Evaluating the Efficiency of Foliar Applications of Transit Premium Trace® and Transit Iron® on Improving Leaf Nutrient Levels in Nectarine Trees Effected by Lime Induced Chlorosis

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Lime induced chlorosis is known as the deficiency of Iron caused by soil alkalinity or calcareous soils. It has a major production constraint in agriculture and especially in the horticultural industry where between 20% to 50% of fruit trees show symptoms such as interveinal chlorosis (Rombolà and Tagliavini, 2006). This causes issues such as poor photosynthesis and reductions in metabolic reactions ultimately effecting yields. This trial used foliar applications of Transit Premium Trace® and Transit Iron® to reduce iron deficiency in nectarines and improve iron concentrations in the leaves. It was found that using foliar applications of Transit Premium Trace® and Transit Iron® increased the iron concentration in the treated leaves by 30.4% whereas in the control, the iron concertation was increased by 19.3%. Other elements such as Magnesium, Manganese, Zinc and Copper showed higher concentrations in the treated compared to the control which is due to the multielement fertiliser - Transit Premium Trace®. There was also some improvements in greenness of leaves in the treated nectarine leaves compared to the control.

Key words: lime indued chlorosis, iron deficiency, nectarine, alkalinity, foliar fertilizer, Transit Premium Trace®, Transit Iron®

Introduction

All plants rely on macro and micro elements in order for proper growth and development. One of the main micro elements required by plants is Iron (Fe). Iron is essential to plants as it plays crucial roles in a number of metabolic processes such as DNA synthesis, respiration and photosynthesis (Rout and Sahoo, 2015). Without iron, plants are unable to activate enzymes, produce chlorophyll and ultimately inhibit energy production.

Iron is immobile in both the soil and plant tissue, however use of chelation has helped make iron more readily available for plant uptake and prevent the iron from leaching out of the soil. However, constraints such as alkaline soil and calcareous soil have a severe impact on the availability of iron (Rhododendron-Lime-induced Chlorosis, 2021). In these soil conditions, iron is converted from available ferrous compounds to unavailable ferric compounds. As a result, plants are unable to access the soil available iron and strong deficiencies appear.

These soil constraints often cause a commonly seen issue known as lime induced chlorosis. Lime induced chlorosis is the deficiency of Iron (Fe) or Manganese (Mn) due to high pH and calcareous soils Lime induced chlorosis is common in the horticultural industry with between 20% - 50% of fruit trees showing symptoms (Kassa, 2015). In nectarine crops, lime induced chlorosis has a direct effect on fruit quality such as producing small and bitter fruits which is also accompanied by poor yields (Kassa, 2015).

Dual Chelate Fertilizer® PTY LTD have recognized this issue as a significant production constraint on the horticultural industry and is trialing solutions to alleviate the damage caused by lime induced chlorosis. Due to irons very low plant mobility, direct foliar applications of Transit Premium Trace® and Transit Iron® were used in a lime induced chlorosis nectarine block to help improve chlorophyll production. Transit Premium Trace® is a complete trace element rich formula with amino acid chelated nutrients that will assist in all areas of plant growth ensuring that both vegetative and reproductive stages have adequate macro and micro nutrients for premium plant production. Transit Iron® is an amino acid chelated iron formulation which assists in chlorophyll formation, whilst also improving plant respiration through the activation of enzymes. When used together, these 2 foliar fertilizers provide approximately 12.3% chelated iron directly to the leaves. See figure 1 for elemental analysis.

Table 1: Elemental analysis of Transit Premium Trace® and Transit Iron®.

	N%	Mg%	Mn%	Zn%	Cu%	Fe%	B%	Mo%	Co%	Chelation
Transit Premium Trace®	3.68	2.10	2.30	2.20	0.56	2.10	0.52	0.02	0.02	Amino Acids
Transit Iron®	3.64					10.20				Amino Acids

In this study, the effect of foliar applied nutrients (especially iron) will be analyzed as a potential way to improve iron in nectarine plant tissue which is directly affected by lime-induced chlorosis. Leaf tissue analyses will be done to evaluate the effectiveness of foliar applied iron and other elements. Visual assessments against control trees will also be done to give an insight into whole tree health using comparative photos of treated and control nectarine trees.

Objectives

1. Assess the effectiveness of transit Premium Trace® and Transit Iron® in improving leaf nutrient levels in nectarines suffering from lime induced chlorosis.
2. Analyse the physical growth and crop vigour of the nectarine trees in the control and treated areas.
3. Compare control and treated leaf analyses before and after foliar application of Transit Premium Trace® and Transit Iron®.

Materials and Methods

Site Selection and Trial Design

This trial was conducted on a stone fruit farm in Swan Hill, Victoria. The 2 ha block was selected due to its severe leaf yellowing which had been observed over a number of years. Previous applications of iron had been done but no visual differences were seen by the farmer. It was observed that the block had high variability in soil types, with the iron induced chlorosis being mostly observed in middle and left (west) regions of the paddock (see figure 1).

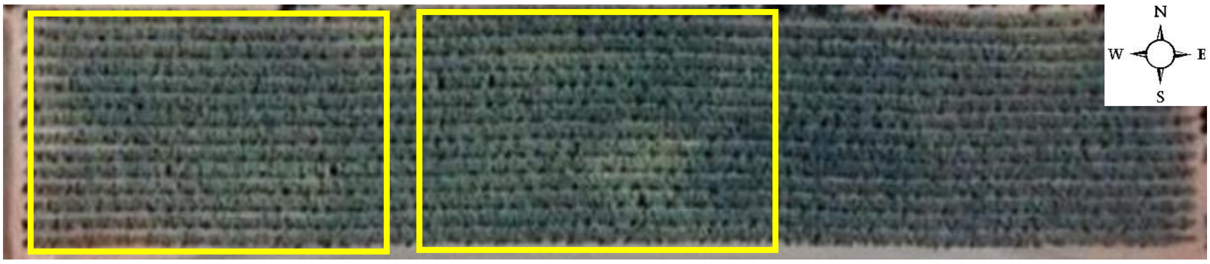


Figure 1: Aerial image of the block showing symptoms of lime induced chlorosis. Note the yellowing patches.

One row was isolated as the control row which received no applications of iron fertilizer but still continued to receive the farmers normal fertilizer application regime. The rest of the block was treated with foliar applications of Transit Premium Trace® and Transit Iron. See figure 2 for trial layout which also highlights the sampling points were leaf tissue was analyzed from. There was 3 replicates for both treatments (treated and control).

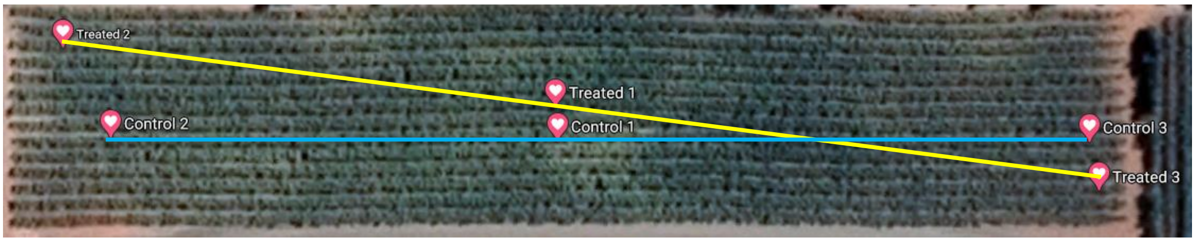


Figure 2: Leaf sampling and monitoring locations

Fertilizer Application

Table 2: Application rates and application times for foliar applied Transit Premium Trace® and Transit Iron®. Both foliar products were mixed together and applied.

	Products used	Rate	Growth Stage	Date
Application 1	• Transit Premium Trace • Transit Iron	1 kg/ha each	End of flowering	24/08/20
Application 2	• Transit Premium Trace • Transit Iron	1 kg/ha each	Schuck fall	06/09/20

Table 2 highlights the foliar application details. Both the Transit Premium Trace® and Transit Iron® were applied at the same time, both at 1kg/ha. Leaf nutrient samples were taken just prior to the first application and again 1 week after the last application.

Observations

Leaf Nutrient Analysis

Before and after the application of Transit Premium Trace® and Transit Iron®, the youngest maturing leaf was collected from a handful of trees in the different sampling locations at the contorl and treated sites (refer to figure 2). These leaves were washed and analysed at Analytical Laboratories and Technical Services Australia (ALTSA), Victoria for the presence of the listed elements: Nitrogen (N), Posphorus (P), Potassium (K), Sulfur (S), Calcium (Ca), Magnesium (Mg), Sodium (Na), Alminium (Al), Boron (B), Copper (Cu), Iron (Fe), Magnanese (Mn), Zinc (Zn), Silicon (Si) and Molybdenum (Mo).

Comparative Photos

After the last foliar application, photos of the leaves were taken at the same height on each tree at each sampling location and compared for a visual analysis to see if there was still iron deficiencies caused by the lime induced chlorosis.

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.

Results

Table 3: Results summary table calculated from the plant tissue tests. Specifically highlighting iron levels in the plant tissue before and after application. Percentages indicate the percentage increase from before application to after application.

	Before Foliar Application		After Foliar Application	
	Control	Treated	Control	Treated
Iron	88.5 mg/kg	81.2 mg/kg	105.6 mg/kg (+19.3%)	105.9 mg/kg (+30.4%)

Leaf Analysis Pre-Fertilizer Application on Nectarines

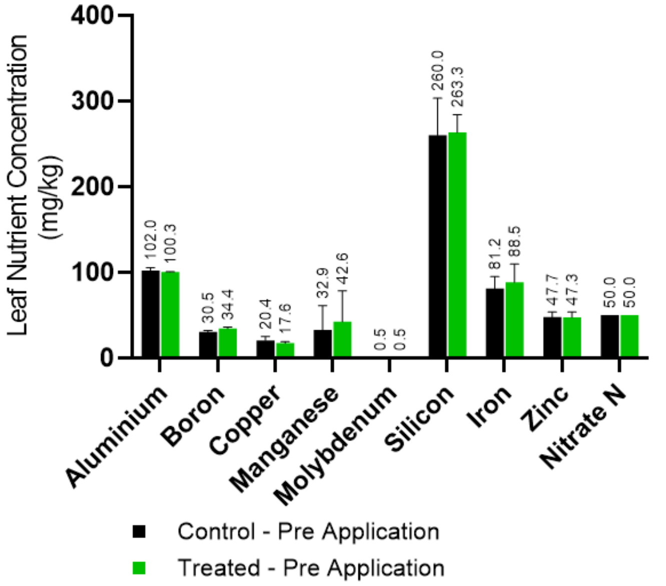


*Figure 3: Leaf nutrient concentration **(mg/kg)** of nectarines leaves **before application** of foliar Transit Premium Trace® and Transit Iron®. Averages are highlighted on the graphs. No significant differences (P<0.05).*

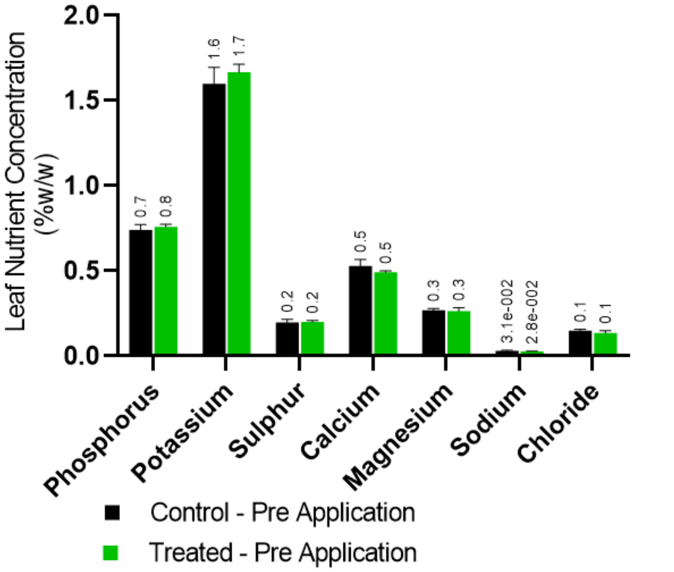


*Figure 4: Leaf nutrient concentration **(%w/w)** of nectarines leaves **before application** of foliar Transit Premium Trace® and Transit Iron®. Averages are highlighted on the graphs. No significant differences (P<0.05).*

Leaf Analysis Post-Fertilizer Application on Nectarines

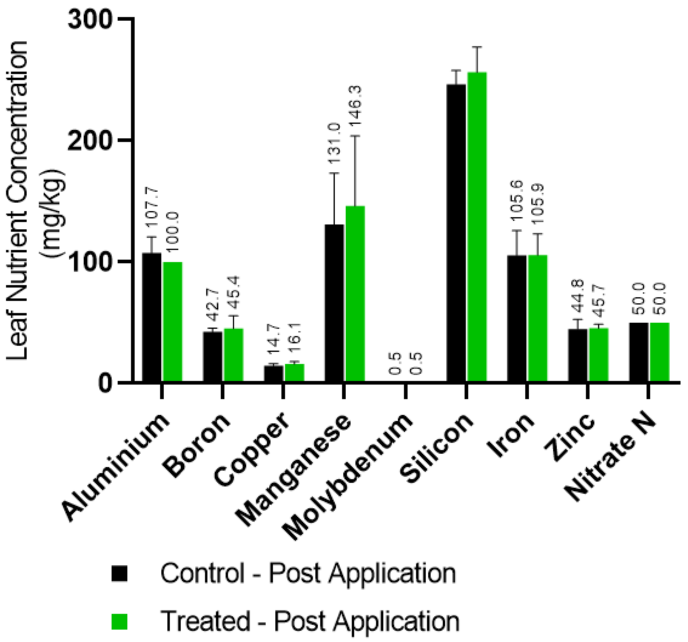


*Figure 5: Leaf nutrient concentration **(mg/kg)** of nectarines leaves **after application** of foliar Transit Premium Trace® and Transit Iron®. Averages are highlighted on the graphs. No significant difference (P<0.05).*

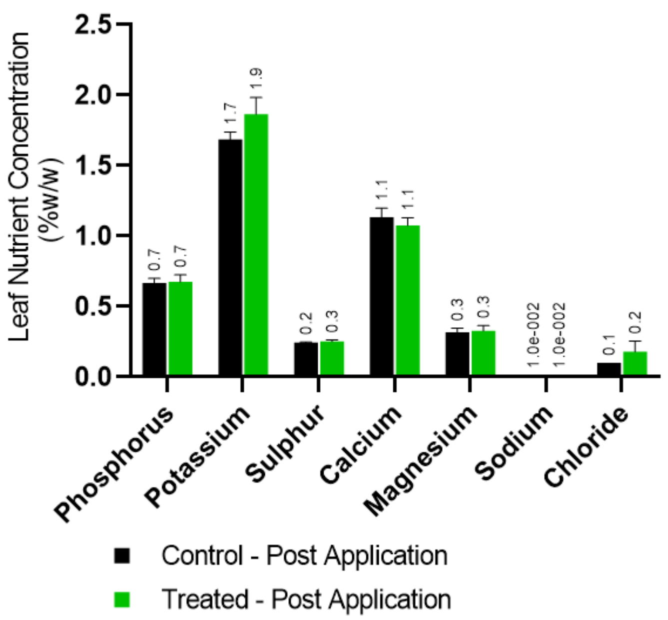


*Figure 6: Leaf nutrient concentration **(mg/kg)** of nectarines leaves **after application** of foliar Transit Premium Trace® and Transit Iron®. Averages are highlighted on the graphs. No significant difference (P<0.05).*

Percentage Difference in Nutrients Pre-Fertilizer Application on Nectarines

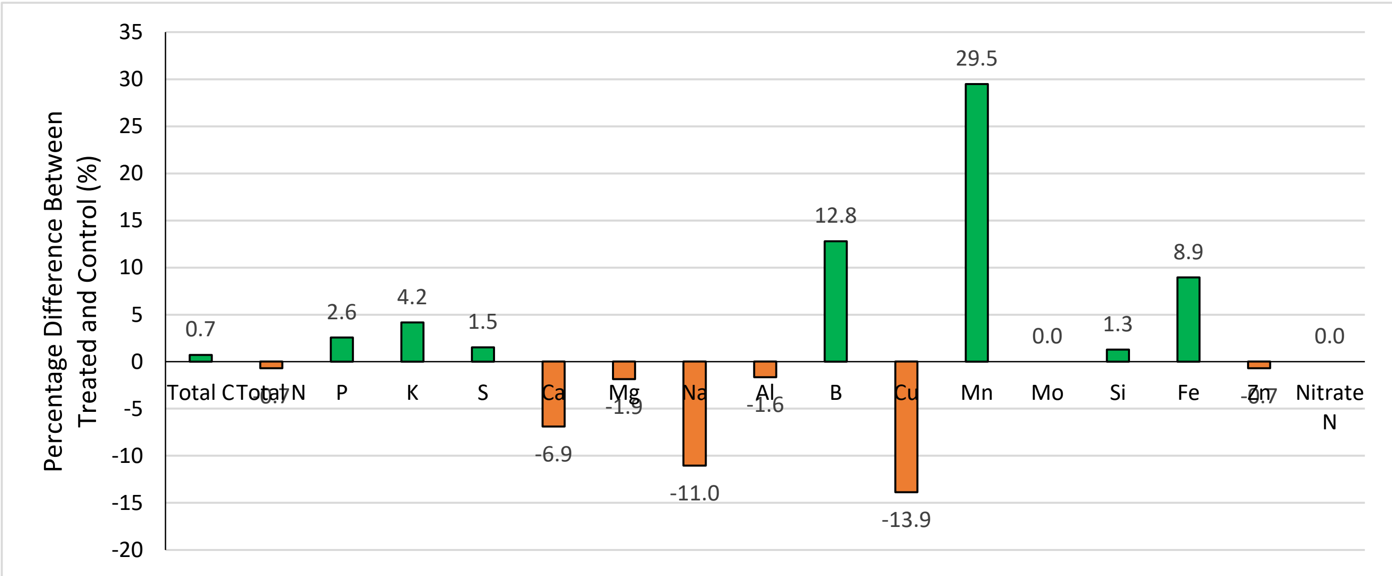


*Figure 6: The percentage change of nutrient concentrations measured in the leaves collected from treated and control treated nectarine plants **before application** of foliar Transit Premium Trace® and Transit Iron®. Values with a positive percentage change indicate that nutrient levels were higher in treated plants. Values with a negative percentage change indicate that nutrient levels were higher in control plants.*

Percentage Difference in Nutrients Post-Fertilizer Application on Nectarines

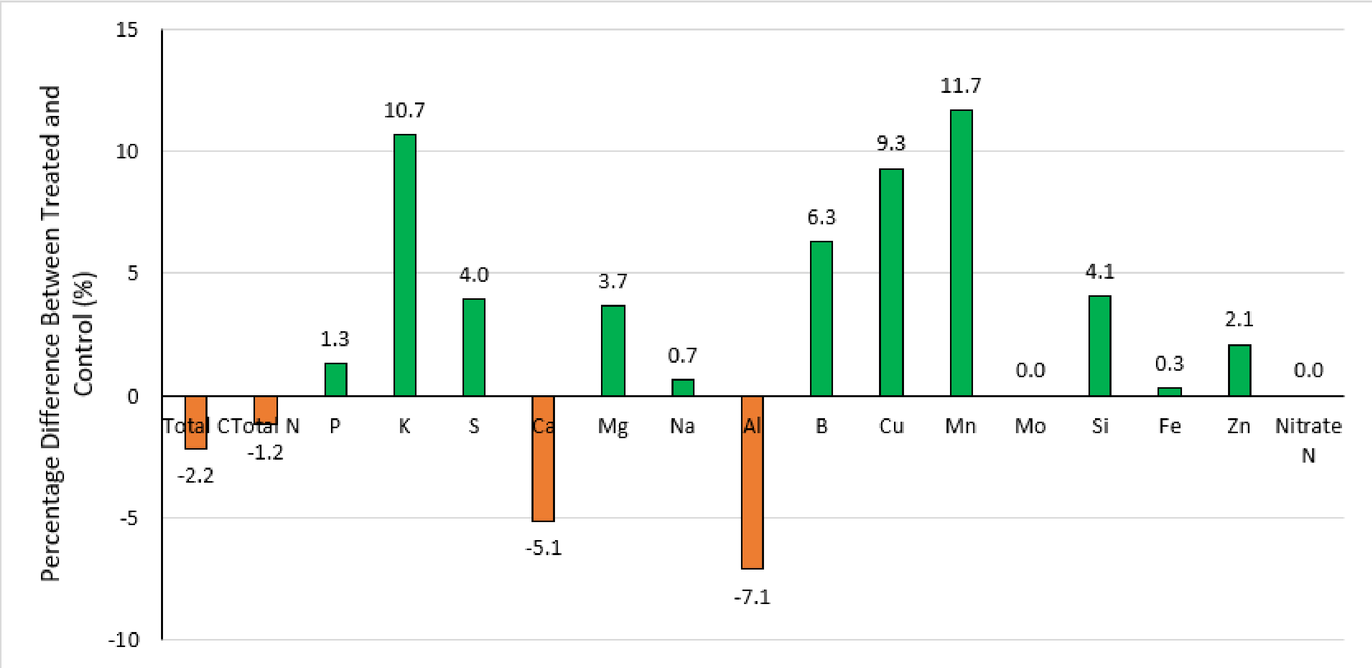
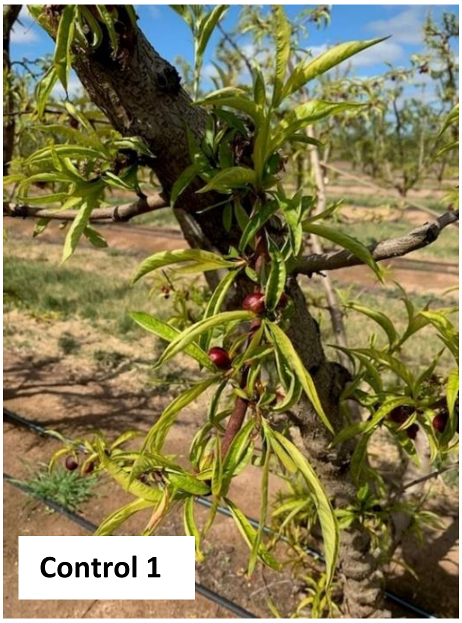


*Figure 7: The percentage change of nutrient concentrations measured in the leaves collected from treated and control treated nectarine plants **after application** of foliar Transit Premium Trace® and Transit Iron®. Values with a positive percentage change indicate that nutrient levels were higher in treated plants. Values with a negative percentage change indicate that nutrient levels were higher in control plants.*

Visual Assessment of Leaves after Application of Foliar Treatments



Discussion

When looking at the results summary table in table 3, it can be seen that there was a 30.4% increase in iron levels in the leaves of the nectarines after the final application of Transit Premium Trace® and Transit Iron®. This increase was from 81.2 mg/kg to 105.9 mg/kg where as the control only had a percentage increase of 19.3% in iron levels in the leaves. Although there was no statistically significant difference between the control and treated iron levels in the leaves after the final application, there was a larger uptake of iron in the treated nectarine trees.

This higher percentage increase in iron on the leaves is due to the amino acid chelated iron in both the Transit Premium Trace® and Transit Iron®. Amino acid chelated iron boosts absorption into the plant tissue by preventing the iron from interacting with other minerals and compounds. The amino acid chelation technology used at Dual Chelate Fertilizer contains a mixture of 17 different amino acids. Due to the large range of diversity of amino acids, it is guaranteed that the chelated mentals will make it into the plant tissue and be absorbed. Plant absorption is also enhanced due to amino acids being a natural and organic molecule which is recognized by the plant and are therefore able to move though cell walls and membranes much easier than synthetic chelating agents.

After foliar applications of Transit Premium Trace® and Transit Iron®, there was higher concentrations of Phosphorous, Potassium, Sulphur, Magnesium, Boron, Copper, Manganese, Silicon, Iron and Zinc in the treated nectarine tree leaves compared to the control (seen in figure 7). Notably, there was 10.7% increase in Potassium and 11.7% increase in Manganese compared to the control again shown in figure 7. This outcome is mainly due to the multielement fertilizer Transit Premium Trace®. Again, these increases in elements after application of Transit Premium Trace® and Transit Iron® would have been enhanced due to the amino acid chelation.

Once the last foliar application had been applied to the nectarines, images were taken to compare the leaf color and development between the treated and control. Each replicate was compared – e.g. treated 1 was compared to treated 1. Firstly, when comparing treated 1 to control 1, it can be seen that there is a significant improvement in the colouring of the leaves with the treated leaves looking larger and greener compared to the control. The control leaves were much yellower and thinner with a curled look. Treated 1 and control 1 were situated in a yellow patch which was obvious from the aerial image seen in figure 2. Secondly, when comparing treated 2 to control 2, there is not much of a difference seen in the images, the control leaves have some slight yellowing, but is not as severe compared to control 1. The treated 2 and control 2 replicates were taken in the West end of the block which did no not have much lime induced chlorosis compared to the middle of the block (seen in figure 2). Finally, when comparing treated 3 and control 3, there was no visible improvement between the two treatments. These replicates were taken on then Eastern side of the block which also did not display much lime induced chlorosis.

Conclusion

In conclusion, this trial was conducted to evaluate the efficiency of foliar application of Transit Premium Trace® and Transit Iron® to improve the leaf nutrient levels in nectarines that were affected by lime induced chlorosis. Both leaf nutrient levels and visual comparisons were done to assess the possible reversal of the lime induced chlorosis seen in patches in the block. The main symptom identified was low iron levels in the leaves which was previously observed on this block. From this research it was found that there was an increase of 30.4% in iron levels in the plant tissue after the final foliar application whereas the control had an increase of 19.3%. This percentage difference is not significant and therefore it is unclear if Transit Premium Trace® and Transit Iron® had a significant effect on mitigating the lime induce chlorosis effects on the leaves.

However, after the final application of treatments there was more concentrations of Magnesium, Manganese, Zinc, Copper and Iron in the treated leaves compared to the control which proves the benefits of the multielement analysis seen in Transit Premium Trace®.

Some visual benefits were seen in the photo comparison between each replicate, especially between treated 1 and control 1. However, between replicates 2 and 3 there was not much of a visual difference.

In future trials, it would be beneficial to use a SPAD meter to measure chlorophyll levels and concentrate the replicates in an area which is severely affected by lime induced chlorosis instead of getting a whole block average. It would also be beneficial to possibly increase the rate of Transit Premium Trace® and Transit Iron® to 1.5 or 2 kg/ha at each application. It would also be beneficial to apply the foliar application when the leaves are more developed and larger to increase the surface area and contact area where the nutrients can be absorbed more effectively.

References

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