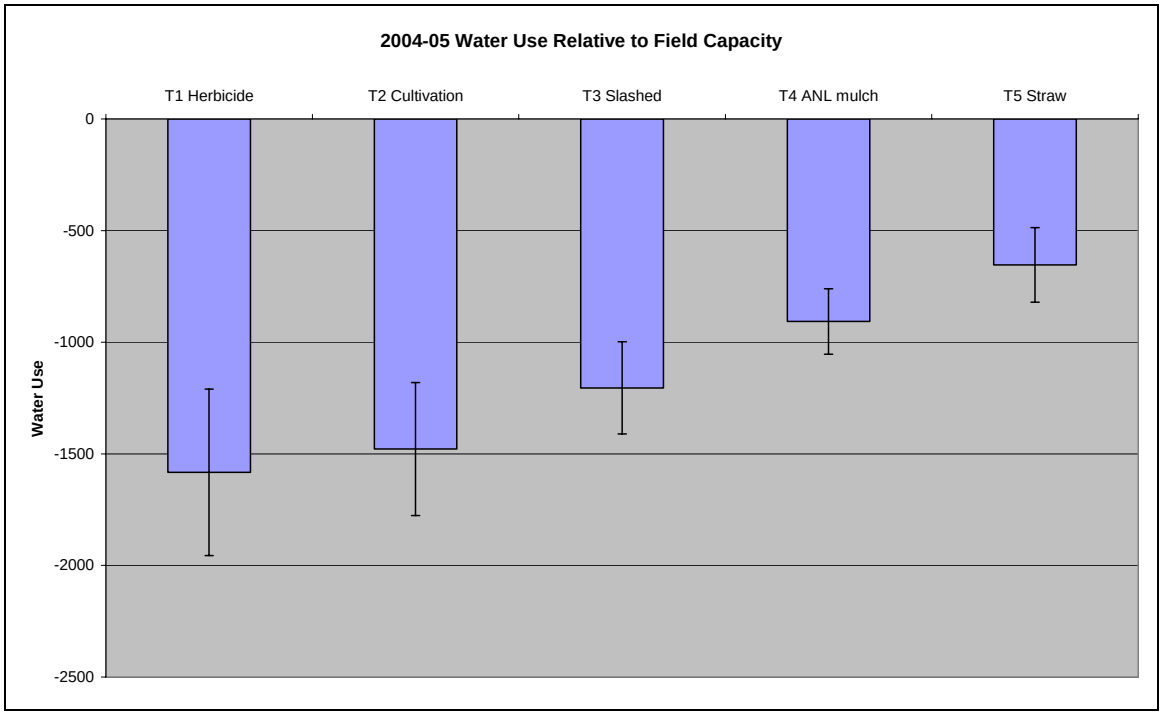

Figure 6: 2004/05 Total Water Use

Figure 6 details the total water use relative to field capacity. All readings taken throughout the season are less than field capacity (profiles were not waterlogged when Diviner readings were taken) therefore the difference between the treatments result from *how much less than field capacity* the total of the summed readings were.

The results indicate that there were no significant differences in total water use between the Herbicide, Cultivated and Slash Only treatments, while the ANL Mulch and Straw treatments had a *less negative* total moisture use at the end of the season. This further supports the results shown previously (Figure 5) where moisture levels were maintained at a higher level throughout the season in both of the mulched treatments.

2005/06 Season

The 2005/06 season commenced with the ANL Mulch and to a lesser extent, the Cultivated treatments, showing the highest soil moisture contents. The Herbicide, Slash Only and Straw Mulch treatments began the season at similar levels (Figure 7).

Through October and November, when vine water use is minimal, the ANL Mulch treatment once again held a higher soil moisture content as it had exhibited in the previous spring. The Straw Mulch treatment which had shown a similar trend in the previous year did not display the same trend and was comparable to the other treatments.

Through December, the moisture levels dropped rapidly across all treatments with no obvious differences between the treatments until late December where the ANL Mulch

treatment became noticeably drier. The canopies in the mulched replicates were visibly larger than the other treatments and the soil moisture may have become drier due to a larger transpirational demand. The Herbicide, Slashed and Straw Mulch treatments had similar moisture contents while the Cultivated treatment dropped the least.

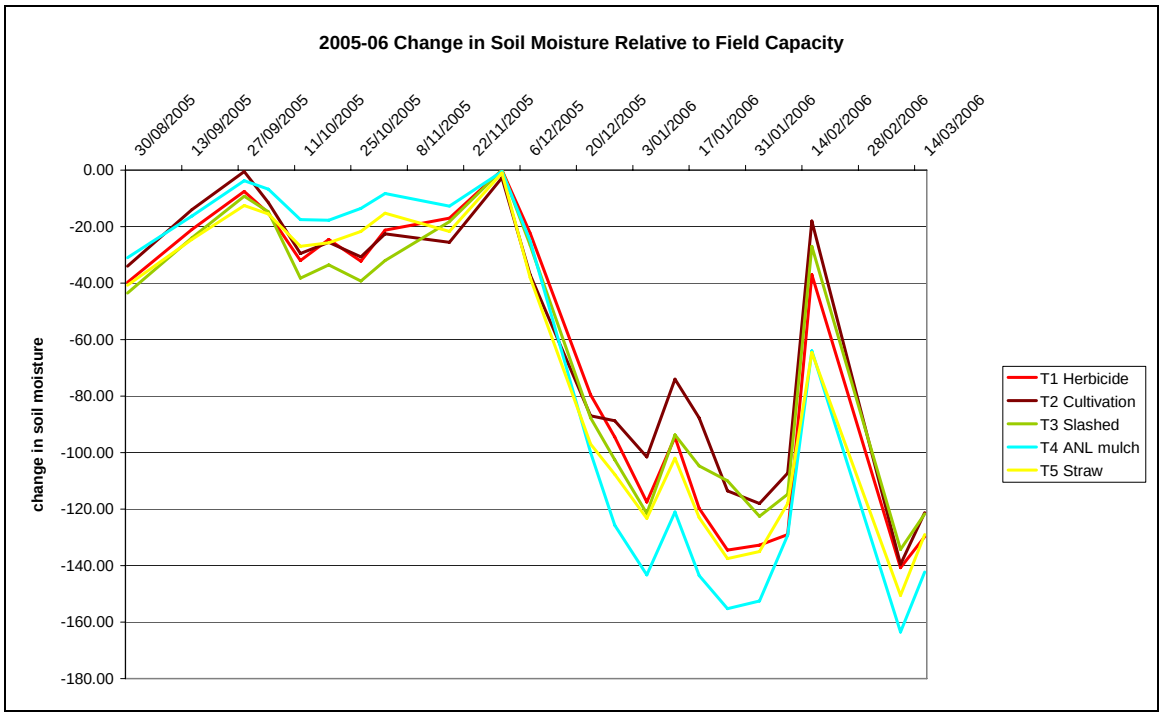

Figure 7: 2005/06 Soil Moisture Data

Toward the middle of January, vines in the ANL treatment remained the driest with vines extracting more moisture from the profile. The Herbicide treatment was the second driest followed by the Straw Mulch, Cultivated and finally the Slash Only treatment.

Following significant rains in February, the Herbicide, Cultivated and Slashed treatments increased more than the ANL and Straw treatments. This may be due to a greater moisture demand by the larger canopies in the mulched treatments.

The total water use in 2005/06 season was in stark contrast to the previous season with both of the mulch treatments showing a higher total water use (Figure 8). In this season there were no significant differences in total moisture use between all treatments. While the ANL Mulch tended to maintain higher moisture levels early in the season, this treatment became the driest of all treatments by early March. It is proposed that the larger canopy associated with this treatment resulted in a higher use of moisture toward the end of the season. Although not a problem in this trial, this result may have serious implications for fruit ripening where late season water availability may be limited or where summer rains are not forthcoming.

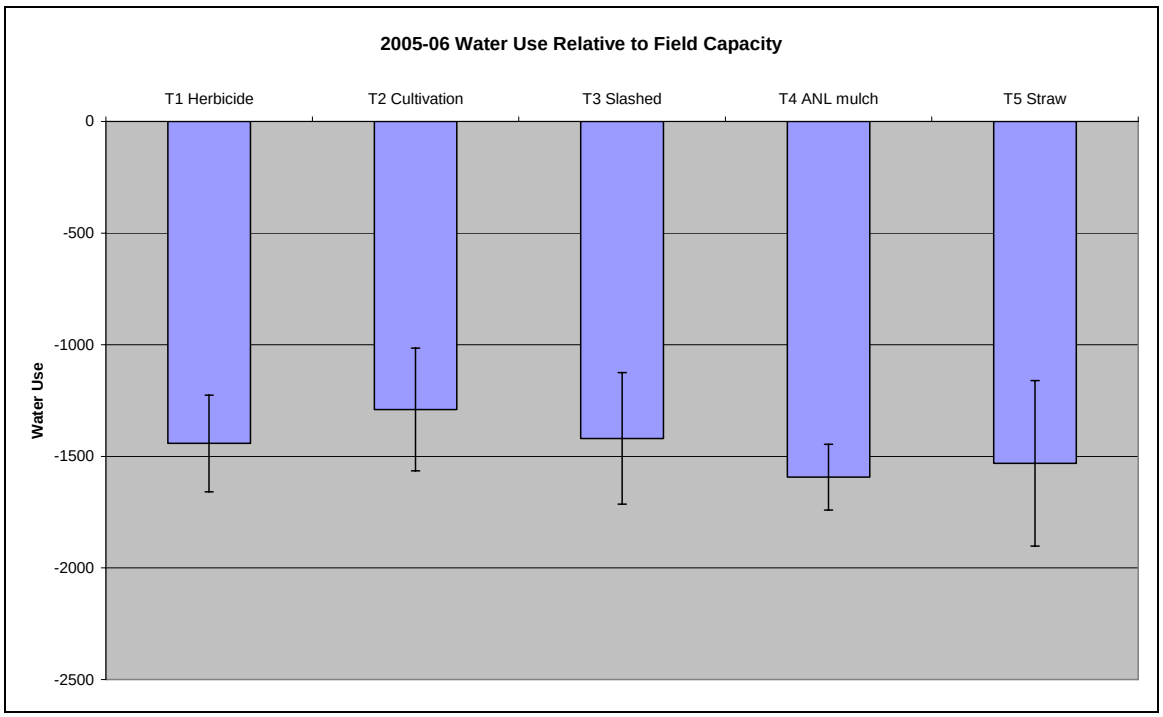

Figure 8: 2005/06 Total Water Use

Soil Moisture Conclusion:
While the pattern of water use varied, there were no significant differences in total water use between treatments in the 2005/06 season. The difference and subsequent benefit may lie in the yield and general vine health under the different treatments. In the 2005/06 season both of the mulch treatments had larger canopies and higher yields for the same amount of water used. This suggests that these treatments were far more effective in utilising the available soil moisture and turning it into greater fruit production. This is known as the Water use Efficiency (**WUE**) and is calculated by dividing the total yield per treatment (t/Ha) by the total water used (ML/Ha)

The following information was used to determine differences in **WUE** and was calculated for the growing season August to March.

- Irrigation: 0.7404 ML/ha
- Rainfall: 484.5mm or 4.845 ML/ha
- Total Water: 5.59 ML/ha

Table 4 details the WUE for all treatments. From these results it is clear that the two mulched treatments provided the greatest WUE in this trial during the 2005/06 season.
The Slashed treatment had the lowest WUE whilst the other two treatments fell midway between.

Table 4: 2005-06 Water Use Effeciency

Treatment	Herbicide	Cultivate	Slash Only	ANL Mulch	Straw Mulch
WUE	1.68	1.82	1.29	2.83	2.86

Economics
The cost benefit details will be different from vineyard to vineyard and compost and mulching decision making will be influenced by:

- Environmental Management Systems and Policy
- availability of green waste and other materials
- the grape marc supply, estimated to be 20% of winegrape production
- the use of commercially developed compost products
- possible negatives including cost and loss of control of canopy and cropping level in wet seasons
- the importance of any compost, soil conditioner and mulch complying with Standards Australia quality grading
- Estimated useful life of mulch after spreading, depending on thickness. Compost 2- 4 yrs (estimated to be 3-4 years for commercial treatment T4 in this trial). Straw 2- 3 yrs (2 years in this trial)

Case Studies
Four have been reviewed and more details are available in the appendices.

- Composting Mixed Materials: cost to prepare and spread $4,836 / ha
- Composting Grape Marc : cost to prepare and spread $1,430 / ha
- Commercial Compost : cost to purchase and spread $2,910 / ha
- Straw Mulch : contract spread plus purchase $2,121 / ha

Mulching Electronic Cost Benefit Model
The Mulching Electronic Cost Benefit model prepared (in the appendices) shows there are economic benefits to be gained from mulching. There are obvious savings to be made with the bonus of increased yield over the life of the mulch and a number of mulching options look affordable.

Conclusion
Two year's data has been collected and whilst the first growing season was a settling in period, the second season's results are considered those that would normally be expected.

The **ANL** and **Straw Mulch** treatments were the highlight of the trial by delivering up to 60% extra yield whilst maintaining grape quality specifications for winemaking. The mulch treatments also demonstrated the potential to save on irrigation water inputs, permit superior WUE and reduced herbicide usage.

With industry interest in mulching increasing, private firms are developing the market for recycled organic products throughout NSW. It is important that any compost materials entering Phylloxera quarantine areas meet Compliance Agreement 05, to ensure the materials are free and safe of Phylloxera and properly composted to Australian Standard ASA 4454.

Some issues concerned with mulching include the economics of some compost options, risk of excess soil moisture in wet seasons which will affect canopy growth, cropping levels and subsequent fruit quality.

A full nutritional analysis of any mulch material should also be gained before application as some products may contain elevated levels of salts and other unwanted compounds. Some mulches may also pose an increased fire and frost risk .

The **Conventional herbicide** treatment, used in the trial was considered normal practice for the region and met commercial yield and quality targets for the Gelland Vineyard. There is an opportunity to assess mulching to take advantage of the benefits described.

The **Slash Only** treatment demonstrates the risks associated with weed competition as vines will be at a major soil moisture disadvantage. Tissue analysis was not undertaken, however it is assumed that there would be nutrient competition which could further impact on vine performance. Low vine vigour due to competition from weeds during the growing season is also expected to carryover into the next season. This treatment may have some benefit in high vigour sites.

The **Cultivation treatment** had to be abandoned in the second season due to equipment problem and could not be fully assessed.

Precision Viticulture (PV) Technologies

Variability in vineyards has an influence on fruit yield, quality, profitability and sustainability. Wineries are looking for uniform grapes and if there is variability in fruit yield and quality. PV technologies are being researched to improve management of yield and quality variation in Australian vineyards. Two PV technologies were assessed – Aerial vigour mapping and EM38 Soil Survey.

A **Remote Sensing/vigour map** was prepared. Green areas show the least vigorous areas in a vineyard, red areas show more actively growing foliage. The image below was taken from 1500meters in March 2005. It shows vine growth and highlights healthier vines in the mulched treatments (coloured red). The black dots represent the 25 treatment plot locations.

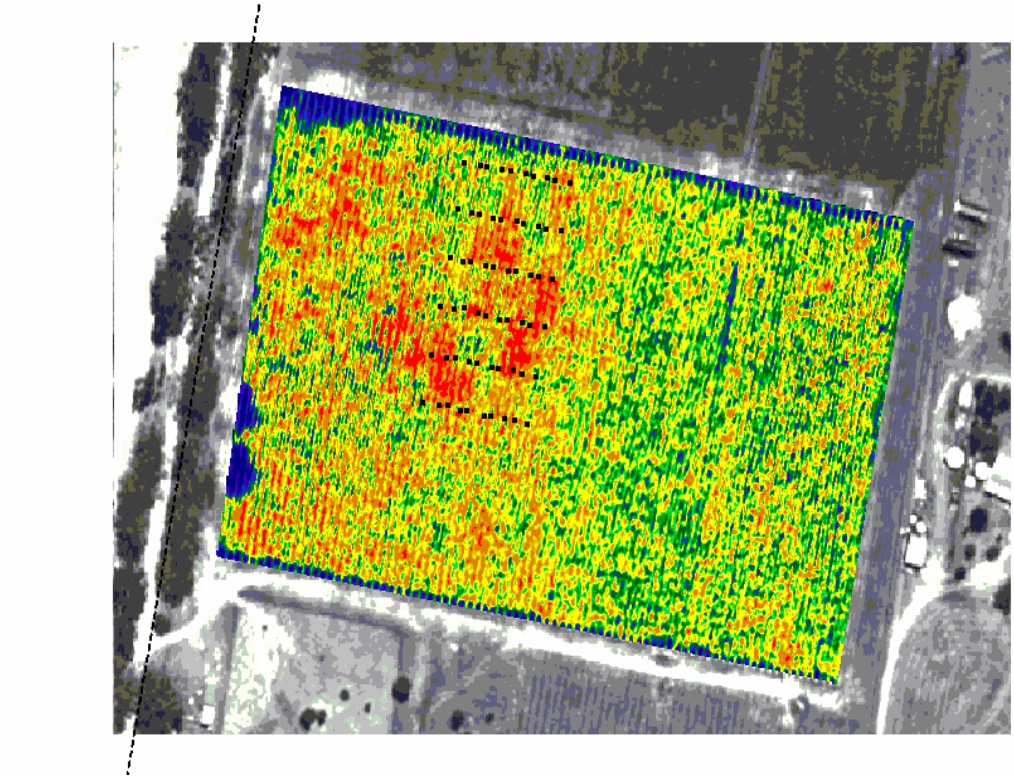

Figure 9: Remote sensing of the Gelland vineyard.

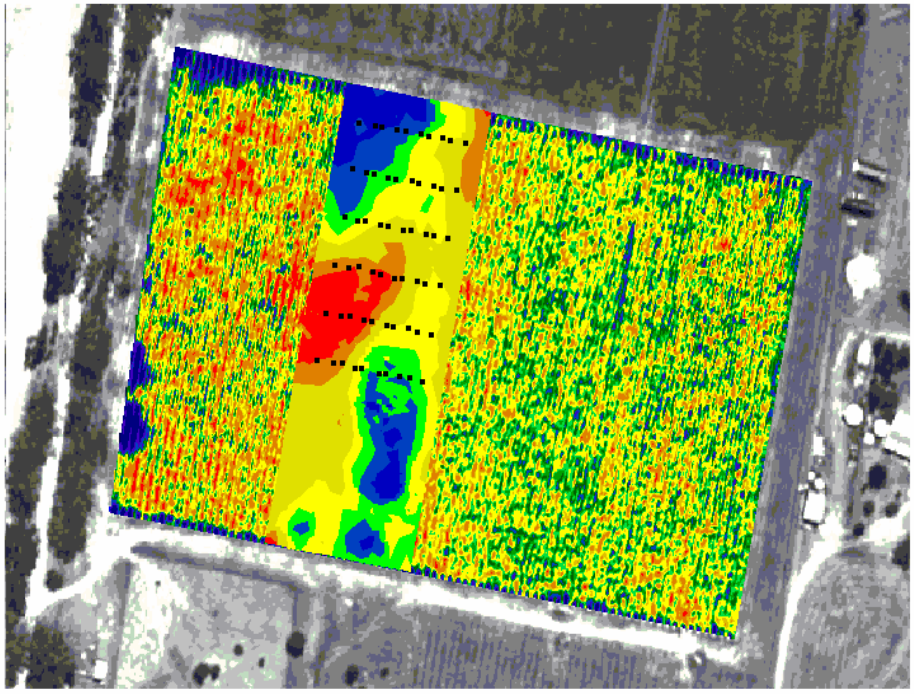

Figure 10: Electromagnetic Survey (EM38) of the Gelland Vineyard

EM 38 (electromagnetic) survey measures the conductivity in the soil and closely correlates to soil texture and readily availably water. An EM 38 soil survey confirmed little variation in soil conductivity and therefore soil uniformity of trial site.

SUMMARY

This trial has provided evidence that mulching in the Mudgee Region can deliver the following benefits:

- **Increased yield** varying between 2 – 6 tonnes per ha
- Reduced herbicide use, estimated at 1- 2 sprays of a 4 spray program
- Affordable mulching technology
- Irrigation water use efficiencies and cost and water savings of about 10-20 %
- An effective life of 2 years for straw and an estimated 3-4 years for the commercial mulch tested.

There is no one prescriptive mulching option for all vineyards. The Mulching Electronic Cost Benefit model allows growers to enter details for a more personalised study of options.

For more information

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