Studying the Effects of Fusion Gyp A & B on Soil Health, Plant Growth, Yield and Yield Quality of Shiraz Wine Grapes

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Abstract

Gypsum is used as a soil amendment to assist in improving soil structure in sodic soil. Gypsum not only improves soil structure, but it also can be a source of soluble essential plant nutrients calcium and sulfur which both improve plant health. This experiment was carried out to assess the effectiveness of Fusion Gyp A&B on improving soil health and crop performance in Shiraz wine grapes. A single application of Gyp A&B was done during the active growth period at the rate of 30L/ha. After six weeks of the application, chlorophyll, aerial drone photos, bunch weight, soil, and tissue nutrients, wine grapes quality including titratable acid pH, YAN, free anthocyanins, total phenolics, total tannins, etc. The application of Gyp A&B significantly improved the chlorophyll content in leaves and the greenness of the vines. Also, Gyp A&B improved the yield and yield quality of Shiraz wine grapes. Gyp A&B application improved the wine grapes' Brix levels by 2%, YAN by 13% and Anthocyanins by 9%. Also, it increased the bunch's weight by 7.6%. In addition, the application of Gyp A&B is beneficial in improving soil nutrients and soil structure. In conclusion, the application of Gyp A&B is beneficial in improving soil health, plant growth, yield, and yield quality in Shiraz wine grapes.

Keywords: Fusion Gyp A&B, Soil Structure, Plant Growth, Yield, Yield Quality

1. Introduction

In agriculture, gypsum is used as a soil amendment to assist in improving the soil structure in sodic and also magnesic soils (soils with high magnesium content). Gypsum is comprised of calcium sulfate dihydrate and had been used in agriculture for more than 250 years (Chen and Dick, 2011).

Often, gypsum is applied to the topsoil before planting or shortly after harvest. When applied to the topsoil, the gypsum then leaches down into the subsoil through irrigation and rainfall where its benefits can take effect. Gypsum can also be deep ripped into the soil to target the subsoil directly if there are hard clay pans. Deep ripping can also break up any hard soil and provide aeration. Gypsum can also be applied as a liquid soil amendment which works faster and more efficiently.

Gypsum not only improves soil structure, but it also can be a source of soluble essential plant nutrients calcium and sulfur which both improve plant health. Gypsum works by separating and disturbing the clay sheets in the soil. Large calcium ions replace the small sodium ions between clay sheets and move the clay sheets apart which breaks up the soil into smaller aggregates. This process helps to prevent soil dispersion, reduces surface crust formation, increases seedling emergence, and increases water infiltration rates in the soil (Chen and Dick, 2011). This process can also reduce the concentration of aluminum in the soil by replacing the aluminum ions with calcium and sulfur ions.

Powdered gypsum has been the main source of gypsum used in agriculture however recently liquid gypsum has come into the market with many benefits over traditional gypsum. Liquid gypsum is easier to handle and apply, it is fast acting and more mobile than natural gypsum, liquid gypsum guarantees a specific elemental analysis compared to natural gypsum and liquid gypsum reaches the subsoil much quicker than natural gypsum which can take many months or years to take effect in the subsoil.

Dual Chelate fertilizer has created a 2-part liquid gypsum soil amendment called Gyp A & B which can create calcium sulfate efficiently in the root zone. This effectively distributes the gypsum to where it is targeted in the subsoil. In this study, Fusion Gyp A&B once in the season to a Shiraz wine grape block which has clay soil with poor soil structure with aims to improve soil health and reduce Sodium and Chloride content in the soil and also increase calcium and sulfur levels in the grape vines.

2. Objectives

The specific objectives of this trial were to:

- Determine if applications of Fusion Gyp A&B increase the soil structure.
- Measure the chlorophyll in each treatment to check the impact of Gyp A&B application on vine growth and development
- Collect soil samples and test for increases in calcium and sulfur post-application.
- Collect tissue samples and test for increases in calcium and sulfur post-application.
- Determine the effectiveness of Gyp A&B application on yield and yield quality increment.

3. Materials and Methods

Site Selection and Trial Design

This trial was conducted in Piangil, Victoria on Shiraz wine grapes. Six adjacent blocks were selected for the trial and three blocks were treated with Gyp A&B and other blocks were considered as controls. Blocks selected for the treatment application had issues with higher Sodium levels and low wine growth. Three blocks were then treated with Gyp A&B at the rate of 30L/ha once during the active growth period. Measurements and sampling were taken before and after the treatment application. Table 1 shows the application rates and dates for the Fusion Gyp A&B trial.

Table 1: Application rates and application dates of Fusion Gyp A&B

Treatment	Rate (L/ha)	Application Date
Control	0 L/ha	N/A
Fusion Gyp A&B	30L/ha Gyp A 30L/ha Gyp B	22/11/2022 20/12/2022

4. Observations

Soil Nutrient Analysis

Soil samples (30cm deep) were taken before the application and 6 weeks post application of Gyp A and B. Soil samples were then sent to Analytical Laboratories & Technical Services Australia (ALTSA) for a full soil nutrient profile analysis. The soil was also tested for emersion classification, bulk density, soil color, and soil texture. The results were then analyzed using GraphPad Prism software to determine any significant differences in soil nutrient concentration between control and treated soil.

Chlorophyll (SPAD values)

Chlorophylls were checked 6 weeks after the treatment application. 30 leaves from each treatment were measured using the SPAD chlorophyll meter to check the greenness of each leaf. Each leaf had 5 tests taken from each side on the main vein and then averaged to get an average whole leaf reading.

Wine Grapes Quality Assessment

Grapes samples were collected at the commercial harvesting time in treated and control vines. Samples were taken randomly in each block. Wine grapes samples were then directly taken to Analytical Laboratories & Technical Services Australia (ALTSA) for a full nutrient profile analysis. At the same time, another set of samples was sent to the Australian Wine Research Institute for the wine grapes quality check including BRIX, free anthocyanins, total phenolics, total tannin, pH, titratable acid, Yeast Assimilable Nitrogen (YAN), etc. The results were then analyzed using GraphPad Prism software to determine any significant differences in grapes nutrient concentration and wine grapes quality between control and treated vines.

Comparative Drone Images

During the time of data collection, drone images were taken to visually compare shoot biomass between each treatment. A DJI Phantom 4 Pro drone was used to take these images.

5. Results

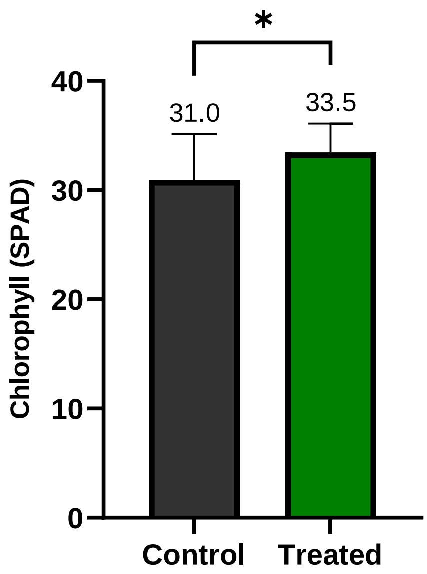

Figure *1*: Effectiveness of Gyp A&B application on leaf Chlorophyll (SPAD) content in vines after 4 weeks of the application.

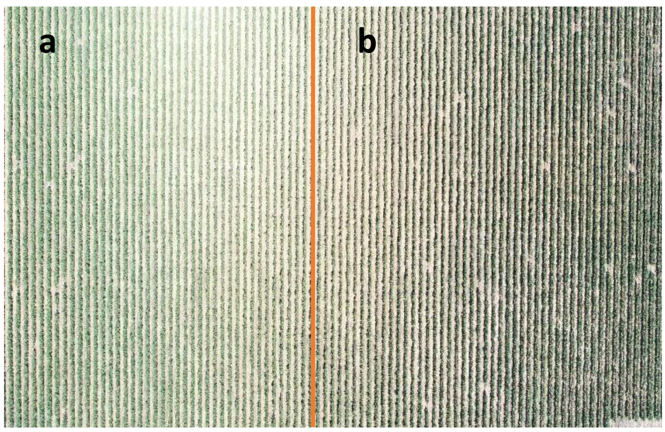

Figure *2*: Aerial drone image of the control and treated blocks after 6 weeks of the second application; (a) Control, (b) Treated.

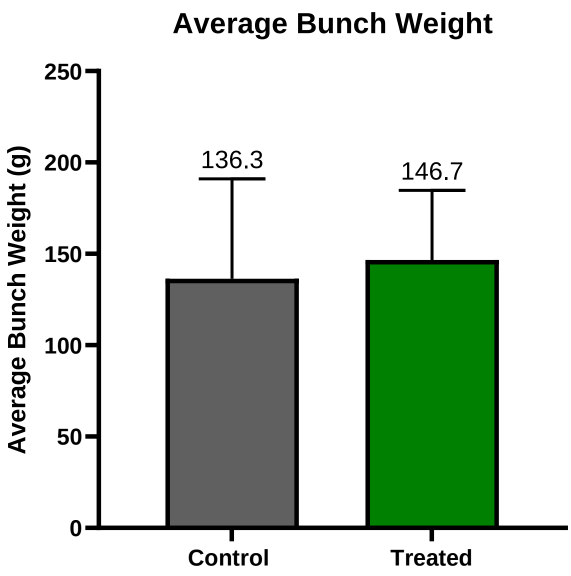

Figure 3: Average weight of grapes bunches collected from control and treated vines at commercial harvesting time.

Grapes bunches were randomly collected from each block to get the average bunch weight. Grapes collected from Gyp A&B treated had the highest bunch weight which is a 7.6% increment compared to the control.

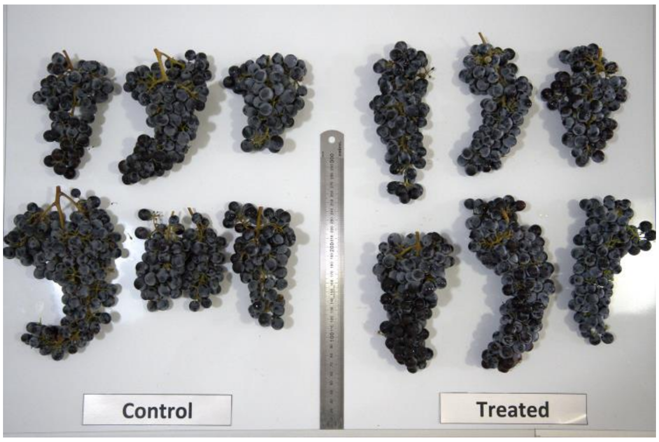

Figure 4: Visual comparison of grapes bunches collected from control and treated blocks at commercial harvesting time.

Table 2: Wine grapes nutrient analysis at commercial harvesting time.

Analysis	Control	Treated
Total Nitrogen	0.64	0.65
TD-Phosphorus (P)	0.198	0.186
TD-Potassium (K)	0.877	1.2
TD-Sulphur (S)	0.0594	0.0573
TD-Calcium (Ca)	0.193	0.164
TD-Magnesium (Mg)	0.0659	0.0643
TD-Boron (B)	40	27.6
TD-Copper (Cu)	6.9	6.4
TD-Iron (Fe)	<10	13.5
TD-Molybdenum (Mo)	<0.5	<0.5
TD-Manganese (Mn)	4.3	4.8
TD-Zinc (Zn)	6	5.4
Chloride (Cl)	<0.1	<0.1
TD-Aluminium (Al)	<100	<100
TD-Cobalt (Co)	<0.5	<0.5
TD-Nickel (Ni)	<0.5	<0.5
TD-Silicon (Si)	<100	<100
Nitrate Nitrogen	<50	<50
Total Carbon	42	42
TD-Sodium (Na)	0.0117	0.0101

Wine grapes were collected during the commercial harvesting time to check the impact of Gyp A&B application on the nutritional status of wine grapes. Results showed that the treated grapes had more Potassium than the grapes collected from control blocks.

Table 3: Wine grapes nutrient quality assessment at commercial harvesting time.

Analysis	Control	Treated
pH	3.73	3.99
Titratable acid pH 7.o	4.4	3.8
Titratable acid pH 8.2	4.6	4
Brix	21.2	22.7
Ammonia	75	84
Alpha Amino Nitrogen	10	10
Yeast Assimilable Nitrogen	67	76
Free Anthocyanins	1.01	1.17
Total Phenolics	127.75	124.30
Total Tannin	5.36	4.70

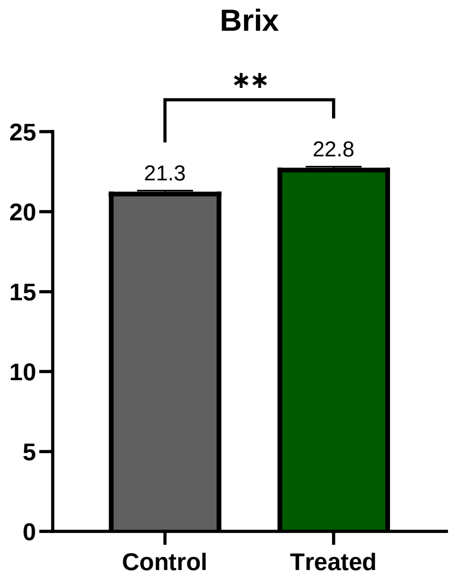

Figure 5: Average BRIX values of wine grapes collected from control and treated vines at commercial harvesting time.

Brix levels of the grapes were checked at the commercial harvesting time and Gyp A&B treated grapes had significantly higher Brix values compared to the control which is a 7% increment.

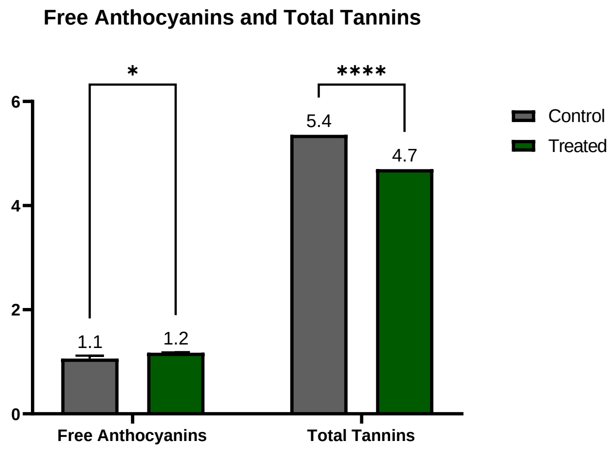

Figure 6: Free Anthocyanins and Total Tannins of wine grapes collected from control and treated vines at commercial harvesting time.

Free anthocyanins and total tannins of the wine grapes were checked by sending samples to Australian Wine Research Institute. Results showed that the Gyp A&B treated grapes had significantly higher free anthocyanins which is 9% increment. However, treated grapes had significantly lower total tannins compared to the control.

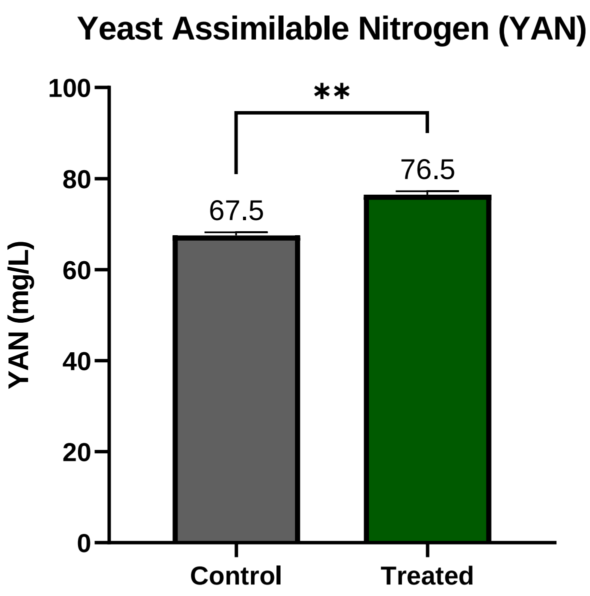

Figure 7: Yeast Assimilable Nitrogen (YAN) of wine grapes collected from control and treated vines at commercial harvesting time.

Table 4: Comparison of soil nutritional status of Gyp A&B treated and control blocks after 6 weeks of the treatment application.

POST-Application Soil Testing		
	Control	**Gyp A&B**
pH (H_2O)	7.3	7.7
EC (mS/cm)	0.03	0.06
Total C (%)	0.23	0.34
Total N (%)	<0.05	<0.05
Nitrate N (mN/kg)	<2	<2
Ammonium N (mgN/kg)	2.5	3.8
P (mgP/kg)	4.4	1.6
Cl (mg/kg)	19	28.7
K (mg/kg)	7.2	9.4
Ca (mg/kg)	8.7	18.6
Mg (mg/kg)	3.4	5.4
B (mg/kg)	<0.1	<0.1
Cu (mg/kg)	<0.1	<0.1
Fe (mg/kg)	<0.1	<0.1
Mn (mg/kg)	<0.1	0.1
Mo (mg/kg)	<0.1	<0.1
Zn (mg/kg)	<0.1	<0.1
Al (mg/kg)	<1	<1
Na (mg/kg)	16.3	28.6
Si (mg/kg)	6.3	11
S (mg/kg)	2	3.6
Ca (CEC%)	53.2	62.4
CEC – Ca:Mg Ratio	1.6	2.4

Table 5: Comparison of petiole nutritional status of Gyp A&B treated and control vines after 6 weeks of the treatment application.

POST-Application Tissue Testing		
	Control	**Gyp A&B**
Total N (%)	0.51	<0.5
P (%)	0.0954	0.0979
K (%)	3.4	2.85
S (%)	0.102	0.0801
Ca (%)	2	2.22
Mg (%)	0.833	0.824
B (mg/kg)	43.1	32.6
Cu (mg/kg)	42.1	42.9
Fe (mg/kg)	15.1	21.5
Mo (mg/kg)	<0.5	<0.5
Mn (mg/kg)	147	215
Zn (mg/kg)	15.2	21.2
Cl (%)	0.197	0.249
Al (mg/kg)	<100	<100
Co (mg/kg)	<0.5	<0.5
Ni (mg/kg)	0.9	0.9
Si (mg/kg)	<100	110
Nitrate N (mgN/kg)	<50	<50
Total Carbon (%)	38	38
Sodium (%)	0.195	0.152

6. Discussion

After six weeks of the treatment application, the Chlorophyll content of leaves was measured by using a SPAD chlorophyll meter. Gyp A&B treated blocks had significantly higher chlorophyll content compared to the control blocks (Figure 1). Numerous studies have found that there is a relationship between the SPAD values and the leaf chlorophyll content as well as leaf Nitrogen content (Xiong et al., 2015). Aerial drone images were taken after six weeks of the treatment application. Gyp A&B treated blocks showed more greenness and evenness compared to the control blocks (Figure 2). Hence, the highest chlorophyll results can be explained by the aerial drone image as treated blocks have more chlorophyll and more greenness compared to the control block. Similar to these results, Amer, Aboelsoud, Sakher, & Hashem found that the application of gypsum significantly increased the leaf chlorophyll content I faba beans.

Grapes bunches were randomly collected from each block at the commercial harvesting time to assess the impact of Gyp A&B on yield increment. Gyp A&B treated block had the highest average bunch weight compared to the control (Figure 3). A few bunches were randomly selected and took photos for visual comparison. Treated bunches looked more filled and long compared to the control (Figure 4). It was well documented that the application of gypsum caused to increase the crop in many crops such as corn, alfalfa, wheat, white oats, barley, rice, etc. (De Castro Pias, Tiecher, Cherubin, Silva, & Bayer, 2020; Toma, Sumner, Weeks, & Saigusa, 1999).

Wine grapes quality analysis was done by sending samples to two independent laboratories in Australia. Table 3 shows the wine grapes quality check results and according to that treated grapes had lower titratable acid pH, total phenolics, and higher ammonia compared to the control.

The BRIX levels of the wine grapes collected from Gyp A&B wines were significantly higher than the control which is a 7% increment. (Figure 5). A higher BRIX level is accountable for the higher maturity rate and higher sugar accumulation in grapes berries. Therefore, these results indicated that the Gyp A&B application improved the sugar accumulation and maturity in wine grapes. Yeast Assimilable Nitrogen (YAN) is another wine grapes quality parameter that is associated with the wine fermentation process. In this study, it was found that the wine grapes collected from treated blocks had significantly higher YAN levels compared to the control which is a 13% increment (Figure 7). Higher YAN is good for wine fermentation and therefore it is directly affected to the wine quality. In addition to the Brix and YAN, grapes were tested for free anthocyanins and total tannins. Grapes collected from Gyp A&B treated blocks had significantly higher free anthocyanins. Free anthocyanins are responsible for good color in wines. As treated blocks had significantly higher free anthocyanins, it ensures that Gyp A&B application is beneficial in improving wine color and thereby wine quality (Figure 6). Total tannin is associated with wine quality and higher tannin ensures good quality. However, in this study, we found that treated grapes had fewer tannins compared to the control (Figure 6). Furthermore, grapes berries were tested to check the nutritional status of the control and treated berries (Table 2). Gyp A&B treated grapes had higher Potassium and Magnesium levels.

After six weeks of the treatment application, soil, and tissue samples were analyzed to check the nutritional status in control and treated blocks. Treated blocks had comparatively higher levels of soil pH and some nutrients such as Nitrogen, Potassium, Calcium, Magnesium, Silicon, Calcium, and Ca: Mg ratio (Table 4). Tissue testing results showed that treated vines had comparatively higher levels of Potassium, Calcium, Iron, Manganese, Zinc, and Silicon Table 5). Calcium plays a crucial role in fruit growth and quality in grapes. Also, calcium is beneficial in maintaining the firmness of the cell wall (Gomes et al., 2020). Therefore, higher calcium levels in grapes berries ensure a high-quality yield. Hence, the application of Gyp A&B is beneficial in improving the quality of table grapes. Not only the Calcium but also the Silicon level is also significantly higher in grapes collected from treated blocks (Figure 8). Silicon is beneficial for plants to improve abiotic and biotic stress tolerance, pest and disease resistance and to manage the nutrients (Gomes et al., 2020). In addition, Gomes et al. revealed that the application of Calcium and Silicon improved vineyard productivity as well as wine grapes quality. Similar to these results, several studies have found that the application of gypsum is beneficial in improving plant growth and development as well as crop yield in different crops such as faba beans, Jasmin rice, and maize (Amer, Aboelsoud, Sakher, & Hashem, 2023; Cha-um, Pokasombat, & Kirdmanee, 2011; Downey, 1971). In addition, Saeed & Ahmad revealed that the application of gypsum increased the plant growth and yield in tomatoes.

Gypsum is used as a soil amendment to assist in improving the soil structure in sodic soil and also soil with high magnesium content. Gypsum is comprised of calcium sulphate dihydrate and had been used in agriculture for more than 250 years (Chen and Dick, 2011). It is well documented the benefits of gypsum application on plant growth and development. In addition, gypsum is one of the most frequently used soil amendments in sodic or saline soils to improve the soil structure (Naveed et al., 2021). Gypsum helps to maintain the high Calcium: Magnesium ratio and therefore it helps to minimize the soil dispersion. As proven by previous studies, in this study we observed that the application of Gyp A&B improved the soil Ca: Mg ratio compared to the control.

7. Conclusion

This experiment was carried out to assess the effectiveness of Fusion Gyp A&B on improving soil health and crop performance in Shiraz wine grapes. A single application of Gyp A&B significantly improved the chlorophyll content in leaves and the greenness of the vines. Also, Gyp A&B improved the yield and yield quality of Shiraz wine grapes. Gyp A&B application improved the wine grapes' Brix levels by 2%, YAN by 13% and Anthocyanins by 9%. Also, it increased the grapes' bunch weight by 7.6%. In addition, the application of Gyp A&B is beneficial in improving soil nutrients and soil structure. In conclusion, the application of Gyp A&B is beneficial in improving soil health, plant growth, yield, and yield quality in Shiraz wine grapes.

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Affinity Labs

ANALYTICAL SERVICE REPORT

Attention : Dinesha Madhushani
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Dual Chelate Fertilizer Pty Ltd

162 New Guinea Road

ROBINVALE

VIC 3549 AUS

Sample Received : 3 April, 2023

Report Date : 3 April, 2023

Report Type : Final

Report Number : 113366

Sample ID	Sample Description	Analysis	Method	Results	Units
AF66889	**Control**	pH	LM04	3.73	-
		Titratable acid pH 7.0	LM04	4.4	g/L
		Titratable acid pH 8.2	LM04	4.6	g/L
		Brix	GM03 *	21.2	°Brix
		Yeast assimilable nitrogen	GM170 *	75	mg/L
		Ammonia	GM170 *	10	mg/L
		Alpha Amino Nitrogen	GM170 *	67	mg/L
		Free Anthocyanins	GM107 *	1.01	mg/g
		Total phenolics	GM107 *	127.75	a.u./g
		Total tannin	GM107 *	5.36	mg/g
AF66890	**Treated**	pH	LM04	3.99	-
		Titratable acid pH 7.0	LM04	3.8	g/L
		Titratable acid pH 8.2	LM04	4.0	g/L
		Brix	GM03 *	22.7	°Brix
		Yeast assimilable nitrogen	GM170 *	84	mg/L
		Ammonia	GM170 *	10	mg/L
		Alpha Amino Nitrogen	GM170 *	76	mg/L
		Free Anthocyanins	GM107 *	1.17	mg/g
		Total phenolics	GM107 *	124.30	a.u./g
		Total tannin	GM107 *	4.70	mg/g

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Sample analysed as received.

Signatory:

Bryan Newell
Team Leader
Analytical Laboratory

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