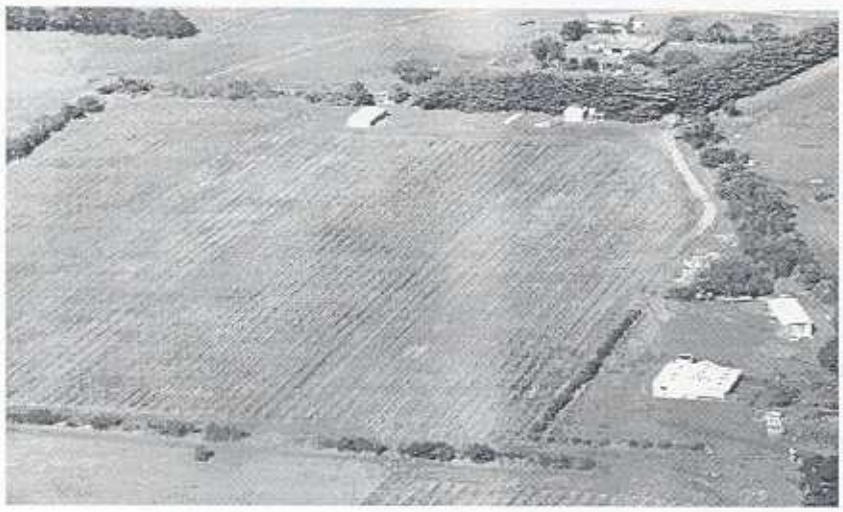
Sunbury District
Grapegrowers Association Inc.

Investigation of the effects of mulch on Vineyard performance in Southern Victoria.



FINAL REPORT to
GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: RT 02/26-3

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Research Organisation: Sunbury District Grapegrowers Association

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1. *Executive Summary*

A mulch experiment was run at Ray-Monde Farm from winter 2000 to winter 2003. The treatments used were composted green garden waste, barley straw and herbicide. The mulches were applied undervine to achieve a depth of 50mm to 100mm in a method that could be used by any commercial vineyard.

Findings included the following:

- straw gave better soil moisture retention
- compost and straw treatments resulted in higher soil nitrogen and potassium levels
- compost treated vines resulted in higher tissue potassium levels
- straw treated vines resulted in higher tissue nitrogen levels
- mulch treated vines resulted in higher yielded with increased bunch numbers
- no significant variation occurred in bunch weights
- variation in wine quality parameters of pH and soluble solids were found to be statistically significant but not oenologically.

Some common beliefs about mulch such as delay of bud burst and efficacy as a weed suppressant were not found in this experiment. No significant variation across the treatments was found in budburst data. A side throw slasher was used to throw straw undervine and the mechanical damage suffered by straw may have led to rapid break down

Results from this suggest the adoption of undervine mulching. Mulch material should be selected to best match economic and vineyard goals. A Grapecheque field day was held at Ray-Monde Vineyard on the 9th of May 2003. Vanessa Hood and Natalie Laukart of DPI, Victoria, facilitated the field day. Several DPI staff attended the day, including Kevin Wilkinson and Emily Tee.

Approximately 60 people from around Ballarat, Bendigo, Geelong, Heathcote, Macedon Ranges, Sunbury and Yarra Valley regions attended. Vincent Lakey presented a detailed analysis of the findings (outlined in the Executive Summary). John Lakey discussed oenological impacts. A vineyard walk followed. We returned to the winery for afternoon tea and informal discussion followed by an open panel discussion of the application and use of mulch in vineyards.

Discussion and questions touched on a number of areas these included frost and delayed budburst effects, (which our results indicate as not significant risks), to improved water retention, nutrients, concerns about the potential for excess vigour and poor wine quality. Result from Ray-Monde Vineyard found no correlation, however Kevin Wilkinson indicated that growers on high vigour sites may be wise to use composted green waste with caution.

2. *Background*

Many aspects of commercial vineyard management strip biota from soils. Use of pesticides, Gupta (1999), cultivation, bare undervine strips and removal of prunings all consume, deplete or remove organic matter (OM) from the soil and consequently remove food sources for soil biota. Cass et al (1998a) suggest that OM is the engine fuel of soil organisms", low OM soils can have low soil biota activity, increasing OM levels through the adoption of minimum tillage, mowing rather than spraying of the inter-row swards and use of mulching and manures will help build OM and improve soil structure.

Inadequate root systems may develop due to poor soil structure or chemical barriers ie low pH, Cass et al (1998b). They define ideal soil structure as 25% of large pores, 25% medium pores and 30% small pores and the last 20% consist of very large pores and a small proportion small pores.

Goldspink and Paulin (Goldspink et al, 2002) report that compost enhances soil organic matter levels and organic cycles and will improve soil quality and hence crop growth by increasing available water-holding capacity of the soil, increasing nutrient availability and nutrient-holding capacity as well as improving soil structure. Agnew, Mundy and Spiers (2002 December) report that key benefits for using mulch were, Soil moisture retention, nutrient release, weed suppression. A detailed analysis of their mulch composition is reported.

Buckerfield et al (1998) trialed composted urban green waste as mulch for managing young vines. They reported that after six weeks of being mulched vines had improved in colour and had a 70% increase in shoot extension. They then yielded at triple the rate of unmulched vines due to better bunch survival. Increased bunch survival was a key factor in increased yields at another trial, Buckerfield et al (1999). Both bunch and berry weight increased slightly, bunch numbers were double on mulched vines compared to untreated vines even though bunches were formed before the compost mulch spread undervine. Compost and straw applied to 5 year old vines showed that 5 cm of compost gave similar yield response to 20 cm of straw.

Wilkinson and Baila (2001) recognise that mulch can tie up nitrogen and other nutrients due to mineralisation processes occurring in the mulch. McCarthy et al (1992) also recognise that use of mulch can be associated with increased frost and fire risk and harbour pests.

3. *Objectives*

To compare the effect of two mulching materials with herbicide treatment on soil chemical properties and moisture retention, soil biota and on vine vigour, nutrition and fruit quality parameters.

4. *Method*

In July and August 2000 an experiment was set up on Ray-Monde Vineyard located in the Sunbury region of Victoria. The soils are generally black cracking clays derived from surrounding igneous rock from volcanic activity. Pinot Noir, D5V12 clone, was planted in 1987 and 1988. The rows run in a north south direction.

The trial was set up with 5 to 6 buffer rows at each end and 6 complete rows of each treatment with 3 repetitions. There were two assessment points per treatment. There are 9 vines selected for measurement in each assessment block (three vines in three rows). There are two assessment blocks per treatment block, one with a northerly and the other with a southerly aspect. There are three treatments, three repetitions, two assessment blocks per treatment and nine vines per block. That is 3*3*2*9= 162 vines were assessed. Vines were caned pruned to two 10 node canes, with two x 2 node replacement spurs. Total node number per vine = 24

The blocks were selected on soil type with vines of similar vigour as indicated by trunk diameter at 200mm above the soil surface. Some of the data collected to date include bud burst dates, soil moisture levels, yield and fruit quality (pH, TA, TSS), pruning weights, soil fertility and plant nutrition status.

Soil and petiole samples were taken at ~40-60% flowering. Six soil samples per assessment point were collected after removal of surface treatment to a depth of 50mm. Petioles were taken from vines in the trial area. Soil and petiole analysis was conducted by the DPI of Victoria. The Soil Food Web Laboratory in Lismore NSW conducted microbial analysis.

Data has been analysed using ANOVA with a significance level set at 0.05 or less . Minitab version 13 software was used.

5. *Results*

Table 1 Application costs

Treatment	Materials $/Ha of vineyard	Application $/ Ha of vineyards	Total $ per Hectare
Herbicide (Basta x 2)	$70	$50	$120.00
Straw 9 tonne /ha	$720	$800	$1520.00
Compost 180m^3 /ha	$3240	$1000	$4240.00

Table 2 Vine growth data

Treatment	Herbicide	Straw	Compost	ANOVA
bunch number 02	32.1	37.2	38.5	<0.01
Yield 02 kg	1.11	1.55	1.51	<0.01
Yield : pruning weight 02	1.00	1.12	1.32	<0.01
PH 02	3.32	3.39	3.35	<0.05
TA 02g/l H_2TA	7.66	7.84	8.01	Not significant
TSS 02	25.4	24.5	25.3	<0.05

a) Outcomes December 2002 data

The tables below contain average results for identified parameters and ANOVA refers to the level of statistical significance of the mulch treatments compared to the herbicide treatment.

Table 3 Soil Factors.

Treatment	Range	Herbicide	Straw	Compost	ANOVA
Soil Carbon %w/w	2 – 4 *	3.60	3.90	4.42	<0.01
Moisture (% moisture)		9.7	13.7	9.2	<0.01
Total fungi (µg/g)	200-300**	34.4	121.7	24.8	<0.01
Total bacteria (µg/g)	100-150**	62.57	115.2	66.47	<0.01
Soil pH (1:5 $CaCl_2$)	5.0 – 7.0	4.92	5.08	5.75	<0.01
Sum of 4 cations calc.(meq/100g)		8.62	15.68	15.38	<0.01
Calcium % of cations	40% - 80%	19.23	16.87	15.39	<0.01
water sol. Ca, (meq/100g)	5 - 10	1.62	2.62	2.37	<0.01
Magnesium % of cations	10% – 40%	19.55	19.19	12.01	<0.01
water sol Mg (meq/100g)	1 – 5	1.67	3.04	1.85	<0.01
Sodium % of cations	1% - 6%	52.17	29.3	40.14	<0.01
water sol. Na, (meq/100g)	0.3 - 1.0	4.53	4.6	6.18	<0.01
Potassium % of cations	3% - 10%	9.06	34.16	32.44	<0.01
water sol. K, (meq/100g)	0.5 – 1.0	0.77	5.42	4.98	<0.01
Calcium : Magnesium ratio	>2.4	1.01	0.90	1.29	<0.01
soluble Cl (%w/w)	<120	76	108	187	<0.01

Table 4 Nutrients

Treatment	Adequate level	Herbicide 02	Straw02	Compost 02	ANOVA
Soil Potassium (meq/100g)	0.5 – 1.0	0.77	5.42	4.98	<0.05
Tissue K (%w/w)	1.3– 3.0	1.6	1.7	1.9	<0.01
Soil Total N (%w/w)	0.1 – 0.25 *	0.05	0.11	0.09	<0.01
Tissue nitrate N mg/kg	600 -1500	179	1317	117	<0.01
Soil P (mg/kg)	30 - 40	11.2	24.0	24.3	<0.01
Tissue P (mg/kg)	0.20 – 0.46	0.18	0.21	0.30	<0.01

All standards draw from Fertilisers for winegrapes Anon 2002 except * taken from Viticultural Resources Vol 2 Ed Coombe & Dry and **from the Soil Food Web standards

6. *Discussion*

Yield of treated vines increased due an increase in bunch numbers. This is consistent with Buckerfield and Webster (1999) who identified increased bunch survival as a key reason for better yields on mulched vines. Wine and juice quality parameters of pH, Titratable Acidity and Totals Soluble Solids showed little or no "winemaking" significant variation throughout the trial. Delayed budburst and increased frost risk were not found during this experiment as was reported by Agnew et al (2002).

(1) Application costs

Straw and compost application costs are high initial investments for a vineyard compared to herbicide application. The straw and compost are not annual costs and it is anticipated application of a three year cycle that would broadened over time as organic matter is accumulated in the soil. The straw treatment had almost completely mineralised over the three years of the trial period and needed topping up to be an effective mulch. Compost was the most expensive mulch.

(2) Soil factors

Total soil carbon was increased by compost (4.42) and straw (3.9) from a base of 3.6 for the herbicide control. Straw had the most affect on soil moisture at flowering with a greater increase than either compost or herbicide (13.7 cf 9.2-9.7). Soil total bacteria was under straw was double the level of either herbicide or compost. Similarly total soil fungi under straw was three times the level under the other treatments. A side throw slasher was used to throw straw undervine and the mechanical damage suffered by straw has led to rapid break down conditions that may have encouraged soil microbes. Compost dried out under the low winter spring rainfall conditions experienced during 2002. A total of 240 mm of rain fell compared to 476 mm in 2000. Dry compost formed a hydrophobic crust that turned water such that soils sampled under compost had lower moisture levels than under herbicide.

However changes in soil pH reversed the above trend with compost pH 5.75 increasing from the herbicide and straw pH = 4.92 – 5.08. Using data supplied by the fertiliser for winegrapes recommendation, to achieve a pH change of this magnitude would require ~12 tonne of pure lime per hectare.

Cation exchange capacity approached doubling under both straw and compost from herbicide. The make up of the total cations varied between the straw and compost treatments. Soil Calcium levels approached doubling under both treatments. Soil Magnesium was not significantly increased by compost but approached doubling under straw. Compost increased calcium to magnesium ratio by ~30% reflecting the increase under straw.

Compost increased Soil Sodium by approximately 50% compared to either straw or herbicide. Compost contributed Chlorine (as Sodium Chloride) lifting the soil level found under herbicide of 0.013 % w/w to 0.03 % w/w under compost. Northcote describes salt as becoming a problem when surface soils reach a level of 0.15 % w/w. Use of compost in areas prone to salting may require consideration. Soil potassium increased by seven times under straw and six fold under compost compared to herbicide.

(3) Nutrients

Potassium levels were increased three - four fold by both straw and compost treatments but tissue analysis showed no significant variation between the straw and compost treatments and herbicide.

Total soil nitrogen doubled under the mulch treatments from 0.05 to 0.1 % w/w compared to the herbicide. The straw treatment had a significant increase in tissue nitrogen compared to either herbicide or compost. Both straw and compost treated soils approached adequate nitrogen levels. Straw mulched vines had fivefold increase in tissue nitrate nitrogen compared to either herbicide or compost treated vines. This result may be due to the much higher soil moisture levels found under the straw treatment.

Soil phosphorus doubled under both treatments from 11.2 to 24 % w/w. Levels under straw and compost treatments approached the bottom end of adequate soil phosphorus levels. Tissue phosphorus in the herbicide treatment did not reflect the deficient soil level and approached an adequate level. Compost treatment was mid range and showed the biggest increase to 0.30mg/kg.

7. *Outcomes and Conclusion*

The experiment found a strong positive correlation between soil moisture level and soilbiota under the straw treatment. Straw had higher soil moisture levels and higher soilbiota levels. Robinson (1992) reports that nitrogen is taken by vines from the soil solution. The resulting Tissue levels of the water soluble nutrients of nitrogen (as nitrate) this result may also be due to the higher soil moisture levels facilitating uptake. Improved soil moisture retention improved uptake of water soluble nutrients.

Gourlay (1999) states that plant potassium is almost entirely taken from potassium in the soil solution. Soil potassium levels increased substantially under treatments but plant tissue levels were in the adequate range for all treatments. Despite the high soil potassium and increased soil moisture under straw little variation in plant tissue levels were found. Possibly vine self regulation may be influencing the uptake of potassium?

Phosphorus levels increased under both treatments in both soil and plant tissue. Moody and Bolland (1999) reported evidence that increased soil organic content both increased phosphorus sorption and decreased phosphorus sorption. Agnew et al (2002) reported increases in soil phosphorus after the first year and a tissue analysis results that varied markedly between sites. All sites showed an increase in tissue phosphorus over the trial.

Both straw and compost mulch increased Cation Exchange Capacity (CEC). Both treatments had soil organic levels compared to herbicide. McCarthy et al (1992) identify that increasing soil organic material results in an increase soil CEC. Compost and straw treatments showed increases in the cations that are assessed in CEC. Both treatments showed an increase in calcium, potassium, while straw treated area increased magnesium and compost treated area increased sodium.

Soil pH increased from $pH = 4.92_{(CaCl)}$ under herbicide to $pH = 5.75_{(CaCl)}$ under compost. Soil pH (Northcote 1988) is controlled by the CEC. Typically increased CEC would be associated with increases in soil pH and increases in potassium, calcium and magnesium. Both CEC under straw and compost are similar. However the increase in soil pH is not. Possible factors for this observation are the level of organic material in the soil and the rate mineralisation of soil organic material. Agnew et al (2002) found minor pH increases.

From this experiment I would recommend the use of straw as a mulch treatment, ahead of compost for a vineyard with similar soils and climate, for the following reasions.

cheaper than compost to apply

gave better soil moisture retention

gave similar change in the cation exchange capacity

showed improved tissue nutrition levels

However the straw treatment showed an increase in soil magnesium levels which may present problems on some sites.

8. References

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