Studying the Effects of Fusion Gyp A & B on Soil Health and Plant Growth in Crimson Table Grapes

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Abstract

This trial was conducted to analyse the effects that Fusion Gyp A&B has on clay-type soil, observe the nutritional benefits it provides plants, and measure changes in the volumetric water capacity of the soil. It was found that after 2 weeks post application of Gyp A&B, treated soil had a significantly higher percentage increase in the soil's volumetric water content than the control. This percentage increase was observed at the 10cm, 20cm and 30cm depths, showcasing the benefits of using liquid gypsum as opposed to traditional gypsum, which would have to be leached into the subsurface before a similar effect was observed. When sampling soil nutritional content before and after the application of Gyp A&B, it was found that there was a significant increase in the sulphur concentration in the treated soil compared to the control. This is due to the sulphur component of the liquid calcium sulphate (Gyp A). It was also observed that there was a significant decrease in the aluminium concentration in the soil after the application of Gyp A&B compared to the control. This is due to calcium ions displacing the aluminium ions in the soil, allowing them to leach out of the root zone and reducing the risk of aluminium toxicity.

Keywords: Fusion Gyp A&B, liquid gypsum, volumetric water capacity, sulphur, aluminium toxicity

1. Introduction

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

Gypsum is often applied to the topsoil before planting or shortly after harvest. When applied to the topsoil, the gypsum leaches down into the subsoil through irrigation and rainfall, where its benefits can take effect. If there are hard clay pans, gypsum can also be deep ripped into the soil to target the subsoil directly. 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 improves soil structure and can also be a source of soluble essential plant nutrients, calcium and sulphur, 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 aluminium concentration in the soil by replacing the aluminium ions with calcium and sulphur ions.

Powdered gypsum has been the primary 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, fast-acting, and more mobile than natural gypsum. Compared to natural gypsum, liquid gypsum guarantees a specific elemental analysis, and it reaches the subsoil much quicker than natural gypsum, which can take many months or years to take effect in the subsoil.

Dual Chelate fertiliser has created a two-part liquid gypsum soil amendment that efficiently creates calcium sulphate in the root zone. Gyp A is calcium sulphate in a liquid form that is applied through fertigation. Gyp B is then applied two weeks later through fertigation and converts the liquid calcium sulphate into a solid through an oxidation reaction. This effectively distributes the gypsum to where it is targeted in the subsoil.

In this study, Fusion Gyp A&B will be applied to a Crimson seedless block with clay soil and poor soil structure. The aim is to improve water infiltration, reduce sodium and aluminium content in the soil, and increase calcium and sulphur levels in the grape vines.

2. Objectives

The specific objectives of this trial were to:

- Measure the water infiltrate rate using a simple water infiltrometer and the permanent soil monitoring probe.
- Collect soil samples and test for increases in calcium and sulphur post-application.
- Determine if applications of Fusion Gyp A&B increase the soil structure.
- Collect petiole samples to test for increases in calcium and sulphur concentrations.

3. Materials and Methods

Site Selection and Trial Design

This trial was conducted in Merbein on a Crimson table grape block within the Sunraysia region of Victoria. The areas were divided into four irrigation sections, each roughly 4 ha. One 4ha section (section D) was a control, and another 4ha section (Section C) was treated with Fusion Gyp A&B. Section C has a soil monitoring probe that measures soil temperature, water volumetric content, and soil EC. Data was gathered before and after the application of Gyp A&B to get quantitative soil data.

Each section had roughly 20 rows of Crimson table grape vines. In sections C and D, the middle of the 10th row was selected to take measurements to prevent biases. Fusion Gyp A&B was applied through drip irrigation to section C.

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 (Section D)	0 L/ha	N/A
Fusion Gyp A&B (Section C)	30L/ha Gyp A 30L/ha Gyp B	8/10/21 22/10/21

4. Observations

Soil Nutrient Analysis

Soil samples (30cm deep) were taken before application and 2 weeks post application of Gyp A and B. Samples were collected in the same spots pre and post-treatment. Three samples were taken in the treated and controlled areas for statistical analysis. Soil samples were then sent to Analytical Laboratories & Technical Services Australia (ALTSA) for a complete soil nutrient profile analysis. The soil was also tested for the emersion classification, bulk density, soil colour and soil texture. The results were then analysed using GraphPad Prism software to determine any significant differences in soil nutrient concentration between control and treated soil.

Petiole Nutrient Analysis

Petiole samples were taken before application and 2 weeks post application of Gyp A and B. Petiole samples were taken randomly in the 10th row in each treatment area. 3 Replicates per treatment were collected to analyse the leaf nutrient concentration differences between treated and control vines. Petiole samples were then directly taken to Analytical Laboratories & Technical Services Australia (ALTSA) for a complete petiole nutrient profile analysis. The results were then analysed using GraphPad Prism software to determine any significant differences in petiole nutrient concentration between control and treated vines.

Soil Infiltration Test

A simple manual single-ring soil infiltrometer was made using a 10.5 cm diameter PVC pipe to measure the water infiltration rate into the soil. The Murray Catchment Management Authority (NSW Government) was referenced when making this soil infiltrometer. A 20cm tube of PVC was cut. On the outside perimeter of the pipe, a 5cm line was marked, which indicated how far the pipe was to be hammered into the ground. On the inside of the tube, a 0.5cm mark was made from the top, which indicates when to start timing water infiltration, and two other lines, 5 and 10cm from the 0.5cm line, indicate when to record the time it takes for the water to drop from the initial 0.5cm line to the subsequence 5cm and 10cm lines (How to Measure Infiltration, 2012). Figure 1 shows the soil infiltrometer being used in the field. Measurements were taken in the treated and control blocks before and after applying Gyp A&B.

Collecting Data from the Soil Probe

In the Gyp A&B treated block, a soil monitoring probe measures soil temperature, volumetric water content, and electric conductivity at 10cm intervals from 10cm to 80cm. Measurement readings were taken pre- and post-application of Gyp A&B to see if there were any changes to soil structure and water infiltration after applying GYP A&B in the treated block.

Figure 1: Soil infiltrometer

5. Results

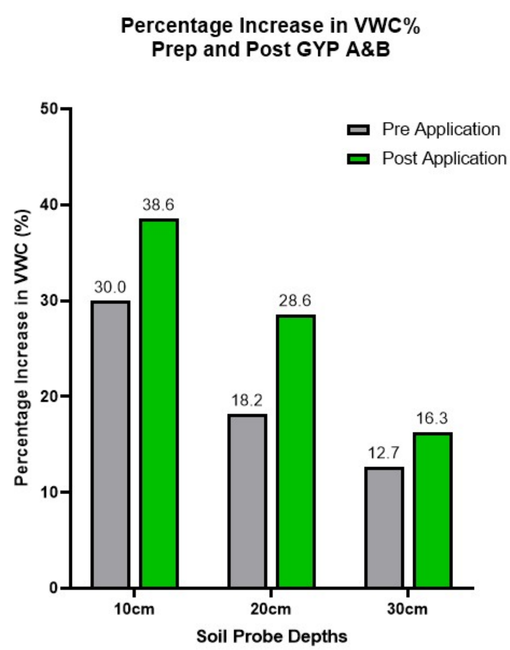

Figure 2: Percentage increase in volumetric water content in Gyp A&B treated soil pre and post application

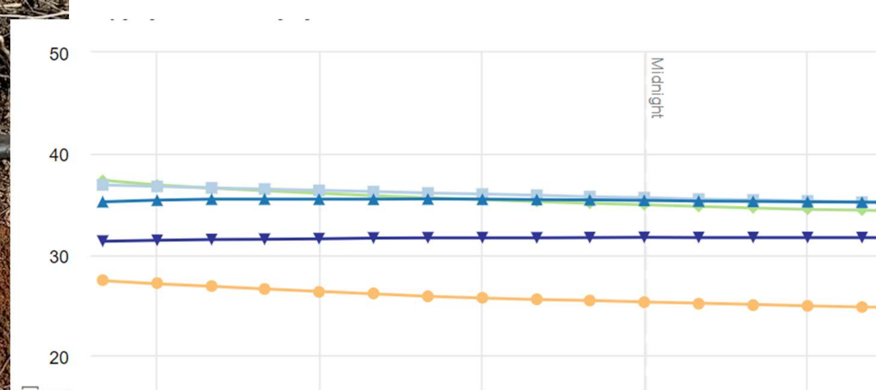

Figure 3: A screen capture of the soil probe data pre application of Gyp A&B

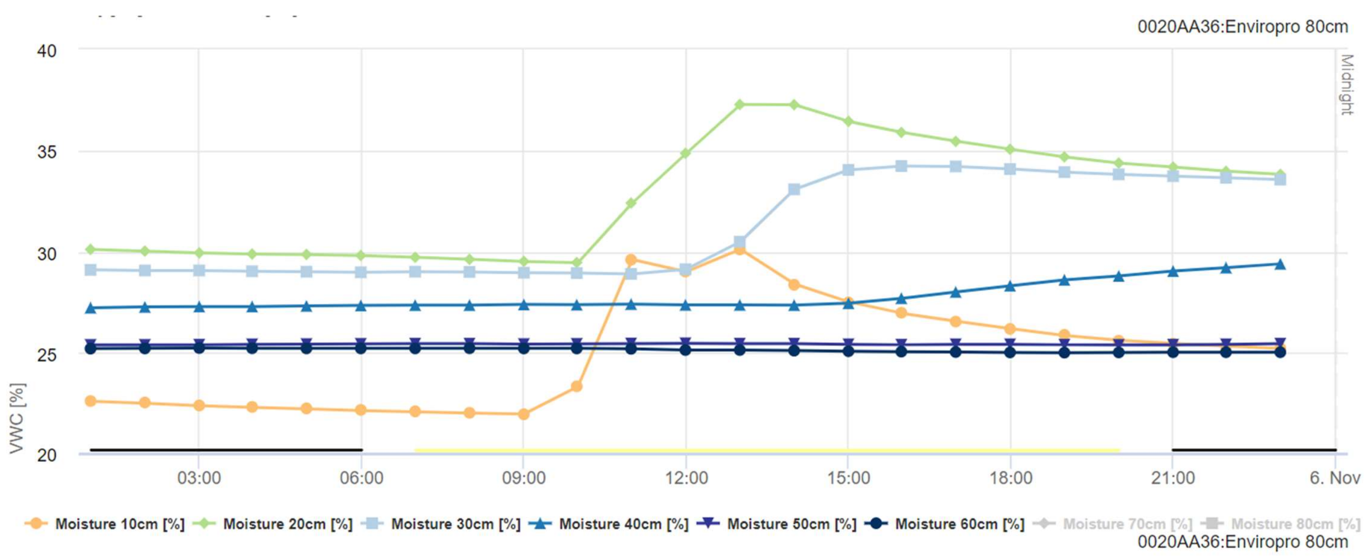

Figure 4: A screen capture of the soil probe data post application of Gyp A&B

Table 2: Pre Gyp A&B application petiole nutrient analysis

PRE-Application Tissue Testing		
	Gyp A&B	Control
Total N (%)	2.6	2.2
P (%)	0.51	0.49
K (%)	2.93	3.22
S (%)	0.269	0.266
Ca (%)	0.983	1.06
Mg (%)	0.407	0.388
B (mg/kg)	26.8	31.1
Cu (mg/kg)	13.1	12.9
Fe (mg/kg)	62.8	77.4
Mo (mg/kg)	<0.5	<0.5

Table 3: Post Gyp A&B application petiole nutrient analysis

POST-Application Tissue Testing		
	Gyp A&B	Control
Total N (%)	0.96	0.93
P (%)	0.295	0.335
K (%)	3.23	3
S (%)	0.125	0.146
Ca (%)	1.24	1.54
Mg (%)	0.52	0.563
B (mg/kg)	37.7	40.1
Cu (mg/kg)	7	6.9
Fe (mg/kg)	19.6	23.4
Mo (mg/kg)	<0.5	<0.5
Mn (mg/kg)	58.9	73.7
Zn (mg/kg)	24.5	27
Cl (%)	0.119	0.141
Al (mg/kg)	<100	<100
Co (mg/kg)	<0.5	<0.5
Ni (mg/kg)	<0.5	<0.5
Si (mg/kg)	130	140
Nitrate N (mgN/kg)	1360	1060
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Table 4: Pre Gyp A&B application soil nutrient analysis

PRE-Application Soil Testing		
	Gyp A&B	Control
pH (H_2O)	8.8	8.8
EC (mS/cm)	0.18	0.16
Total C (%)	2.2	2.0
Total N (%)	0.07	0.06
Nitrate N (mN/kg)	24.7	27.8
Ammonium N (mgN/kg)	2	2
P (mgP/kg)	37.5	42.2
K (mg/kg)	50.6	27.6

Table 5: Post Gyp A&B application soil nutrient analysis

POST-Application Soil Testing		
	Gyp A&B	Control
pH (H_2O)	8.8	8.8
EC (mS/cm)	0.21	0.19
Total C (%)	2.2	2.07
Total N (%)	0.0755	0.0623
Nitrate N (mN/kg)	26.1	24.7
Ammonium N (mgN/kg)	2	2
P (mgP/kg)	23.0	23.0
K (mg/kg)	51.9	33.8
Ca (mg/kg)	61.9	57.7
Mg (mg/kg)	10.8	10.3
B	0.3	0.3
Cu	0.1	0.1
Fe	5.3	8.2
Mn	0.2	0.2
Mo	0.1	0.1
Zn	0.1	0.1
Al	10.2	15.5
Na	26.8	36.2
Si	28.3	38.3
S	15.3	7.7

6. Di

Volum

A soil monitoring probe was used in the Gyp A&B treated block to measure increases in volumetric water capacity. This probe was permanently placed in the treated block and measured multiple different soil parameters, such as soil temperature, soil EC, and volumetric water capacity. Figures 3 and 4 show the volumetric water capacity of the soil (%) pre- and post-application, respectively. Irrigations were made approximately at the same time.

Figure 3 shows the pre-application soil volumetric water capacity, and there are only small increases in the capacity of water the soil can hold in the 10, 20 and 30cm depths. When comparing this chart to Figure 4 (post-application data), there is a significant increase in the volumetric water capacity %. The percentage increase in volumetric water capacity (VWC) % from the start to the end of each irrigation shift was calculated to quantify this data.

Figure 2 shows the percentage increase in VWC pre- and post-application. This graph clearly shows that two weeks after the application of Gyp B, there was a significant increase in the VWC% in the soil. A higher VWC indicates a higher water-holding capacity in the soil and the ability to hold water in the soil profile for longer. This trend was observed at 10, 20, and 30cm down in the soil profile.

Gyp A and B increased the VWC% by improving the water infiltration rate and soil structure. This is done by replacing small sodium and magnesium ions between clay sheets with larger calcium ions, which are contained in the Gyp A&B product. When calcium ions move between clay sheets, the soil structure is altered, and hard clay pans break up into smaller aggregates.

Petiole Tissue Analysis

Tables 2 and 3 show the pre- and post-application petiole tissue tests. It is hypothesised that after the application of Gyp B, there should be an increase in calcium levels in the petioles of the young grape vines. However, due to the vines being young and actively growing, calcium and other elements, such as phosphorus and nitrogen, declined in the post-application sampling. Therefore, there is no increase in these elements in the post-application tissue test.

Calcium would have been used to promote cell wall structure, stimulate root and leaf development, and improve disease resistance. Phosphorus would have been used to increase root production and stimulate early growth. Nitrogen assists in rapid growth and enhances nutrient uptake.

Soil Nutrient Analysis

Figures 4 and 5 show the pre- and post-application soil nutrient tests. Like the petiole tests, many nutrients in the soil may have been uptake and utilised due to the actively growing grape vines. However, Sulphur increased from 5.3mg/kg to 15.3 mg/kg in the treated block, a 188.7% increase from pre- to post-application sampling. In the control block, there was a percentage decrease of -18.9% for sulphur. Gyp A&B is comprised of soluble calcium sulphate, which is why there was a significant increase in sulphur in the soil of the treated block compared to the control.

Interestingly, the aluminium content in the treated soil decreased significantly to -50.5% after the application of Gyp A&B. In the control block, the decrease was much smaller, at -18.0%. Gypsum can reduce possible aluminium toxicity in the soil by displacing aluminium ions between the clay particles and calcium. This allows the aluminium to fall out of the soil profile and be leached away (Begum et al., 2016).

7. Conclusion

In conclusion, this trial was conducted to evaluate how a single application of 30L/ha of Gyp A and 30L/ha of Gyp B improves the soil structure, water infiltration rate, volumetric water capacity of the soil and assess the soil and petiole nutrient concentrations before and after the application of Gyp A&B.

When studying the figures presented, it can be found that soil treated with Gyp A&B had the following results:

- Increased the volumetric water capacity percentage of the soil significantly compared to the control.
- Significant increase in the sulphur concentration in the soil treated with Gyp A&B compared to the control soil.
- Significant decrease in the aluminium concentration in the soil after the application of Gyp A&B compared to the control

8. References

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