Evaluation of the efficiency of Complete Blend 10 DC for improving plant nutrient status and yield in almonds

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Missed application of Complete Blend 10

Macro and micro elements are an integral part to proper plant nutrition. Every plant needs these elements in order to function correctly and reproduce. Macro elements include Nitrogen (N), Phosphorus (P), Potassium (K), Sulfur (S), Calcium (Ca), and Magnesium (Mg). Micro elements include Iron (Fe), Manganese (Mn), Copper (Cu), Zinc (Zn), Boron (B), Chloride (Cl) and Molybdenum (Mo). Although these elements are categorized into macro and micro, all these elements are essential, just in different concentrations. Maintaining macro and micro nutrients also have a direct influence on achieving the best yields, especially in almond crops. With the macro and micro nutrients combined, the plant status is improved through increased photosynthesis, sugar translocation, biotic and abiotic stress resistance, increased flower to fruit development ratios and regulate processes within the plants such as the opening and closing of stomata.

Key words: Almond production, macro nutrients, micro nutrients, plant nutrition, yields, photosynthesis, sugar translocation, stress resistance, flower to fruit ratio, process regulations.

In almond production, supplying a blanket fertiliser of a combination of macro and micro elements is essential, especially at post-harvest, spring root flush and shortly after fruit set to provide the trees with enough nutrients to promote good root growth, increased flower development, optimal fruit fill and kernel development as well as promoting the vegetative growth of the almond trees. Dual Chelate Fertilize Pty LTD has developed a liquid, fertigated macro nutrient and micro nutrient fertilizer called Complete Blend 10®. Complete Blend 10® is carefully designed to provide an effective blanket of both macro and micro nutrients including: Nitrogen (N), Phosphorus (P), Potassium (K), Sulfur (S), Magnesium (Mg), Zinc (Zn), Copper (Cu), Iron (Fe), Boron (B) and Molybdenum (Mo). All these nutrients play key roles in achieving optimal yields and growth in agricultural production. Along with the core nutrients, Complete Blend 10® also contains Biologically Active Organic Molecules (BAOM) at a concentration of 1%. BAOM is a key patented chelation technology designed to enhance the translocation and availability of nutrients within the plant system.

In this study, the effect of soil applied Complete Blend 10® will be assessed in increasing almond yields and almond parameters such as hull weight and kernel weight. These parameters will be compared to control almond trees. Leaf nutrient analyses will also be done to assess tree growth along with comparative photos of treated and control rows and nut development. It is important to notes that this year's trial was not completed successfully with the control rows

receiving applications of Complete Blend 10® shortly after fruit set. Therefore, this trials results will be deemed inconclusive, however moving forward the Complete Bland 10® trial will be completed as intended.

Objectives

1. Assess the effectiveness of Complete Blend 10® in improving almond yield parameters via evaluation of whole nut and kernel weight.
2. Analyse the physical growth and crop vigor of the trees and nuts through images.
3. Compare leaf nutrient analyses to show differences in leaf nitrogen concentrations and other macro and micro nutrients.
4. Determine out-turn differences between almond trees treated with complete blend 10 and control almond trees.

Materials and Methods

Site Selection and Trial Design

This trial was conducted in an Almond orchard within the Sunraysia region of Victoria. Two areas of the orchard were chosen for analysis with each area of the orchard having 2 sperate replications in 2 neighbouring blocks. The trial layout is shown in figure 1. Commercial applications of Complete Blend 10® were applied through fertigation following the orchards fertigation program. Treated and control rows each had 7 trees which were analysed and used to gather data such as leaves and nuts. Control trees were isolated using isolation taps which were fixated on the drip lines.

Area 2	Block 4	Control	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Treatment	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Control	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Treatment	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
	Block 3	Control	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Treatment	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Control	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Treatment	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
Area 1	Block 2	Control	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Treatment	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Control	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Treatment	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
	Block 1	Control	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Treatment	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Control	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Treatment	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Control	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Treatment	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Control	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7
		Treatment	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7

Figure 1: Trail design layout in 2 separate areas of the almond orchard. Each area has 2 separate blocks which were tested. In total, there are 4 replicates of this trial spread over 4 blocks in 2 different areas. Note that control rows received application of Complete Blend 10® by mistake.

Table 1: Application rates and application timing of Complete Blend 10®. Complete Blend 10 was mistakenly applied to control trees as well as the treated trees.

Treatment	Rate/ha	Application timing
Control	0	(Complete Blend 10 applied to control trees by mistake)
Complete Blend 10 DC	30 L/ha	Shortly after fruit set

Observations

Leaf nutrient analysis

After the application of Complete Blend 10®, twenty leaves per plant were collected from each tree in both the control and treatment rows. 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).

Kernel Weight, Hull weight and Nut Weight.

Before commercial harvest, 20 nuts per tree were collected to get whole nut weights, hull weights and kernel weights. These kernels and hulls were sent to ALTSA for a nutrient analysis.

During harvest when the trial trees had been shaken, a 1 metre transect of whole nuts was collected from the ground between the 5^{th} and 6^{th} trees in each row. Whole nut weights and average out-turn percentages were recorded.

Statistical Analysis

A statistical analysis (T-test) was done using Prism 7 (Graph Pad Software). Significant difference ($P<0.15$) between the treatments was determined by comparing the replicate means. Graphs with error bars were also created using Prism 7.

Results

Figure 2: A photo taken of almond trees treated with Complete Blend 10® (treatment) before shaking.

Figure 3: A photo taken of control almond trees before shaking.

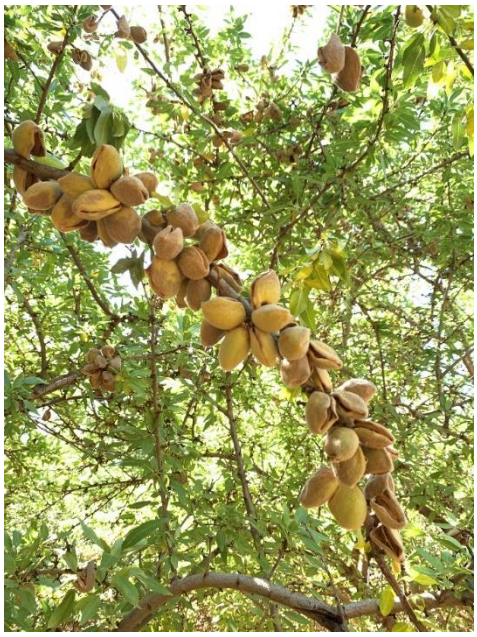

Figure 4: Almond branch from a tree treated with Complete Blend 10® before shaking.

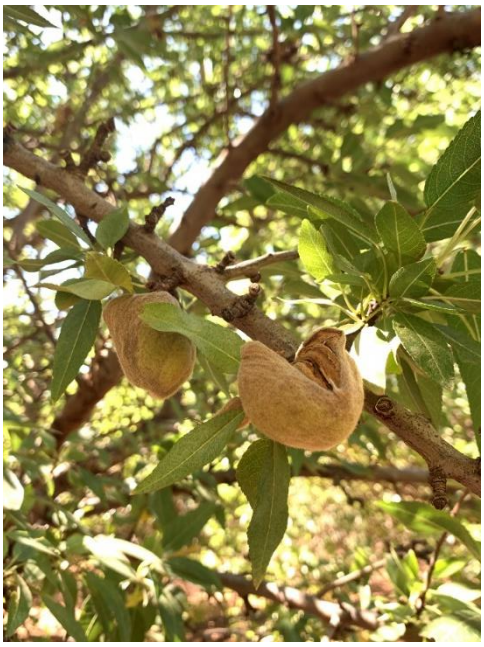

Figure 5: Control almond tree branch in the Complete Blend 10 trial ® before shaking.

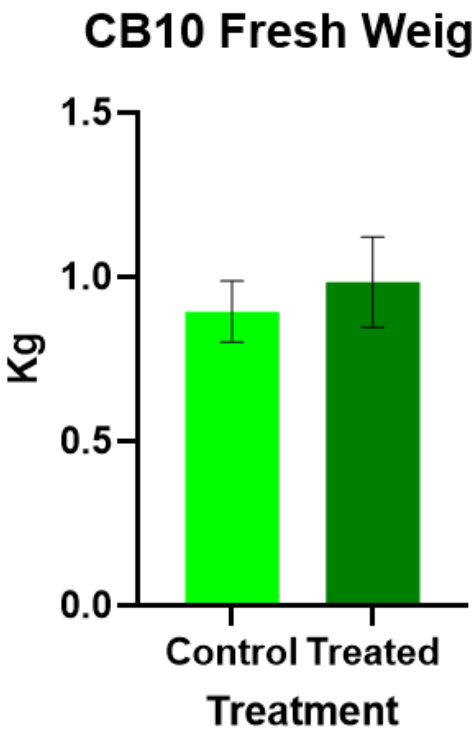

Figure 6: The average fresh weight of almonds collected from almond trees in the Complete Blend 10® trial (P<0.15).

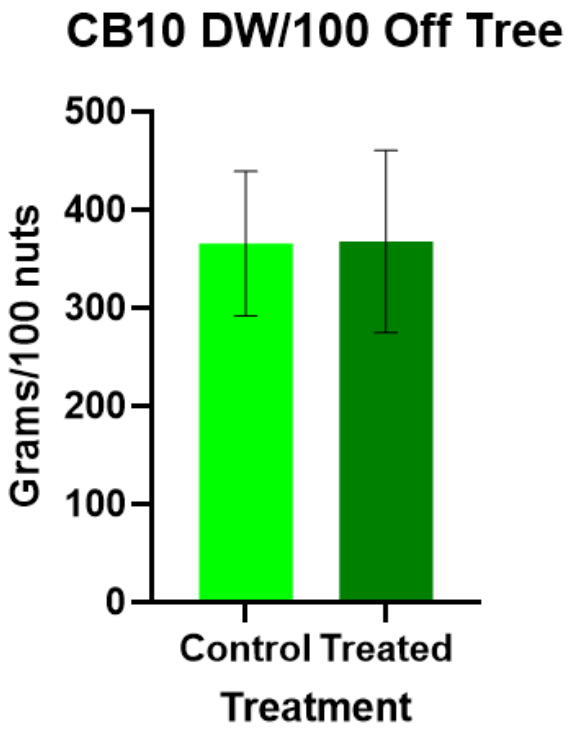

Figure 7: The average dry whole weight of 100 nuts collected from almond trees in the Complete Blend 10® trial. (P<0.15)

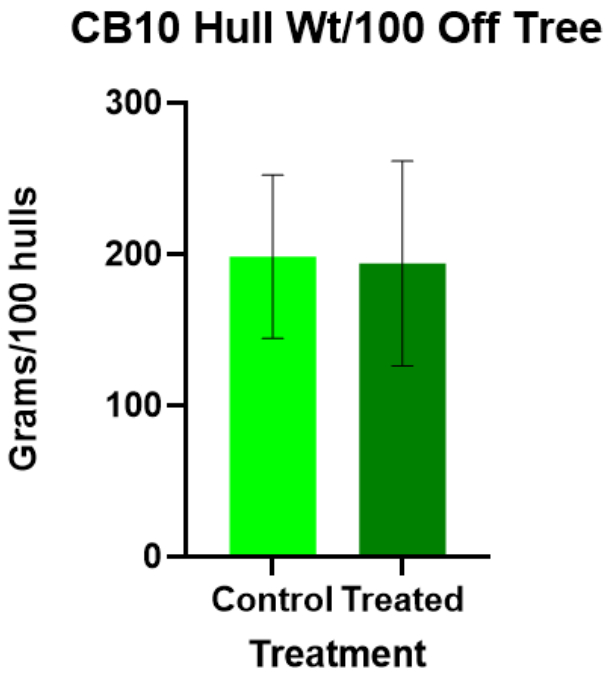

Figure 8: The average hull weight of 100 nuts collected from almond trees in the Complete Blend 10® trial. (P<0.15)

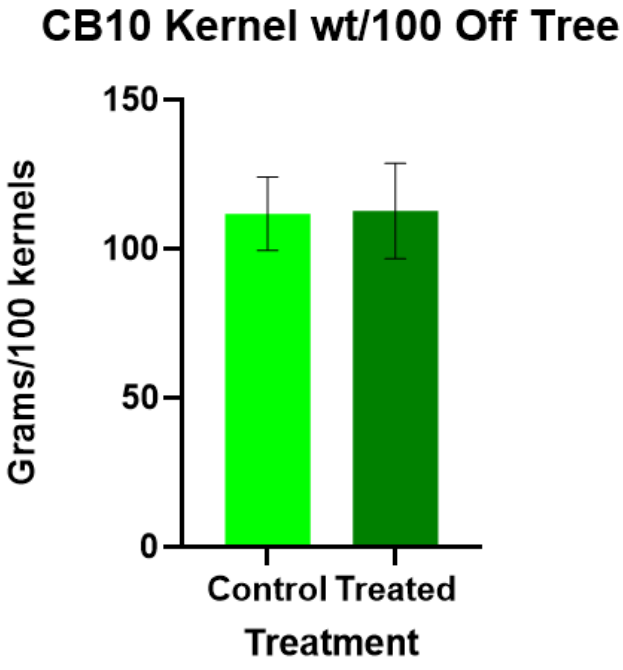

Figure 9: The average kernel weight of 100 nuts collected from almond trees in the Complete Blend 10® trial. (P<0.15)

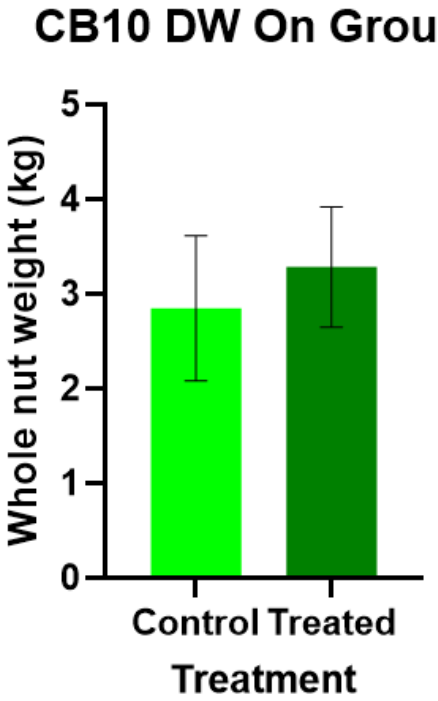

Figure 10: The average whole nut weight of nuts collected off the ground in a 1 meter transect. Nuts collected from almond trees shook in the Complete Blend 10® trial. (P<0.15)

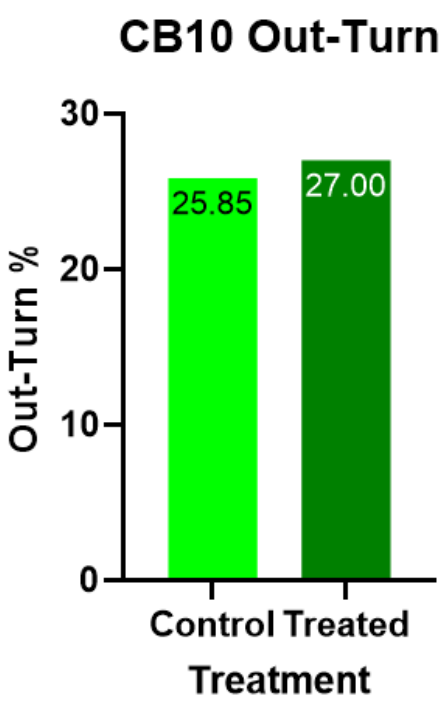

Figure 11: The out-turn percentage of the control and treated almonds collected from the ground after shaking in the Complete Blend 10® trial.

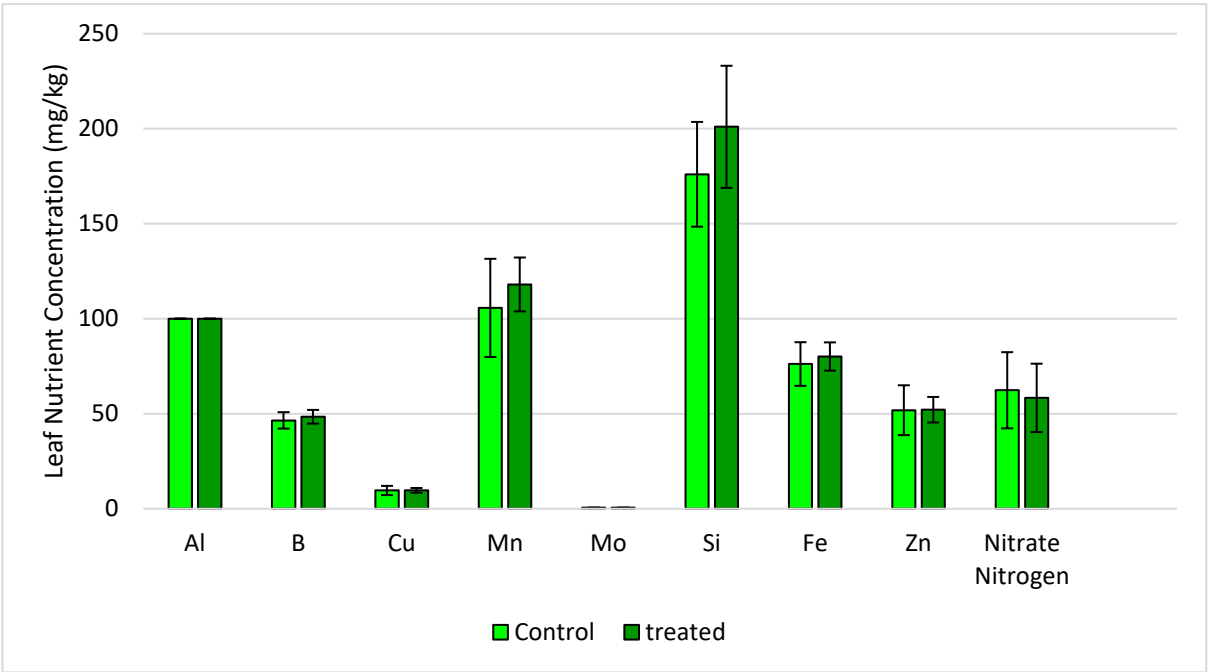

Figure 12: Leaf nutrient concentrations of almond leaves in the Complete Blend 10® trial. Measurements are taken in mg/kg. A t-test was performed to determine the significant difference between the control vs treated (Complete Blend 10), error bars show significant difference (P<0.15). The t-test was performed with Prism 7 (Graph Pad Software).

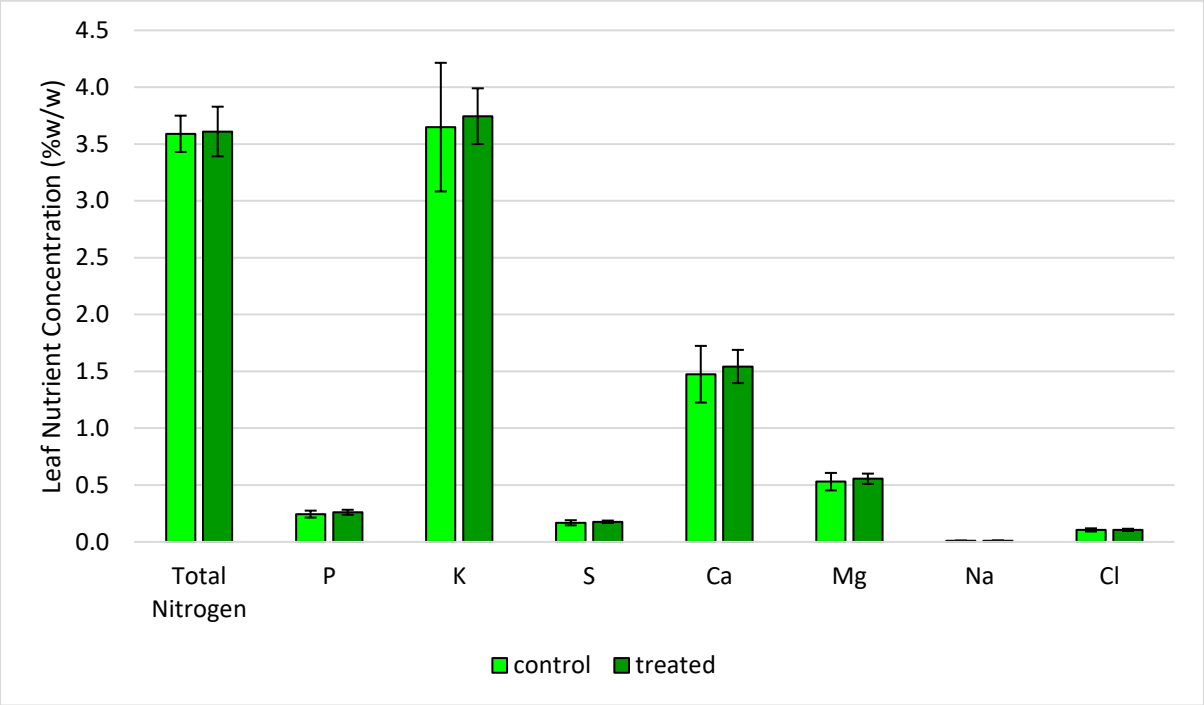

Figure 13: Leaf nutrient concentrations of almond leaves in the Complete Blend 10® trial. Measurements are taken in %w/w. A t-test was performed to determine the significant difference between the control vs treated (Complete Blend 10®, different error bars show significant difference (P<0.15). The t-test was performed with Prism 7 (Graph Pad Software).

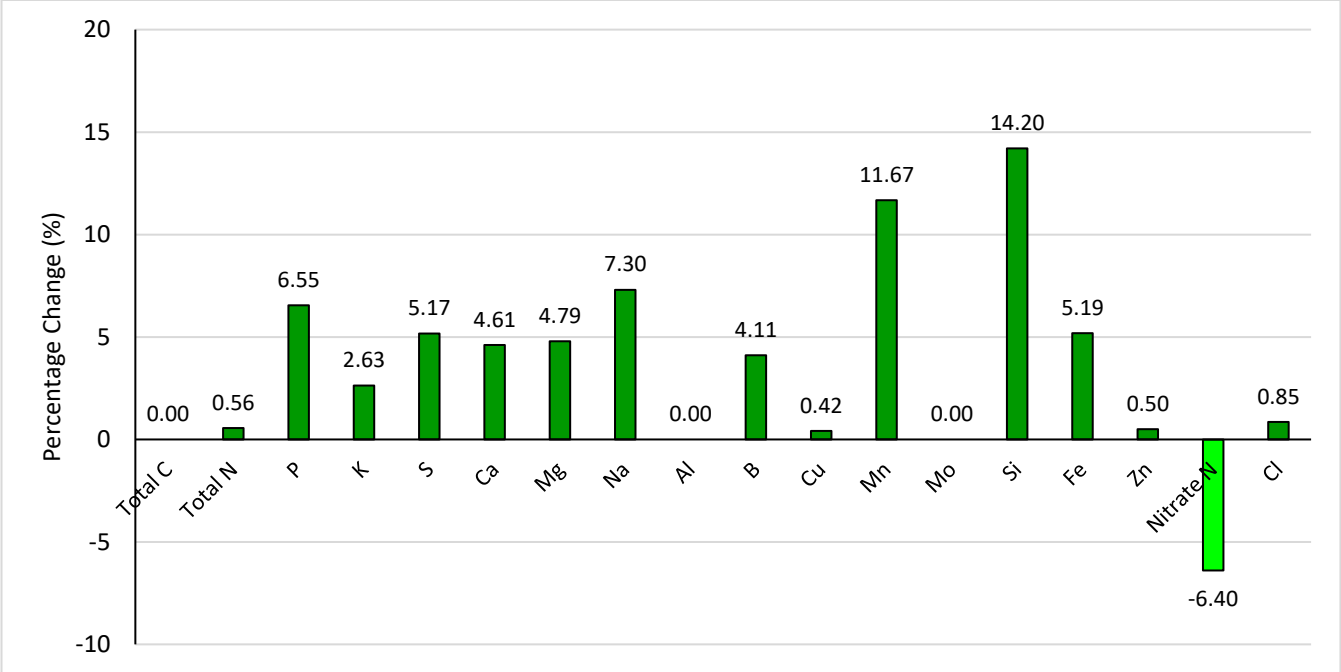

Figure 14: The percentage change of nutrient concentrations measured in the leaves collected from treated and control rows in the Complete Blend 10® trial. Values with a positive percentage change indicate that nutrient levels were higher in Complete Blend 10® treated plants. Values with a negative percentage change indicate that nutrient levels were higher in control plants.

Discussion

It is important to note that this trial was not undertaken correctly and as a result, Complete Blend 10® was applied to the control trees as well as the treated tree. However, this experiment has been running for a couple of years. Therefore, results obtained from this trial are not 100% valid, however Complete Blend 10® trees did out-perform the control trees in nutrient analyses and almond parameters which will be discussed.

When looking at the images taken in figure 2 and 3, there is little to no difference between the 2 rows of trees. These images were taken parallel to each other. When looking carefully at the images, Complete Blend 10® treated trees seen in figure 2 seem to have a more filled-out appearance in their canopy in comparison to the control rows. This more filled-out appearance most likely is a result of more available nutrients provided to the plant. In previous years when this experiment was run, this was also a common result seen. This increase in canopy density can be explained by the more available nutrients to the tree provided though application of Complete Blend 10®. When looking at figure 14, elements responsible for new growth such as total nitrogen and phosphorus had higher nutrients concentrations in Complete Blend 10® treated leaves. There was a slight increase in total nitrogen by 0.6% and a 7% increase in the phosphorus concentration levels. There are also higher levels of copper, zinc, manganese, boron, potassium and silicon which all play roles in stress management. Since there were higher concentrations in Complete Blend 10® treated trees, there may have been a lesser degree of stress on the tree from nut development which can prevent the loss of leaves displaying a fuller tree.

Figure 4 and 5 show images of a typical branch see between Complete Blend 10® trees and control trees. When harvesting nuts for analyses of almond parameters such as hull and kernel weights, there seemed to be more nuts available on trees treated with Complete Blend 10® in comparison to the control trees (figure 5). Again, this increase in nuts may be related to the increased in macro and micro nutrients available to the treated trees from previous years applications of Complete Blend 10®. Again, when looking at figure 14, there was higher levels of magnesium, iron and zinc which all play critical roles in chlorophyll production and hence photosynthesis. Increased photosynthesis boosts sugar and carbohydrate accumulation and promotes kernel filling whilst also providing the tree with energy to undertake daily biochemical reactions to encourage proper growth.

Before commercial shaking begun, almonds were collected from trees for weight differential analyses and also to analyse hull and kernel weight differences between the treated and control trees. Figure 6 shows that there was approximately a 10% percentage increase in the fresh weight of almond picked from Complete Blend 10® trees in comparison to the control trees. This difference was deemed to be statistically significant. However, there was no statistically significant increases in the dry weight, hull weight and kernel weights of the nuts. This most likely is a result of the Complete Blend 10® being applied to the control trees at nut set which provided the trees with the nutrients to encourage the growth of the nuts. However, in previous years, there has been statistically significant increases in kernel weights which highlighted the benefits of application of Complete Blend 10® at nut set.

At the time of commercial harvest, nuts where collected from the ground from each row in the trial. A 1 meter transect was taken for analysis where whole nut weights and out-turns were calculated. Figure 10 shows the average weight of dry nuts between the 2 treatments. Although there is not a statistically significant difference in weight, the Complete Blend 10 trees produced more nuts/heavier nuts which resulted in a percentage increase of 15% when comparing the average weight of nuts collected from the control trees. Because of this, Complete Blend 10® trees produced a higher out-turn percentage of 27% in comparison to the control out-turn of 25.85% which is displayed in figure 11.

Conclusion

In conclusion, this trial was conducted to evaluate the effectiveness of using Complete Blend 10® for improving the pant nutrients status in almond plants and also positively influencing yields. Multiple different aspects were compared including visual tree differences, leaf nutrient status, fresh, dry, hull and kernel weights to aid in evaluating the effectiveness of Complete Blend 10®. Due to the missed fertigation at nut set, this seasons data will be deemed inconclusive, however there were key differences seen between the Complete Blend 10® treated trees and the control trees.

When studying the figures presented, it can be found that almond trees treated with Complete Blend 10® had the following improvements:

- Increased vegetative growth resulting in a denser and more filled look along with more available nuts for picking in treed treated with Compete Blend 10® in comparison to the control trees.
- The out-turn of almond production had a percentage increase of approximately 4% in almond trees treated with Complete Blend 10® in comparison to the control trees.
- Statistically significant increase in the fresh of nuts treated with Complete Blend 10® at nut set in comparison to the control.
- All nutrients analysed except of Nitrate N had higher nutrient concentration in leaves tested from trees treated with Complete Blend 10® in comparison to the control trees. Noticeably in elements not contained in Complete Blend 10 such as silicon and calcium. This can be explained through added BAOM (Biologically Activate Organic Molecules) which assist in naturally chelating elements to increase the movement and transportation of elements within in plants.

Key Findings	Description
Treated trees displayed more clusters of nuts in comparison to the control trees.	Trees treated with Complete Blend 10 had more bunches of nuts on the lower portion of the canopy compared to the control trees which had more sporadic nuts (figure 4 and 5).
10% percentage increase in **fresh weight** of whole nuts collected from trees.	When colleting nuts for analysis, trees treated with Complete Blend 10 produced heavier nuts than control trees which was a statistically significant result (figure 6).
15% percentage increase in **dry weight** of whole nuts collected at harvest.	When colleting nuts from the ground at harvest, trees treated with Complete Blend 10 produced more nuts in a 1 meter transect than control trees (figure 10).
Complete Blend 10 treated trees had an out-turn of **27.00%** and **control** trees had an out-turn of **25.85%.**	When comparing the out-turn differences between the treated and control trees in the Complete Blend 10 trial, the treated trees resulted in a higher out-turn (figure 11).
All elements besides **Nitrate N** had nutrient concentration in leaves treated with Complete Blend 10.	Trees treated with Complete Blend 10 produced leaves which had higher levels of all macro and micro elements except for Nitrate N (figure 14). This is possibly a result of previous years when this trial occurs which may have resulted in an accumulation of macro and micro elements in the treated trees.

Appendix 1. Statistical Analysis of Results

Table 1: Analysis of yield parameters with reference to control and treated (Complete Blend 10®) almond trees. Values are given mean ± standard deviation. P value <0.15 was considered to be statistically significant.

Parameter	Treatment		*P*-Value	Significance	% increase
	Control	Complete Blend 10			
Fresh Whole Nut Weight (kg) **Figure 6**	0.895 ± 0.092	0.984 ± 0.136	0.107	Yes	9.94
Dry Whole Nut Weight (g) (100 Nuts) **Figure 7**	365.6 ± 73.68	367.6 ± 95.85	0.958	No	0.55
Hull Weight (g) (100 Nuts) **Figure 8**	198.4 ± 54.05	193.9 ± 67.70	0.871	No	-2.27
Kernel Weight (g) (100 nuts) **Figure 9**	111.7 ± 12.31	112.7 ± 15.95	0.877	No	0.90
Whole Nut weight - 1m transect (kg) **Figure 10**	2.848 ± 0.766	3.284 ± 0.635	0.183	No	15.31

Table 2: Analysis of different nutrient levels in the leaves with reference to Control and Complete Blend 10. P value <0.15 was considered to be statistically significant.

Nutrient	Treatment (Mean)		*P* Value	Significance	% increase
	Control	Complete Blend 10			
Total Carbon (%w/w)	42.70	42.40	0.999	No	-0.70
Total Nitrogen (%w/w)	3.590	3.610	0.818	No	0.56
Phosphorus (%w/w)	0.245	0.262	0.193	No	6.94
Potassium (%w/w)	3.649	3.745	0.628	No	2.63
Sulphur (%w/w)	0.170	0.177	0.379	No	4.12
Calcium (%w/w)	1.475	1.543	0.466	No	4.61
Magnesium (%w/w)	0.529	0.556	0.356	No	5.10
Sodium (%w/w)	0.01	0.0100	N/A	N/A	0
Aluminium (PPM)	100	100	N/A	N/A	0
Boron (PPM)	46.5	48.4	0.297	No	4.09
Copper (PPM)	9.61	9.65	0.964	No	0.42
Manganese (PPM)	106	118	0.202	No	4.64
Molybdenum (PPM)	0.500	0.500	N/A	N/A	11.32
Silicon (PPM)	176	201	0.0782	Yes	14.20
Iron (PPM)	76.2	80.1	0.373	No	5.12
Zinc (PPM)	51.9	52.1	0.956	No	0.39
Nitrate N (PPM)	62.4	58.4	0.645	No	-6.41
Chloride (%w/w)	0.105	0.105	N/A	N/A	0