Innovation Vineyard Project Report

Title: Under vine Mulching. Perceived benefits.

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Date: 24th September 2019.

Abstract

The Dudley block at Ben McLauchlan's has an inherently low level of organic matter as determined from soil test results. This was confirmation by low EM survey values. High penetrometer readings indicated places of high compaction; this being exacerbated where vehicle wheel movements predominate.

Only flat weed species were present; little in the way of other weed species that could penetrate through the compaction that has built up over a period of time.

Could mulch be used to improve soil and vine health in a sustainable manner for both the vineyard and the greater winegrowing industry?

Mulch was applied under vine in May 2018. No pre-application soil surface preparation was conducted. Mulch was placed as a strip, 250m deep. Observations 16 months later in September 2019 found that the mulch had compacted to 20% of its original application depth. Weeds had been supressed to about 50% of the non-mulched rows. Worm activity was present in the A soil horizon, but no noticeable mixing of soil and mulch had taken place. To date (early spring 2019), the mulch had essentially created cap on top of the soil.

Penetrometer readings also confirmed that soil compaction was receding compared to where no mulch had been applied.

Several benefits have already been noted; improved soil and vine health. Vine vigour had improved and increased the uniformity of vine canopy throughout the mulched rows.

On-site marc composting could be more cost effective and allow greater marc volume utilisation as costly mixing additives would not be necessary.

Introduction

Question. Could the Innovation Vineyard Project look to return its waste organic material from harvest, and utilise it to solve a couple of concerns?

Concern 1. The Dudley block A soil horizon consists of a clay silt loam, that has little organic matter, and can dry out quickly in the summer, hence requiring significant irrigation input and trimming to grow and manage quality canopy, and mature the crop.

Concern 2. Crop is being removed each harvest. From this volume, 20 to 24% of this material is waste grape marc left over from the winery that needs to be disposed of.

Grape marc is the solid remaining waste residue after the winemaking process; skins, seeds, some rachis stalk and left-over pulp that is generated from the pressing process. Hirlam et al. (2017). Marc is not a homogenous product. It can have origins from either white or red grapes, and of various levels of post stock piling treatment; all availing to marc with differences in constituents and concentrations.

Many studies have and are being conducted to look at both the extraction of products from grape marc, as well as value adding. For example, the extraction of tartrates and ethanol, or the production of biofuels, seed oil extracts, animal feeds, composts and biochar for soil amendment.

To address the two primary concerns, Ben McLauchlan looked at options to incorporate grape marc with other products to produce an optimum material for strip placement under-vine. Typical analysis of marc applied to land according to Laurenson & Houlbrooke (2012) is 8% seeds, 10% stems, 25% skins and 57% pulp.

Parameter	Fresh[#]	Composted
Dry matter content (%)	49	42-53
pH		
EC (dS/m)		
Total nitrogen (%)	1.2-1.88	1.5-2.2
Total phosphorus (mg/L)	2500	1700-3100
Total potassium (mg/L)	24000	23000-31000
Total sodium (mg/L)	550	370-740
Total calcium (mg/L)	5400	5200-9800
Total magnesium (mg/L)	2200	1600-2500
Total sulphur (mg/kg)	1400	1300-2000
C:N Ratio	21	15-21
Trace elements (mg/kg)		
Copper	83	49-95
Zinc	62	23-34
Manganese	130	38-86
Molybdenum	<10	<10
Iron	6400	3000-5100
Boron	25	23-53
Other metals (mg/kg)		
Asenic	2.4	<0.02-1.5
Cadmium	<0.5	<0.5
Lead	<10.0	<10.0
Mercury	0.079	0.055-0.096
Selenium	0.14	0.031-0.089
Aluminium	11000	4000-9100
Chromium	16	7-15
Nickel	6	<5

[#] based on a single sample of grape marc that was 3 months old with exception of total N where n= 8.

TABLE 1. SELECTED CHEMICAL CONCENTRATIONS OF WINERY WASTEWATERS. LAURENSON & HOUBROOKE (2012).

Composts and mulch provide many benefits for the vineyard;

- **Compost** – Is a soil amendment resulting from the decomposition of organic materials. Producers must subject this to a “time and temperature” process that kills pathogens and weed seeds. Compost is commonly added to increase soil organic matter, retain moisture, increase microorganism diversity and increase porosity.
- **Mulch** – Can consist of many mediums such as coarsely ground up organic matter or shells. Mulch is commonly used for erosion control, moisture management, reduced topsoil temperature fluctuations and weed suppression.

There were concerns arounds pH and C:N ratio of composted grape marc. Ben looked to produce a mulch mix that would be beneficial; help with his soil moisture retention, but would decompose over time and become incorporated for improving soil quality and microbial health.

Analysis suggests typical grape marc components to be as in Table 1.

C:N ratio of 21 would suggest a high primary organic carbon source for soil microbe energy. Hill Laboratories (n.d.). Hill Laboratories would advise C:N ratios above 25 could immobilise N in the soil; it is utilised by microbes for their own requirements, thus drawing levels away from the vine. At a C:N of 21, organic matter decomposition will proceed to produces mineralised nitrogen that is surplus to the microbe's requirements; hence available to the vine. See Table 1.

pH of grape marc can vary anywhere between 3.8 for fresh marc, to 7.5-8 for composted grape marc with stems. Moldes et al. (2006). Such pH extremes could be detrimental to the soil underneath; changing it to undesirable levels and impact on potential vine nutrient availability. A low pH decreases the binding of cations (Ca, K, Mg) to soil particles, increasing their susceptibility to leaching, as well as making metal ions more available (Cu, Fe, Mn, Ni, Zn) and potentially toxic.

We also want to build levels of soil microbes. Microbes decompose organic matter, incorporating the constituents into their own body mass – potential source of available vine nutrition. These too prefer a neutral soil pH of 6-7. McCauley (2009).

It is also hoped that the mulch layer will increase the soils water holding capacity, and suppress weed growth under vine.

Materials and Methods

1.5 ha of the Dudley Block, clone 6 Chardonnay was managed under vine with marc mix. Application was made in May 2018.

A local winery was used to source grape marc. Other inputs for carbon, a mix supplied by Wholesale Landscapes (See appendix); aged bark fines and wood shavings. The overall mix applied to the under-vine rows was;

- 50% grape marc,
- 10% wood shavings,
- 40% bark fines.

The marc and additives were delivered to site from a supplier – Wholesale Landscapes (See appendix). Material was briefly stock piled and mixed with front end loader.

The marc mix was spread by a side discharging mobile hopper that placed it under vine in the weed strip. It was spread to a height of 250mm as a mounded row, which worked out at $300m^3$/3m row ha.

FIGURE 1. SIDE DISCHARGE HOPPER FOR SPREADING MARC MIX UNDER VINE. PHOTO LIBRARY. MCMILLAN (2019).

Results

- The marc mix when applied had a C:N ratio of 30, and the pH was 6.6. See Appendix.
- Observations through the growing season of V2019 indicated;
    - An improved water holding capacity.
    - More uniform canopy growth, even though it had gone through a very dry and hot summer.
    - Less compacted soil as measured by a penetrometer test.
    - The mulch depth had decreased from 250mm to 50mm over a 16-month period.
    - The mulch mix component of wood chip was still very noticeable – little decomposition.
    - There was no soil and mulch mixing at the interface with the soil surface.
    - Similar worm activity in the A horizon under the mulch as compared to worm activity in rows where no mulch had been applied. No worms were seen in the mulch zone.
    - Under vine weed growth in winter July 2019 was suppressed to about 50% of the non-mulched under vine rows. Grasses regress, but not flat weeds.

FIGURE 2. NON-MULCHED UNDER VINE WINTER WEED COVER

FIGURE 3. MULCHED UNDER VINE WINTER WEED COVER

FIGURE 4. MULCH LAYER AFTER 16 MONTHS ON TOP OF A-SOIL HORIZON.

Mulch Calculations - Free marc and delivery			
			Total Costs
Material Inputs	Per m3	Mix ratio	
Grape Marc	$ -	0.5	$ -
Wood Shavings	$ 28.00	0.1	$ 2.80
Aged Bark Fines	$ 34.50	0.4	$ 13.80
Marc Mix Cost per m3	$ 16.60		**$ 16.60**
Total Volume m3	450		
Total Cost of materials	$ 7,470.00		**$ 7,470.00**
Mixing with front-end loader tractor			
Hours	12		
Cost per hour	$ 100.00		
Total Cost Mixing	$ 1,200.00		**$ 1,200.00**
Tractor Cost per m3	$ 2.67		
Spreading			
Spreader Hire Per Day	$ 400.00		
Days	3		
Cost of Spreading	$ 1,200.00		
Tractor Hours Cost	$ 2,400.00		
Spreading Cost per m3	$ 8.00		
Total Cost of Spreading	$3,600.00		**$ 3,600.00**
Tot. Material & Spreading Cost /m3	$ 27.27		
Mulch Strip			
Height	0.25	m	
Width	0.75	m	
Per meter	0.09375	m3	(1m x Height x Width)/2
Volume (m3) Per Km (1000m)	93.75	m3	
Row Spacing 3m equals 3.33km	312.19	m3 per hectare	
Number of spread Ha	1.44	Ha	
Total job cost to apply 450m3 mulch	$12,270.00		**$12,270.00**
Cost per Hectare	$ 8,512.31		
Rotation Years	5		
Cost/year/Ha	$ 1,702.46		

TABLE 2. COSTS ASSOCIATED WITH MATERIALS AND APPLICATION UNDER VINE

Discussion and Conclusion

Fresh grape marc on its own could lead to soil imbalances.

Mixing marc with other materials facilitated the neutralising of the pH of any leachates that could move into the soil profile. Any such low pH leachate would cause a detrimental/toxic release of cations. Soil Health (n.d.).

Worms and other larger soil organisms like ants and mites, are responsible for fragmenting organic material, increasing the surface area, and allowing smaller microorganisms to colonise and then decompose. Soil Health (n.d.). Observation suggests that over the past 16 months, marc and bark fines have decomposed well contributing to a significant reduction in the original mulch volume. Wood chip content with its high lignin: cellulose content, is only now decomposing. Worms have not yet been enticed to rise into the mulch layer and facilitate mixing.

By adding the high C:N ratio wood shavings, we elevated the C:N ration to 30. This helped to aerate the marc mix so that it would be less likely to form an anaerobic cap on the soil surface. But this could have had a negative impact on vine vigour. During the decomposition process where microbial breakdown is taking place, limited N would necessitate fungi and bacteria to utilise all the N in the mulch, as well as scavenge N from surrounding soil - immobilisation of N for their own. Plants are not as efficient at competing with microorganisms for nutrients like N. If the mulch had been incorporated into the soil, we could have seen a reduction in vine vigour due to this competition requirements; a point that would have undone the aim of mulching - to increase uniformity and vigour in lower vigour areas. As the marc mix decomposes, its C:N ratio will continue to fall, allowing a surplus of N release to become available and utilised by the vine, and potential positive impacts on vigour.

Any reduced vigour may have needed fertigation to manage; at least in the short term. This was not the case.

Moisture management: Such measurements were not taken, so no comment can be made. As the V2019 season we vary dry, it would have been interesting to note any restraining impact the mulch would have had to water loss.

Weed suppression: Figures 2 and 3 highlight the suppression to weed development over the first 16 months of mulch cover. Where the mulch had been placed, there was a 50% reduction in weed growth. The weeds that came away were predominantly grasses; a complete change from the previous flat weed population. This suppression would have reduced competition to the vines for nutrients and moisture.

Cost benefits: Our project example would suggest that applying mulch under vines does not come cheap. At $8500/ha it is a significant expense, even with efficient application equipment for delivery to the targeted under vine strip. 39% of the cost is in the application. The marc mix being 61% of the total cost is where the biggest savings could come.

If other materials were unnecessary for balancing the properties of our marc, the only cost would be in spreading; $2500/ha. Distribute this cost over 5 years would have an annual cost of $500/ha.

Other materials were added to our marc to lift its pH and open it up to reduce anaerobic capping. What if we could stock pile and mature marc and not have the added material input costs? This could be a feasible option via on-site purpose-built marc composting pads; manage the decomposition and maturing of marc prior to spreading. The capital expense of a pad would need exploring.

Short term, this is costly in both time and capital inputs. Long-term, this exercise has shown that mulching can deliver very cost-effective benefits for certain blocks.

Blocks that have limiting factors such as poor nutrient and water holding capacity, and poor microbiology and organic matter levels, when combined, all impact on vine health and fruit quality. Inter and intra block uniformity is often one of the most difficult issues to address.

Poor uniformity impacts on the current season; quantity and quality both impact on grower returns and reputation. Vine condition for coming season is also impacted; balance the need to ripen the current crop, and store reserves for the next. To have the ability to apply mulch to improve struggling blocks, or address stony ridge sections could be very beneficial in lifting uniformity, hence financial return.

Our trial block showed significant improvements in vine and soil health after just one growing season.

1. The vine canopy filled uniformly; a stronger photosynthetic source to develop and fully mature its grape crop.
2. Reduced between vine variability, improving the effectiveness of vineyard activities times to key phenological and physiological stages.
3. Soil compaction decreased suggesting improvement of the environment for root growth and microbial activity.
4. Cane quality for to coming season was not assessed, but one would think that better balanced vines would have better reserves and quality cane.

If marc was applied every 5 years, the annual expense of $1700/ha would only necessitate an increase in production from these vines of 1.0T/ha to pay for it. Stronger, healthier, more balanced vines, able to consistently carry a bigger crop to maturity could well be sustainable going forward. And if on-site marc maturing was conducted, this cost could considerably reduce further.

But several areas need future consideration.

- The need to comply with council regulations; both storage and spread depth. Very hard to get detailed information from council.
- Explore the cost benefit of composting mulch on-site.
- Can we better facilitate the integration of the mulch into the soil profile? Could rotary tillage or use of small tines across the soil surface prior to spreading mulch facilitate this? Would this speed incorporation and improvements to soil and vine? September observations showed little interaction between the mulch and A horizon of the soil. Worms were not moving up into the mulch to help facilitate the mixing with soil lower down.
- This is a long-term project. We need to consider the benefit of future record keeping. Long-term cost benefits will not be realised with out measurables of vine and soil health, crop quality and volume, and impacts on water requirements.
    - Soil moisture probes between treatments would quantify differentiation in soil moisture for the same irrigation/rainfall inputs.
    - Crop levels and harvest quality parameters.
    - Measure cane quality for the coming season.
- Cost of marc and additives. Three quarters of the cost is associated with marc and mulch materials. Can these be sources more cheaply? If the vineyard had its own council approved pad, marc could be potentially provided free of charge by an associated winery. Composting would allow the marc to mature. Mature quality parameters may mean very little refining inputs prior to spreading.

- **Good to Excellence**. Adopt developed good practice into everyday excellence for all of our Cooperative vineyards.
- A sustainability story for our markets; shared inspire and differentiate the Cooperative vineyards from the rest of the industry.

FIGURE 5. BRAUN ROLLHARKE FOR ROUGHING UP THE UNDER-VINE STRIP PRIOR TO MULCH APPLICATION. BETTER FACILITATE MULCH AND SOIL INTERACTION.

FIGURE 6. THE RESULT OF UNDER VINE SOIL SURFACE PRE-TREATMENT PRIOR TO MULCH APPLICATION.

References

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Appendix.

- Wholesale Landscapes. www.wholesalelandscapes.co.nz
- IVP Compost Analysis for material applied to the Dudley Block

Hill Laboratories
TRIED, TESTED AND TRUSTED

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Certificate of Analysis

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CPv1

Client:	Wholesale Landscapes	**Lab No:**	2098247
Contact:	Wholesale Landscapes	**Date Received:**	15-Dec-2018
	PO Box 2180	**Date Reported:**	21-Dec-2018
	Stoke	**Quote No:**	
	Nelson 7041	**Order No:**	PO9575501
		Client Reference:	
		Submitted By:	Simon Kemp

Sample Type: COMPOST, General

Sample Name:		IVP Compost	Guideline NZS 4454:2005*	BioGro Std 2009 Appendix A**
Lab Number:		2098247.1		
Water Extractable Results				
pH	pH Units	6.6	5.0 - 8.5	-
Total Analysis Results - Dry Weight Basis				
Organic Matter*	%	44.2	Greater than 25	-
Total Carbon*	%	25.6	-	-
Total Nitrogen*	%	0.86	Greater than 0.6 (if a contribution to plant nutrition is claimed)	-
C/N Ratio*		30	-	-
Dry Matter*	%	65.4	-	-
'Total' Phosphorus*	mg/kg	1,149	-	-
'Total' Phosphorus*	%	0.11	Greater than 0.1 (if a contribution to plant nutrition is claimed)	-
'Total' Sulphur*	mg/kg	1,151	-	-
'Total' Sulphur*	%	0.12	-	-
'Total' Potassium*	mg/kg	3,810	-	-
'Total' Potassium*	%	0.38	-	-
'Total' Calcium*	mg/kg	7,390	-	-
'Total' Calcium*	%	0.74	-	-
'Total' Magnesium*	mg/kg	5,320	-	-
'Total' Magnesium*	%	0.53	-	-
'Total' Sodium*	mg/kg	96	-	-
'Total' Sodium*	%	< 0.01	-	-
'Total' Iron*	mg/kg	15,800	-	-
'Total' Manganese*	mg/kg	370	-	-
'Total' Zinc*	mg/kg	66	Less than 600	Less than 300
'Total' Copper*	mg/kg	67	Less than 300	Less than 60
'Total' Boron*	mg/kg	35	Less than 200	-

* New Zealand Standard Composts, Soil Conditioners and Mulches: NZS 4454:2005, Table 3.1. Test results apply to the sample(s) submitted for analysis and do not necessarily imply that the product meets all the requirements of the standard. Note that the laboratory methods used for these test results may differ slightly to those referred to in the standard.

** Bio-Gro NZ Organic Standards 2009, Appendix A, Table A3: Limits for Heavy Metals in Soils and Composts: BioGro Standard for compost - ingredients other than household waste. Other limits apply for compost with ingredients including household waste.

IANZ ACCREDITED LABORATORY

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Analyst's Comments

Sample 1 Comment:
Note 1: Reporting Units.
% = g/100g = g analyte/100g compost (dry weight basis)
mg/kg = ppm = mg analyte/kg compost (dry weight basis)
Electrical Conductivity units mS/cm = dS/m

Note 2: % x 10 = kg/T

Note 3: To calculate results to a fresh weight basis:
Result (dry matter basis) x (Dry Matter % / 100) = Result (fresh weight basis)

Sample 1 Comment:
Organic Matter Note: The relationship between carbon and organic matter varies according to organic matter type and soil type if soil is present in the product. Commonly used conversion factors range from 1.65 to 2.2 (Ref: NZS 445:2005). A Loss on Ignition (LOI) test may be requested if a more accurate organic matter value is required.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix.
Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.
Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: COMPOST, General

Test	Method Description	Default Detection Limit	Sample No
Sample Registration*	Samples were registered according to instructions received.	-	1
Media & Compost Prep (Dry & Grind)*	Oven dried at 105°C for 24 hours and ground to pass through a 2.0mm screen.	-	1
'Total' Sulphur*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	45 mg/kg	1
'Total' Sulphur*	Calculated from 'Total' Sulphur result for mg/kg (reported on a dry weight basis).	0.01 %	1
pH	1:1.5 (v/v) Water extraction followed by potentiometric pH determination.	0.1 pH Units	1
Total Carbon*	Sample dried and ground and analysed by Dumas combustion. Results expressed on a dry weight basis.	0.2 %	1
Total Nitrogen*	Sample dried and ground and analysed by Dumas combustion. Results expressed on a dry weight basis.	0.04 %	1
Organic Matter*	Dumas combustion. Organic Matter is 1.72 x Total Carbon.	0.2 %	1
Dry Matter*	Weight loss on drying at 105°C for 24 hours.	0.5 %	1
'Total' Phosphorus*	Calculated from 'Total' Phosphorus result for mg/kg (reported on a dry weight basis).	0.01 %	1
'Total' Phosphorus*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	65 mg/kg	1
'Total' Potassium*	Calculated from 'Total' Potassium result for mg/kg (reported on a dry weight basis).	0.01 %	1
'Total' Potassium*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	70 mg/kg	1
'Total' Calcium*	Calculated from 'Total' Calcium result for mg/kg (reported on a dry weight basis).	0.01 %	1
'Total' Calcium*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	100 mg/kg	1
'Total' Magnesium*	Calculated from 'Total' Magnesium result for mg/kg (reported on a dry weight basis).	0.01 %	1

Sample Type: COMPOST, General			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
'Total' Magnesium*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	40 mg/kg	1
'Total' Sodium*	Calculated from 'Total' Sodium result for mg/kg (reported on a dry weight basis).	0.01 %	1
'Total' Sodium*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	20 mg/kg	1
'Total' Iron*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	40 mg/kg	1
'Total' Manganese*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	3 mg/kg	1
'Total' Zinc*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	4 mg/kg	1
'Total' Copper*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	4 mg/kg	1
'Total' Boron*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	6 mg/kg	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

Andrew Whitmore BSc (Tech)
Client Services Manager - Agriculture