Studying the Effects of Fusion Gyp A & B on Soil Health and Plant Growth in Crimson Table 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 sulphur 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 crimson seedless grapes. Two applications were done during the active growth period at the rate of 30L/ha. After four weeks of the first application, chlorophyll and shoot length were measured. But there was no increment was observed in treated vines. However, after five weeks of the second application, Gyp A&B significantly improved the chlorophyll content in leaves. Also, Gyp A&B improved the bunch weight and BRIX levels in the treated block. Nutritional analysis was done for the grape berries, and Calcium and Silicon levels were significantly higher in grapes collected from treated vines. In addition, the application of Gyp A&B was beneficial in improving soil structure. Overall, the application of Fusion Gyp A&B is a highly promising strategy for soil health, plant growth and development, and crop yield.

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

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 sulphate 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 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 concentration of aluminium in the soil by replacing the aluminium ions with calcium and sulphur 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 sulphate 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 will be applied two times per season to a Crimson seedless block which has clay soil with poor soil structure with aims to improve water infiltration and reduce sodium and aluminium content in the soil and also increase calcium and sulphur 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 shoot length and 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 sulphur post-application.
- Determine the effectiveness of the Gyp A&B application on yield increment.

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 4 irrigation sections roughly 4 ha each. 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 was able to measure soil temperature, water volumetric content, and soil EC. Data were gathered before and after the application of Gyp A&B to get quantitative soil data.

Each section had roughly 20 rows of crimson table grapes vines. In both 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 the entirety of 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) – First Application	30L/ha Gyp A 30L/ha Gyp B	11/10/2022 25/10/2022
Fusion Gyp A&B (Section C) – Second Application	30L/ha Gyp A 30L/ha Gyp B	26/12/2022 09/01/2023

4. Observations

Soil Nutrient Analysis

Soil samples (30cm deep) were taken before the application and 4 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.

Soil Infiltration Test

To measure the water infiltration rate into the soil, a simple manual single-ring soil infiltrometer was made using a 10.5 cm diameter PVC pipe. 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 2 other lines 5 and 10cm from the 0.5cm line indicates when to record the time it takes for the water to drop from then 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 the application of Gyp A&B.

Figure 1: Soil infiltrometer

Shoot Length, Chlorophyll

To measure the shoot length, 50 shoots were randomly selected from each block and shoot lengths were recorded.

Chlorophylls were checked 4 weeks after the first application and 5 weeks after the second application. 30 leaves from each treatment were measured using the SPAD chlorophyll meter to measure 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.

Grapes Nutrient Analysis and BRIX

Grapes samples were collected at the commercial harvesting time in treated and controlled vines. Grapes samples were taken randomly in the 10th row in each treatment area. 3 Replicates per treatment were collected to perform a statistical analysis of the grapes' nutrient concentration differences between treated and control vines. Grapes samples were then directly taken to Analytical Laboratories & Technical Services Australia (ALTSA) for a full nutrient profile analysis. The results were then analyzed using GraphPad Prism software to determine any significant differences in grapes nutrient concentration between control and treated vines.
During the commercial harvesting time, 10 grapes bunches were randomly selected from each block to measure the BRIX in grapes.

Comparative Drone Images

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

5. Results

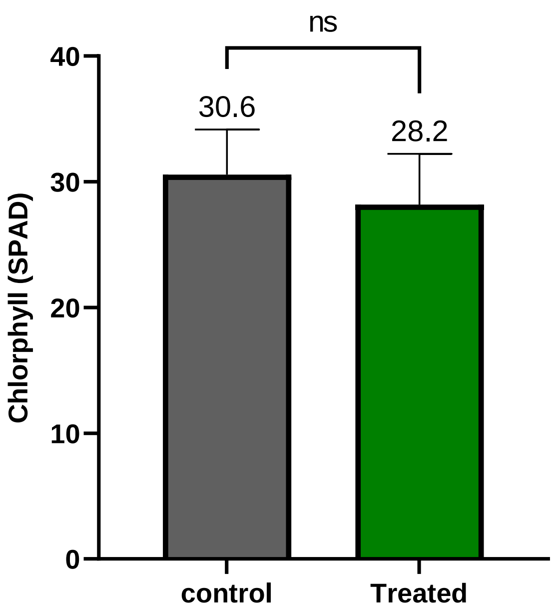

Figure *2a*: Effectiveness of Gyp A&B application on leaf Chlorophyll (SPAD) content in vines after 4 weeks of the first application.

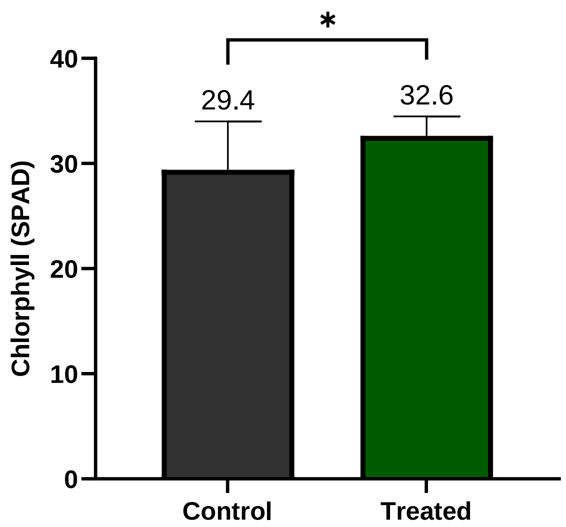

Figure *2b*: Effectiveness of Gyp A&B application on leaf Chlorophyll (SPAD) content in vines after 5 weeks of second application. Asterisks represent statistical significance (*p,0.05).

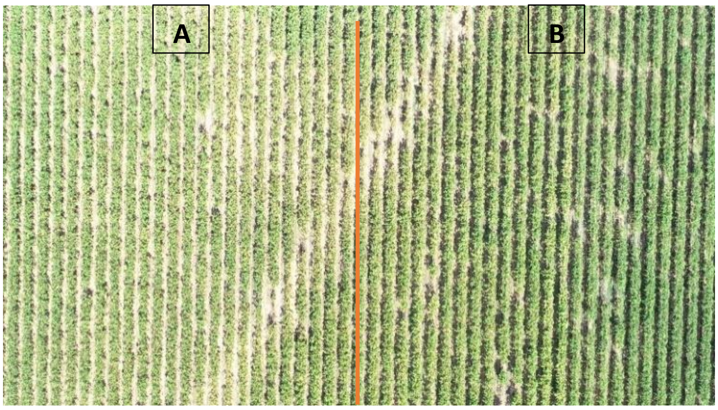

Figure *3*: Aerial drone image of the control and treated blocks after 5 weeks of the second application.

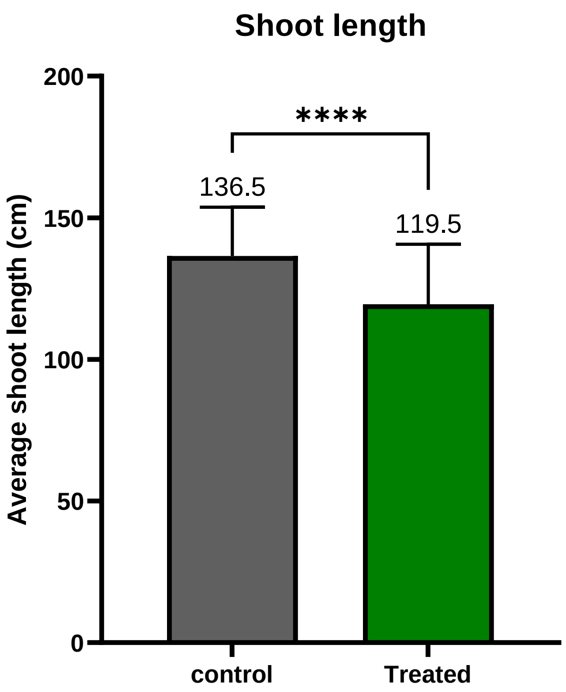

Figure 4: Average length of 50 shoots in treated and control vines after 4 weeks of the first application. Asterisks represent statistical significance (** p,0.0001).**

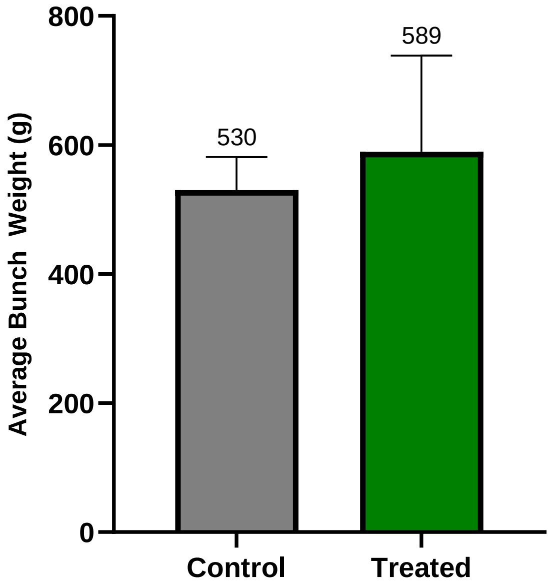

Figure 5: Average weight of grapes bunches collected from control and treated vines at commercial harvesting time.

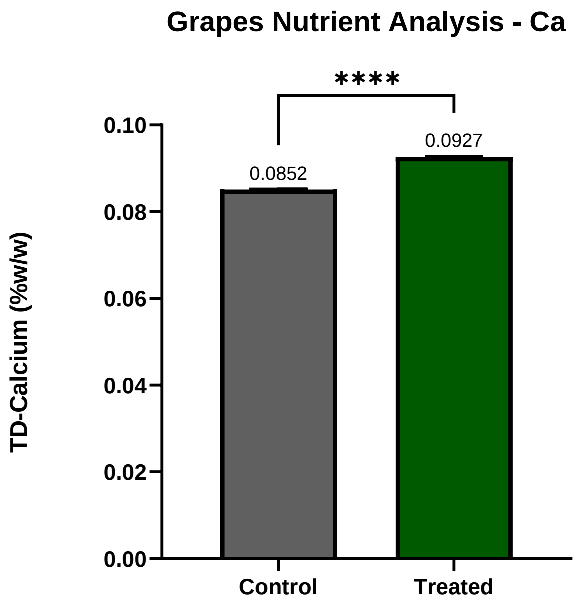

Figure 7: Calcium levels in grapes collected from Gyp A&B treated and control vines. Asterisks represent statistical significance (** p,0.0001).**

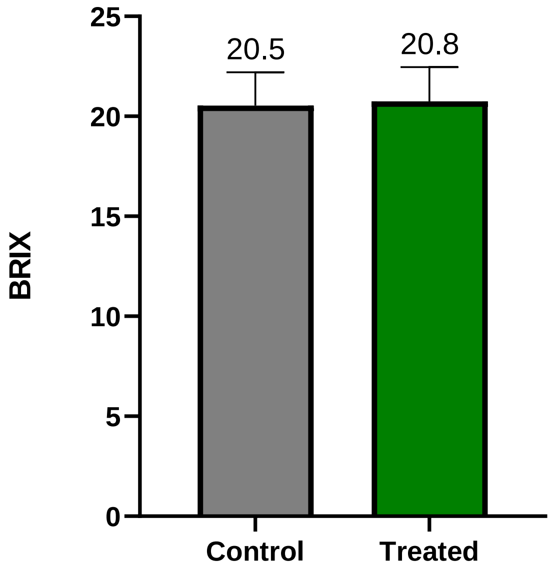

Figure 6: Average BRIX values of grapes collected from control and treated vines at commercial harvesting time.

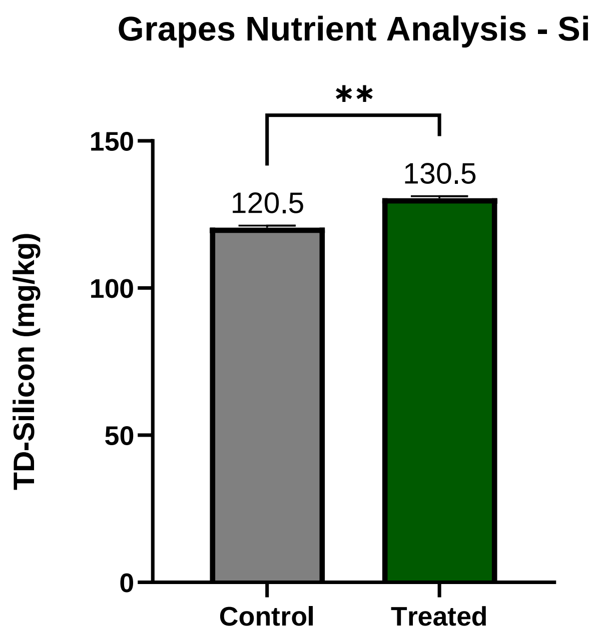

Figure 8: Silicon levels in grapes collected from Gyp A&B treated and control vines. Asterisks represent statistical significance (p,0.01).**

Table 2: Pre-Gyp A&B application soil nutrient analysis

Pre-Application Soil Testing		
	Control	**Gyp A&B**
pH (H_2O)	8.8	8.8
EC (mS/cm)	0.11	0.07
Total C (%)	2.2	2.5
Total N (%)	0.084	0.095
Nitrate N (mN/kg)	2.1	4.1
Ammonium N (mgN/kg)	<2	<2
P (mgP/kg)	2.9	2.8
K (mg/kg)	13.7	18.6
Ca (mg/kg)	57.9	65
Mg (mg/kg)	5.4	6.5
B	0.1	0.1
Cu	0.1	<0.1
Fe	0.2	0.1
Mn	0.1	0.1
Mo	<0.1	<0.1
Zn	<0.1	<0.1
Al	<1	<1
Na	6.3	6.1
Si	9	8
S	1.9	2.3
Ca (CEC%)	91.1	90.7
CEC – Ca:Mg Ratio	13.7	13.1

Table 3: Pre-Gyp A&B application soil nutrient analysis

POST-Application Soil Testing		
	Control	**Gyp A&B**
pH (H_2O)	8.7	8.5
EC (mS/cm)	0.19	0.19
Total C (%)	2.8	2.8
Total N (%)	0.084	0.077
Nitrate N (mN/kg)	<2	<2
Ammonium N (mgN/kg)	<2	<2
P (mgP/kg)	2.8	7
Cl (mg/kg)	51.6	79
K (mg/kg)	34.1	8.3
Ca (mg/kg)	109	106
Mg (mg/kg)	19.1	15.5
B	1.7	0.3
Cu	0.2	0.1
Fe	<0.1	<0.1
Mn	0.2	0.2
Mo	<0.1	<0.1
Zn	<0.1	<0.1
Al	<1	<1
Na	31.5	52.5
Si	11	11
S	13.7	13.7
Ca (CEC%)	86.9	90.1
CEC – Ca:Mg Ratio	8.6	11.6

Figure 9: Visual comparison of grapes bunches collected from control and Gyp A&B treated blocks.

6. Discussion

The chlorophyll content of leaves was measured by using a SPAD chlorophyll meter at two different stages of the growing season. After four weeks of the first treatment application, chlorophyll content was measured and there was no significant difference between control and treated blocks. However, the control block had slightly higher chlorophylls compared to the treated block (Figure 1). After five weeks of the second treatment application, significantly higher chlorophyll content was observed in Gyp A&B treated block compared to the control block (Figure 2b). 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 five weeks after the second treatment application. Gyp A&B treated block showed more greenness and evenness compared to the control block (Figure 3). Hence, the highest chlorophyll results can be explained by the aerial drone image as the treated block has 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. After four weeks of the first treatment application, 50 shoots were randomly selected from each block to measure the average shoot length. However, the control block had significantly the highest shoot length compared to the treated block (Figure 4).

At the commercial harvesting time, 20 grapes bunches were randomly collected from each block to measure the average bunch weight. Gyp A&B treated block had the highest average bunch weight than the control (Figure 5). BRIX levels of the grapes were checked by using the same sample and grapes collected from Gyp A&B treated blocks had comparatively higher BRIX levels than the control (Figure 6). Grapes berries were tested to check the nutritional status of the control and treated berries. Gyp A&B treated grapes had the significantly highest calcium and Silicon levels compared to the control (Figure 7). 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. A soil infiltration test was done by using a soil infiltrometer to check whether any differences between treatments. However, there was no difference was observed in the control and treated blocks.

Before and after the treatment application, soil samples were analyzed to compare the nutritional status of each block (Tables 1 & 2). Before the treatment application, both blocks had the same pH which is 8.8. However, after the treatment application, the treated block had a lower soil pH compared to the control. In addition, the treated block showed a higher level of Phosphorous, Calcium, and Calcium: Magnesium ratio compared to the control block. Figure 9 shows the visual comparison of grapes bunches collected from Gyp A&B treated and control blocks. 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 crimson seedless grapes. The application of Gyp A&B significantly improved the chlorophyll content in leaves after 5 weeks of the second treatment application. However, there was no increment in chlorophyll levels and average shoot length was observed after 4 weeks of the first application. Also, Gyp A&B improved the yield and yield quality in crimson seedless grapes as well as the Calcium and Silicon levels in grapes berries. In addition, the application of Gyp A&B was beneficial in improving soil structure. In conclusion, the application of Gyp A&B is beneficial in improving soil health, plant growth, yield, and yield quality in crimson seedless table grapes.

8. References

Amer, M. M., Aboelsoud, H. M., Sakher, E. M., & Hashem, A. A. (2023). Effect of gypsum, compost, and foliar application of some nanoparticles in improving some chemical and physical properties of soil and the yield and water productivity of faba beans in salt-affected soils. *Agronomy*, *13*(4), 1052. doi:10.3390/agronomy13041052

Cha-um, S., Pokasombat, Y., & Kirdmanee, C. (2011). Remediation of Salt-affected Soil by Gypsum and Farmyard Manure - Importance for the Production of Jasmine Rice. Australian Journal of Crop Science, 5(4), 458–465.

Chen, L. and Dick, W., 2011. Gypsums as an Agricultural Amendment. *The Ohio State University Extension*, [online] (945). Available at: <https://fabe.osu.edu/sites/fabe/files/imce/files/Soybean/Gypsum%20Bulletin.pdf> [Accessed 9 January 2022].

Downey, L. A. (1971). Effect of gypsum and drought stress on maize (zea mays L.). I. Growth, light absorption and yield 1. Agronomy Journal, 63(4), 569–572. doi:10.2134/agronj1971.00021962006300040017x

Gomes, T. M., Mazon, L. F., Panceri, C. P., Machado, B. D., Brighenti, A., Burin, V. M., & Bordignon-Luiz, M. T. (2020). Changes in vineyard productive attributes and phytochemical composition of Sauvignon blanc grape and wine induced by the application of silicon and calcium. Journal of the Science of Food and Agriculture, 100(4), 1547–1557. doi:10.1002/jsfa.10163

How to Measure Infiltration. 2012. [video] New South Wales: Murray Catchment Management Authority.

McLay, C. and Ritchie, G., 1995. Effect of gypsum application rate and leaching regime on wheat growth in a highly acidic subsoil. *Plant-Soil Interactions at Low pH: Principles and Management*, pp.527-530.

Naveed, M., Aslam, M. K., Ahmad, Z., Abbas, T., Al-Huqail, A. A., Siddiqui, M. H., … Mustafa, A. (2021). Growth responses, physiological alterations and alleviation of salinity stress in sunflower (helianthus annuus L.) amended with gypsum and composted Cow Dung. Sustainability, 13(12), 6792. doi:10.3390/su13126792

Saeed, r., & ahmad, r. (2009). Vegetative growth and yield of tomato as affected by the application of organic mulch and gypsum under saline rhizosphere . Pakistan Journal of Botany, 41(6), 3093–3105.

Xiong, D., Chen, J., Yu, T., Gao, W., Ling, X., Li, Y., … Huang, J. (2015). SPAD-based leaf nitrogen estimation is impacted by environmental factors and crop leaf characteristics. Scientific Reports, 5(1). doi:10.1038/srep13389