Evaluate the effectiveness of EDDHSA in correcting iron chlorosis in crimson grapes.

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Abstract

EDDHSA chelated iron is an advanced new-generation formulation to supply plant-available iron via the root system. Micronutrient chelates are an ideal option to supply deficiency micronutrients to plants effectively. Iron chlorosis is a common and a big concern in crop production as it adversely affects plant growth, yield and yield quality. This study assessed the effectiveness of two commercial iron chelated fertiliser products called Dual Chelate® EDDHSA Chelated Iron and EDDHA Fe to correct the iron chlorosis. Two adjacent blocks of a crimson vineyard were selected, and two fertiliser products were applied through fertigation once during the growing season. Soil and petiole samples, SPAD chlorophyll measurements and aerial drone photos were taken before the fertigation and two weeks after the fertigation. Dual Chelate® EDDHSA Chelated Iron treated blocked showed a higher level of nutritional status in soil and chlorophyll content in leaves. Also, it showed a 99.7% increase in iron levels in soil and a 19.40% increase in chlorophyll content in leaves. Furthermore, as a visual observation, aerial drone photos indicated that the Dual Chelate® EDDHSA Chelated Iron treated block showed more greenness, evenness and less patchiness compared to the EDDHA Fe treated block.

Keywords: Dual Chelate® EDDHSA Chelated Iron, Iron chlorosis, Chlorophyll level, crimson grapes

1. Introduction

Iron (Fe) is an essential micronutrient, and it plays a crucial role in plant metabolism, respiration, chlorophyll production, photosynthesis, oxygen transport and DNA stability. Iron availability for plants depends on soil pH and iron is least available to plants growing in alkaline soils. Nearly 30% of the land in the world consists of alkaline soils, and therefore, it is a big concern for farmers. Iron chlorosis is a significant constraint for plant growth, yield and yield quality (Álvarez-Fernández, García-Marco & Lucena, 2005, Li & Lan, 2017). Some plants, such as nectarine and peach, are more susceptible to iron chlorosis, and therefore, it directly affects yield reduction by reducing the fruit size and making fruits more bitter (Álvarez-Fernández, García-Marco & Lucena, 2005).

Micronutrient chelates are an ideal option to supply deficiency micronutrients to plants effectively. Chelates can stabilise the micronutrients in a wide range of pH, and it improves the plant nutrient uptake. However, chelates prevent the plants' excessive nutrient uptake by gradually releasing micronutrients. Iron chelates can correct iron chlorosis because they increase the solubility in the soil solution. Due to the higher stability, iron fertilisers are more common in agriculture (Klem-Marciniak, Huculak-Mączka, Marecka, Hoffmann & Hoffmann, 2021). EDDHSA (ethylenediamine di(2-hydroxy-5-sulfophenylaetic) acid) is one of the most effective and commonly used soil-applied iron fertilizers, and therefore, iron chelate EDDHSA can be used to correct iron chlorosis in plants growing on calcareous soils (Álvarez-Fernández, García-Marco & Lucena, 2005).

Dual Chelate® EDDHSA Chelated Iron is a fertiliser produced by Dual Chelate Fertilizer Pty Ltd, which is effective in a wide range of soil pH, resulting in more plant-available iron. Moreover, Dual Chelate® EDDHSA Chelated Iron is an effective treatment for iron deficiency in commercial crop situations where immediate corrective actions are required. It contains 6.58% of total iron (EDDHSA chelated) and 4.8% of Ortho (Ortho chelated). EDDHSA chelated iron is an advanced new-generation formulation to supply plant-available iron via the root system. The study aims to increase the plant's available iron and assess the effectiveness of Dual Chelate® EDDHSA Chelated Iron to correct the chlorosis in crimson grapes.

2. Objectives

- To assess the effectiveness of Dual Chelate® EDDHSA Chelated Iron to correct the iron chlorosis in crimson grapes.
- To assess the chlorophyll content in vines treated with Dual Chelate® EDDHSA Chelated Iron and other commercial iron products.
- To compare the soil analysis results before and after the treatment application and between two treatments

3. Methodology

Site Selection and Trial Design

This trial was conducted in a vineyard in Euston, New South Wales. The block was crimson seedless with an iron deficiency history. The block was 4.4 acres split into 2 irrigation shifts of 2.2 acres/shift (0.89ha/ shift). Half of the block (2.2 acres) was treated with Dual Chelate® EDDHSA Chelated Iron, and the other half was treated with another commercial iron chelate fertiliser product called EDDHA Fe (Figure 1). EDDHA Fe contained 6% iron, and Dual Chelate® EDDHSA Chelated iron contained 6.58%.

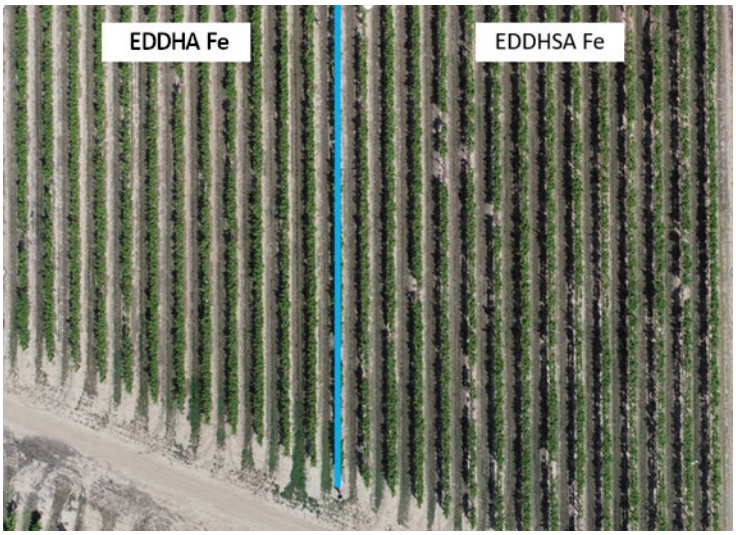

Figure 1: Aerial image of the block showing two areas of the block treated with two products.

Fertigation was done at the recommended rates and once during the growing season.

Table 1*:* Fertilizer products and their application rates.

Product Name	Application Rate
Dual Chelate® EDDHSA Chelated Iron	**4.6kg/ha**
EDDHA Fe	**5kg/ha**

Observations

Soil Nutrient Analysis

Before and after the fertigation of Dual Chelate® EDDHSA Chelated Iron and EDDHA Fe, three soil samples were collected from each treated area. Soil samples were sent to Analytical Laboratories and Technical Services Australia (ALTSA), Victoria for the presence of the listed elements: Nitrogen (N), Phosphorus (P), Potassium (K), Sulfur (S), Calcium (Ca), Magnesium (Mg), Sodium (Na), Aluminum (Al), Boron (B), Copper (Cu), Iron (Fe), Manganese (Mn), Zinc (Zn), Silicon (Si) and Molybdenum (Mo).

Petiole Analysis

Before and after the fertigation of Dual Chelate® EDDHSA Chelated Iron and EDDHA Fe, three petiole

samples were collected from each treated area. Petiole samples were sent to Analytical Laboratories and Technical Services Australia (ALTSA), Victoria for the presence of the listed elements: Nitrogen (N), Phosphorus (P), Potassium (K), Sulfur (S), Calcium (Ca), Magnesium (Mg), Sodium (Na), Aluminum (Al), Boron (B), Copper (Cu), Iron (Fe), Manganese (Mn), Zinc (Zn), Silicon (Si) and Molybdenum (Mo).

Chlorophyll Content

Leaf chlorophyll content was recorded before the treatment application and two weeks after the treatment application in each area by using the SPAD chlorophyll meter. Three vines were selected in each area and three leaves were marked with a flagging tape to get the chlorophyll changes in same leaves.

Aerial Photographs

Aerial drone photographs were taken before and after the treatment application for the visual observation.

Statistical Analysis

A statistical analysis was done using Prism 9 (Graph Pad Software). Significant difference (P<0.05) between the treatments was determined by comparing the replicate means. Graphs with error bars were also created using Prism 9.

4. Results

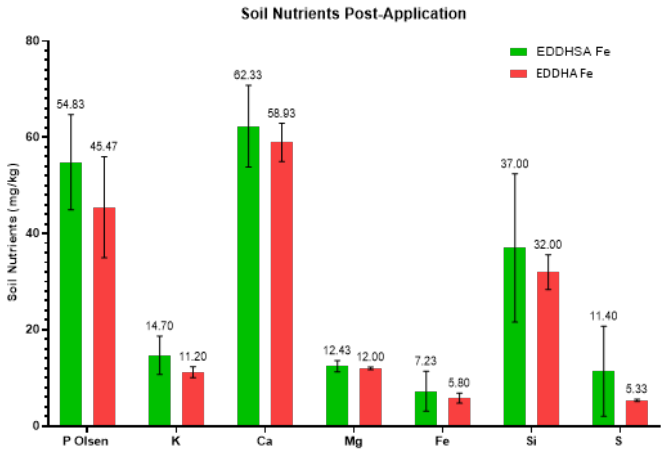

Figure 2: Post-application soil nutrient status of EDDHSA iron and EDDHA Fe treated soils. Letters indicate significant difference at p≤ 0.05 according to DMRT. Interaction

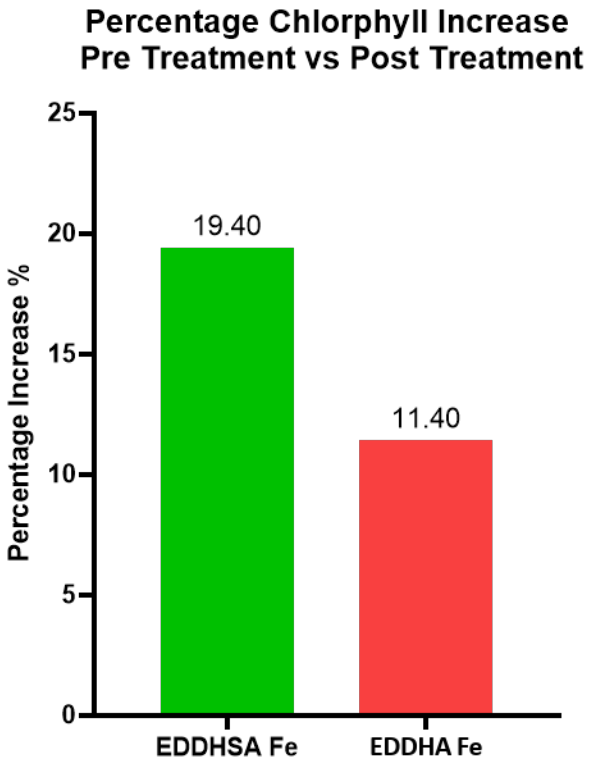

Figure 3: Effect of Dual Chelate® EDDHSA Chelated Iron and EDDHA Fe on the percentage increase of chlorophyll content after two weeks of the treatment application. Letters indicate significant difference at p≤ 0.05 according to DMRT.

Table 2: Results summary of the percentage soil nutrient changes before and after the treatment application. Values followed by the same letter in the same column are not significant at the p≤0.05.

	Percentage Increase	
	Dual Chelate® EDDHSA Chelated Iron	EDDHA Fe
H_2O (pH)	2.68	3.09
EC (mS/cm)	-6.52	-17.39
Total C (%)	14.29	-8.57
Total N (%)	-12.99	-23.16
Nitrate N (mgN/kg)	-20.53	-20.53
Ammonium N (mgN/kg)	0.00	0.00
P (mgP/kg)	-30.61	-39.46
K (mg/kg)	71.60	30.74
Ca (mg/kg)	-12.94	-17.69
Mg (mg/kg)	9.71	5.88
B (mg/kg)	0.00	0.00
Cu (mg/kg)	100.00	0.00
Fe (mg/kg)	99.7	60.37
Mn (mg/kg)	0.00	0.00
Mo (mg/kg)	0.00	0.00
Zn (mg/kg)	0.00	0.00
Al (mg/kg)	52.85	28.46
Na (mg/kg)	1.65	-12.67
Si (mg/kg)	51.02	30.61
S (mg/kg)	474.79	168.91

Figure 4: Aerial image of the two areas treated with Dual Chelate® EDDHSA Chelated Iron and EDDHA Fe after the two weeks of the treatment application.

Aerial drone photographs showed a clear difference between EDDHSA and EDDHA Fe treated areas where more canopy growth was observed in the EDDHSA treated areas.

5. Discussion

Soil samples were analysed before and after the treatment application to evaluate the soil nutritional status and some chemical properties and then to compare the effectiveness of Dual Chelate® EDDHSA Chelated Iron and EDDHA Fe fertilizer products. Post-application soil analysis results indicated that EDDHSA Fe treated soil has more phosphorous, potassium, calcium, magnesium, iron, silicon and Sulphur compared to EDDHA Fe treated soil (Figure 2). This suggests that EDDHSA chelated iron increased the nutritional status of soil specially the iron level in soil. Several studies have found that EDDHSA chelated iron can correct the iron induced chlorosis by improving the iron status in soil and facilitating the iron uptake by plants (Álvarez-Fernández, García-Marco & Lucena, 2005, Álvarez-Fernández et al., 2001).

EDDHSA chelated iron has increased the soil iron level by 99.7% compared to the pre-application soil iron level while EDDHA Fe treated soli increased the iron level by 60.3%. In addition, a significant improvement of other nutrients such as phosphorous, magnesium, copper, silicon and Sulphur was observed in EDDHSA chelated iron treated soil (Table 2). This outcome could be due to the efficacy of EDDHSA fertilizer activity and its ability to chelate other nutrients.

The plant characteristic that is highly associated with the iron chlorosis is the chlorophyll measurements in leaves which is measured by using SPAD chlorophyll meter. EDDHSA treated vines showed a higher level of chlorophyll content compared to EDDHA Fe treated vines. Moreover, EDDHSA showed a significant percentage increase in chlorophyll level from pre-treatment to post-treatment which is 19.40%. (Figure 3). SPAD chlorophyll measurements are an excellent way to quantify the degree of chlorosis, however, leaf iron concentration is not associated with the degree of chlorosis (Pestana et al. 2003). Therefore, a higher level of chlorophyll in EDDHSA treated vines indicates the ability of EDDHSA to reduce the iron induced chlorosis.

Aerial drone photographs of the two blocks clearly showed the difference of greenness, unevenness and patchiness of two blocks treated with two different commercial products. EDDHSA treated area showed a more even, greenness and less patchiness compared to the EDDHA Fe treated vines (Figure 4). Chlorophyll measurements were directly associated with the green color of the vines and therefore green color is a better indicator to assess the iron status in plants (Álvarez-Fernández, García-Marco & Lucena, 2005, Pestana et al. 2003). Higher iron levels and chlorophyll levels ensure a good photosynthesis process and thereby better vine growth. Hence, the area treated with EDDHSA has more chlorophyll in vines and therefore it indicated more greenness in that area and showed less patchiness due to the better vegetative growth in vines.

6. Conclusion

In conclusion, Dual Chelate® EDDHSA Chelated Iron reduced the iron chlorosis in crimson vines and improved the soil nutritional status, chlorophyll content, greenness in vines as well as the evenness in the vineyard. After two weeks of the fertigation,

EDDHSA treated soil showed a higher level of phosphorous, potassium, calcium, magnesium, iron, silicon and Sulphur compared to EDDHA Fe treated soil. It increased the iron level in soil by 99.7% and the chlorophyll level by 19.40%. A single application of EDDHSA gave excellent results which can be measured by quantitatively and qualitatively. Visual observation of the aerial drone photos is a best way to compare the greenness, evenness and patchiness of two blocks treated with two different commercial fertilizer products. Therefore, Dual Chelate® EDDHSA Chelated Iron is an effective and efficient fertilizer to reduce iron induce chlorosis and for re-greening plants affected by iron chlorosis.

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