Evaluation on the Application of UAN and Activated N® as a Superior Nitrogen Fertiliser for Increased Almond Growth and Yields

Dual Chelate Fertilizer Pty Ltd.
PO Box 963, 162 New Guinea Road Robinvale VIC 3549, Australia
Correspondence: info@dualchelate.com

Mixed application of Activated N and Generic UAN

Nitrogen (N) is only of the most important macro elements associated with plant growth and as a result, is one of the core ingredients used in agriculture for the production of crops. Nitrogen is often referred to as the building blocks of life as it is a key element in DNA production and hence protein development. It also is involved in chlorophyll formation and photosynthesis to produce sugars for plants as an energy source. This is what makes nitrogen fertilizers, such as UAN (urea ammonium nitrate), an important and necessary tool to provide nitrogen to plants efficiently and effectively to optimize growth. In Almond production, nitrogen is applied throughout the growing season from the break of dormancy to fruit enlargement. This ensures that there is optimal nitrogen available for shoot, bud and fruit growth which as a direct correlation to potential yield.

Key Words: Nitrogen, fertilizer, plant growth, almonds, UAN, yield

Nitrogen is often applied to crops via UAN (urea ammonium nitrate) fertilizer which is a highly concentrated nitrogen-based fertilizer containing approximately 46% nitrogen. However, with current technology, UAN fertilizers are now being enhanced with the use of chelation technology and added macronutrients. Dual Chelate Fertilizer PTY Ltd has developed an improved and more effective form of UAN known as Activated N®. Activated N® is a liquid fertilizer which contains not only urea (20%), ammonium (10%) and nitrate (10%) but also Zinc (0.2%), Iron EDDHSA chelated (0.2%) and Biologically Active Organic Molecules (BAOM) for superior absorption and translocation of nutrients within plants. The added benefits listed in Activated N® makes it a superior nitrogen delivering fertiliser when compared to a generic liquid UAN fertiliser.

The added Zinc (Zn) and Iron (Fe) in Activated N® both assist in chlorophyll production and plant growth. Fe is an important precursor to a number of reactions required to make chlorophyll and Zn is the main element required to synthesize the plant growth promoting hormones such as auxin. Auxin is the hormone which is responsible for the development of new shoot and root tips. BAOM assist in increasing the translocation and efficiency of nutrients in the plant themselves.

In almond production, the total amount of nitrogen needed each yeah is approximately 290-310 units/hectare. This is why it is necessary to provide nitrogen fertiliser which are high in urea, ammonium and nitrate to ensure all these units are delivered. If insufficient nitrogen is

applied and almond trees become deficient, this will negatively affect yields and reduce kernel numbers and weights. Majority of nitrogen is applied during times where there is significant growth such as during shoot development, bud building and fruit development. It is also necessary to apply nitrogen as a part of a post-harvest regime to ensure that structural proteins are created to support the next seasons tree development.

In this study, the effect of soil applied applications of Activated N® will be compared to application of a generic liquid UAN fertiliser commonly used in the agricultural industry. This trial is undertaken in an almond orchard in the Sunraysia region. Parameters observed will include yield analyses, nutrient leaf concentrations and out turn percentages between the two different treatment blocks.

Objectives

1. Compare and contrast the effectiveness of Activated N® and generic UAN in improving almond yields parameters via the evaluation of whole nut and kernel weight
2. Analyse the physical growth and crop vigour of the trees and nuts through images.
3. Compare leaf nutrient analyses to show difference in leaf nitrogen concentrations and other macro and micro nutrients.
4. Determine out-turn differences between the 2 different treatments and almond blocks.

Materials and Methods

Site selection and Trial design

This trial was conducted in an almond orchard within the Sunraysia region of Victoria. 2 blocked on this orchard were selected for applications of Activated N® and generic UAN. These blocks were separated and chosen based on their irrigation lines so each block could be independently irrigated with the different treatment. 1 block from each treatment was used to take measurements and observations and 3 rows with 10 trees each were used to collect data from such as leaves and nuts for sampling. The almond variety tested was Nonpareil. It should be noted that during this trial Activated N® was mistakenly applied to the generic UAN block which caused issues determining final conclusions. However, leaf samples were taken before this issue, so accurate leaf nutrient concentrations will be observed in this report. Table 1 shows the application times and rates of the Activated N and generic UAN.

Table 1: Application rates of Activated N and generic UAN. Each block was treated with the same amount of each treatment. Dates with astricts indicate application of Activated N® in the Generic UAN block.

Treatment		Application Date	Application Rate L/ha
Activated N	Generic UAN	29/9/19	12
		17/10/19	34
		24/10/19*	34
		4/11/19*	15

Observations

Soil Observation

Soil samples were taken prior to application of Activated N and generic UAN and after the final application of treatment. Soil samples were then analysed by Analytical Laboratories & Technical Services Australia (ALTSA).

Leaf Nutrient

Leaf samples were taken from every tree in the sampling area before applications of treatment, mid-way through trial and again at the end of the trial. These leaves were then washed and analysed at ALTSA, Victoria - for the presence of: Nitrogen (N), Phosphorus (P), Potassium (K), Sulfur (S), Calcium (Ca), Magnesium (Mg), Sodium (Na), Aluminium (Al), Boron (B), Copper (Cu), Iron (Fe), Manganese (Mn), Zinc (Zn), Silicon (Si) and Molybdenum (Mo).

Kernel Weight, Hull weight and Nut Weight

Before commercial harvest, 20 nuts per tree were collected from the trial zones in the 2 blocks 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 1: A photo taken of almond trees treated with **Activated N** before shaking.

Figure 2: A photo taken of almond trees treated with **Generic UAN** before shaking.

Figure 3: Almond tree treated with **Activated N** before shaking.

Figure 4: Almond tree treated with **Generic UAN** before shaking.

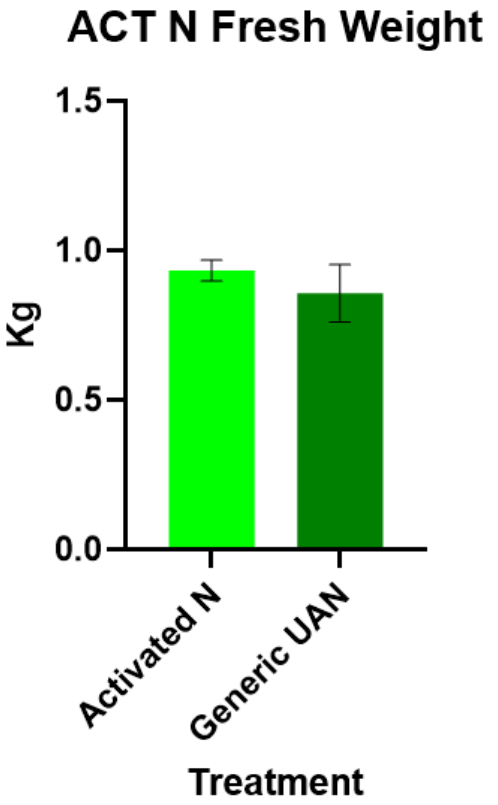

Figure 5: The average fresh weight of almonds collected from almond trees treated with Activated N® and Generic UAN (P<0.15).

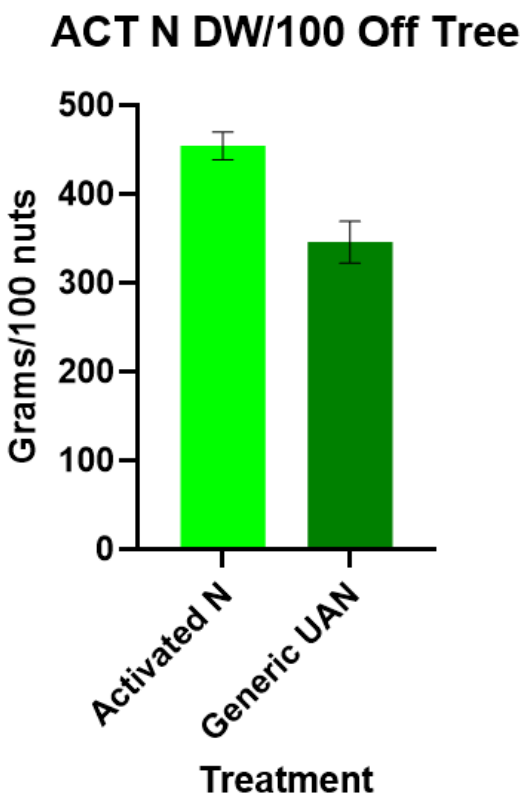

Figure 6: The average dry whole weight of 100 nuts collected from almond trees in the Activated N and Generic UAN blocks. (P<0.15)

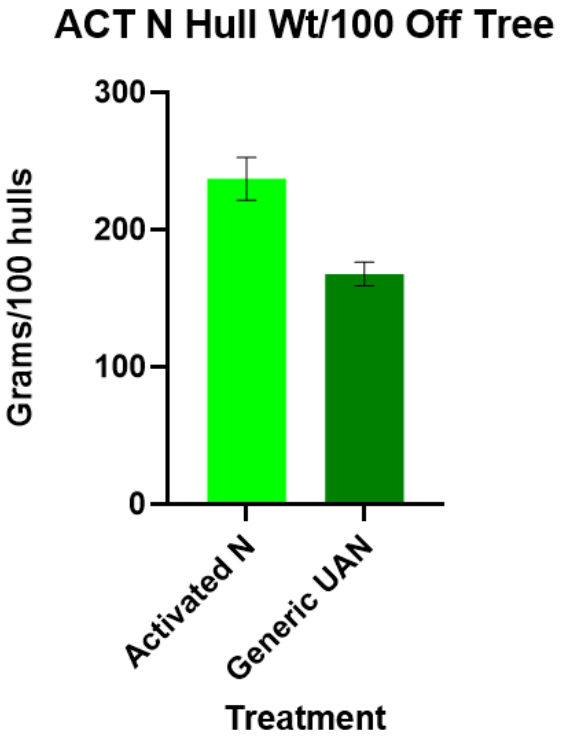

Figure 7: The average hull weight of 100 nuts collected from almond trees in the Activated N and Generic UAN blocks. (P<0.15)

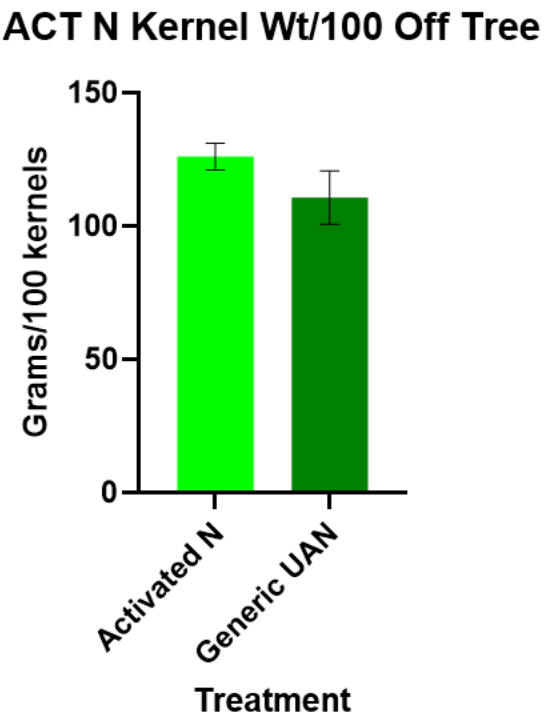

Figure 8: The average kernel weight of 100 nuts collected from almond trees in the Activated N and Generic UAN blocks. (P<0.15)

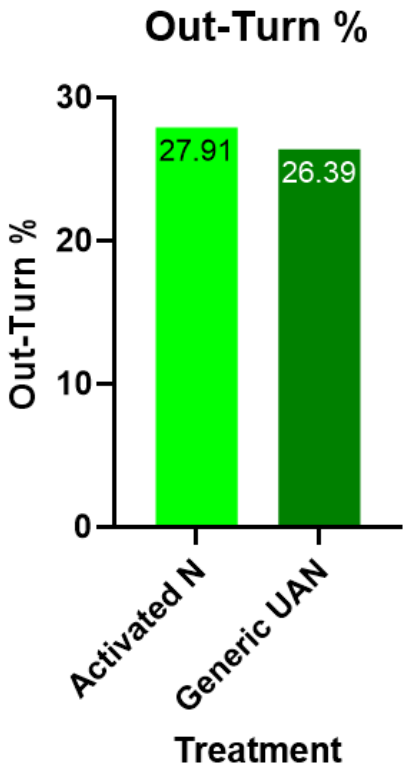

Figure 9: The out-turn percentage of the treated almonds collected from the ground after shaking in the Activated N and Generic UAN treated blocks.

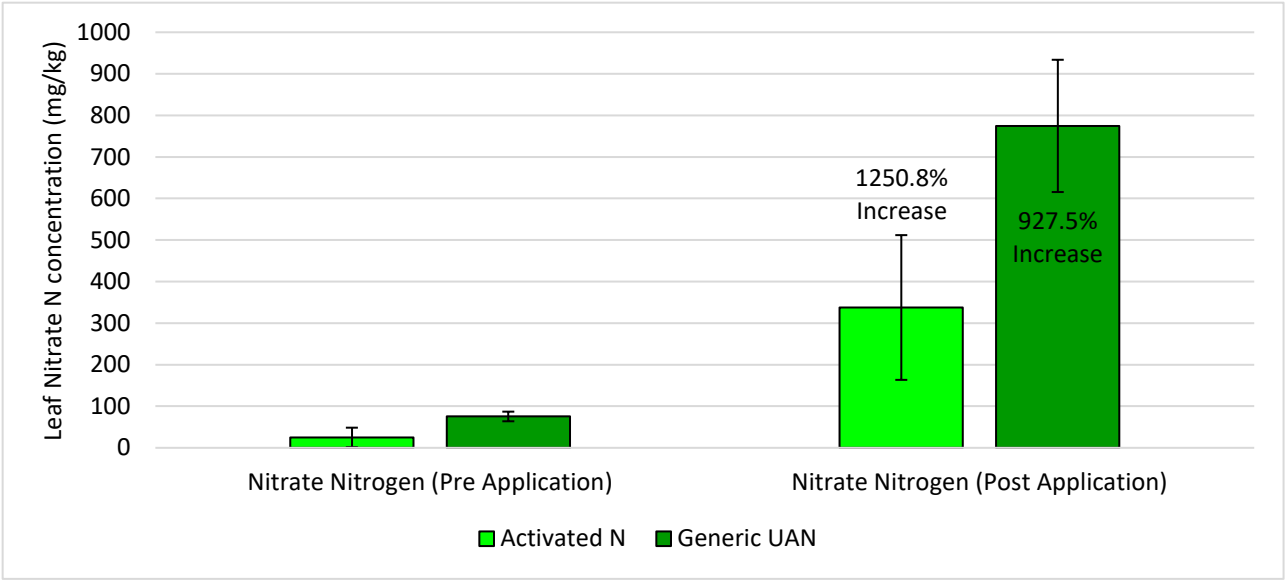

Figure 10: The difference in leaf nitrate concentration (mg/kg) before application of treatments and after the second application of Activated N and Generic UAN. The percentage increase in Nitrate is highlighted in the post application of the two treatments.

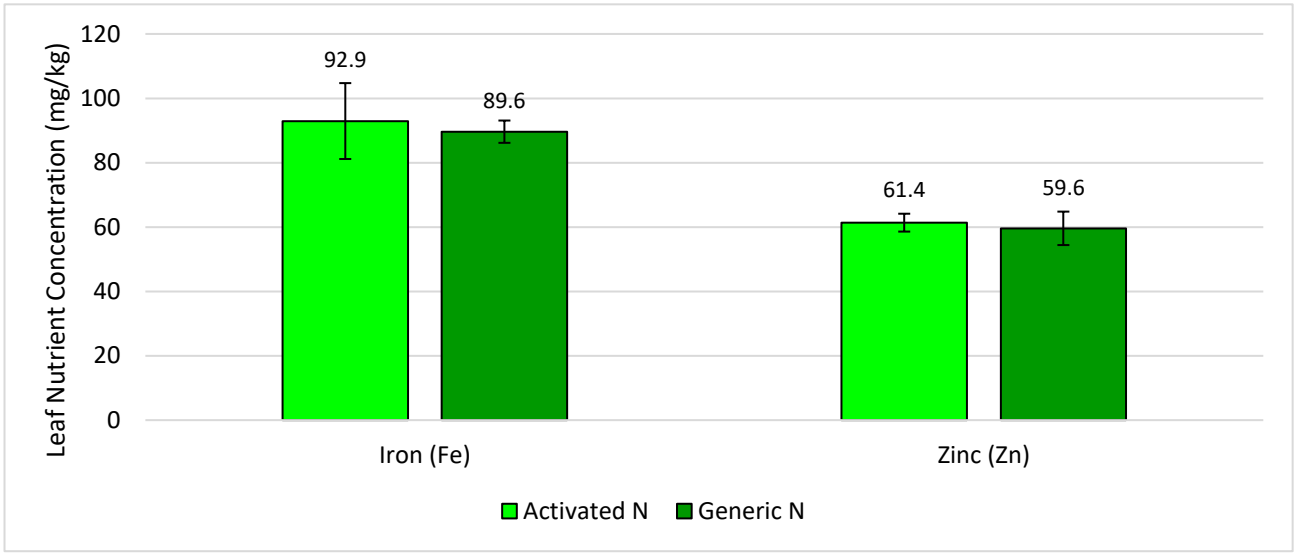

Figure 11: The difference in iron and zinc leaf concentrations (mg/kg) after the second application of Activated N and Generic UAN.

Discussion

When looking at the photos taken highlighted in figures 1 to 4 close to harvest time, some differences can be observed. When comparing the almond tree growth in figure 1 and 2, it can be seen that almond trees treated with Activated N had a denser canopy all over the tree in comparison to figure 2 which shows the trees treated with Generic UAN. This difference may have been a result of variations in tree growth in different blocks. However, when looking at figure 10, it can be seen that almond trees treated with Activated N had a higher percentage increase in the concentration of nitrate in their leaves in comparison to the Generic UAN treated

trees. This increased nitrate percentage seen in Activated N trees may have also contributed to the denser canopy represented in figure 1.

Figures 3 and 4 show close up images of almond trees treated with Activated N and Generic UAN. Trees treated with Activated N visually had more nut per tree in comparison to the Generic UAN treated trees which seemed to have a lower number of nuts on each tree. This observation was noted when collecting nuts for kernel and hull nutrient analyses. This increase in nuts per tree is also related to the out-turn shown in figure 9. Activated N treated trees had a out-turn of 27.9% whereas Generic UAN treated trees had an out-turn of 26.4%. This further shows that there was an increase in the number of visible nuts on almond trees treated with Activated N.

Statistical analyses were done to assess differences in fresh weight, dry weight, kernel weight and hull weight in the 2 treatments. Figure 5 shows the difference in the fresh weight of nuts harvested off the trees. Although this difference is not statistically significant, trees treated with Activated N weighed more in comparison to trees treated with Generic UAN with a percentage increase of 9%. Once these nuts were dried, 100 nuts were randomly selected and measured for their weight (figure 6), hull weight (figure 7) and kernel weight (figure 8). Each of these 3 almond parameters all had statistically significant differences highlighting that Activated N treated almonds had out-performed Generic UAN treated almond trees. These significant differences could be explained by the added zinc, iron and Biologically Active Organic Molecules (BAOM). The Zinc and Iron both assist in chlorophyll production and plant growth. With increases chlorophyll production, there is increased photosynthesis which results in a higher sugar accumulation. These sugars can be used and converted into carbohydrates which serve as an energy source for many reactions within cells. Although these is slightly less total nitrogen in Activated N (shown in table 2), its mobility and translocation is increased through the added BAOM which act as organic chelates. Together, these added nutrients may have increased the Activated N treated trees ability to produce more biomass and carbohydrates which explains the increased weight of hulls and kernels in Activated N treated trees in comparison to the Generic UAN treated trees.

Table 2: The composition differences between Activated N and Generic UAN. Concentrations are measured in W/V %.

Concentrations (W/V) %	**Activated N**	**Generic UAN**
Total Nitrogen	40.9 %	42.5%
N as Nitrate	10.4%	10.5%
N as Ammonium	10.6%	10.5%
N as Urea	19.9%	21.5%
BAOM	0.28%	
Synthetic Chelate	0.02%	
Total Carbon	8.9%	
Zinc	0.11%	
Iron (Fe) EDDHSA Chelated	0.11%	

Finally, when comparing the out-turns shown in figure 9, it can be that there is a percentage increase of approximately 6% in almond trees treated with Activated N in comparison to trees treated with Generic UAN. This difference correlates to the heavier kernel weight seen in figure 8. However, it is important to note that these calculations were performed with nuts which had both applications of Generic UAN and Activated N.

Conclusion

In conclusion, this trial was conducted to evaluate the differences and effectiveness of Activated N in comparison to Generic UAN and assessing changes in almond yields and growth parameters such as fresh, dry, hull and kernel weights. Due to the error in fertiliser application, this trial is yet to be conclusive, however key differences were seen between the 2 treatments.

When studying the figures presented, it can be found that almond trees treated with applications of Activated N instead of Generic UAN had the following improvements:

- Increased vegetative growth in the lower portions of the canopy along with a large number of nuts available for picking in almond trees treated with Activated N
- The out-turn of almond production had a percentage increase of 6% in almond trees treated with Activated N in comparison to trees treated with Generic UAN.
- Statistically significant increases in dry weight, kernel weight and hull weight in almond trees treated with Activated N.
- Higher percentage increase of nitrate nitrogen in trees treated with Activated N (1250.8%) meaning that Activated N treated trees accumulated more nitrate in their leaves in comparison to Generic UAN treated trees (927.5%).
- Increased concentrations of Iron and Zinc in almond trees treated with Activated N which correlates to increased yields through higher levels of photosynthesis and sugar translocation.

Key Findings	Description
Increased lower canopy vegetation growth in trees treated with Activated N.	Trees treated with Activated N had more vegetative growth in the lower portions of the canopy in comparison to the trees treated with generic UAN (figure 1 and 2).
Trees treated with **Activated N** displayed **more nuts** evenly spread around the tree in comparison to the generic UAN treated trees.	Trees treated with Activated N had more nuts on their trees and evenly spaced out compared to the generic UAN trees which had less nuts (figure 3 and 4).
Activated N treated trees had **heavier** nut **fresh weights, dry weights** (significant), **hull weights** (significant) and **kernel weights** (significant).	Trees treated with Activated N had a: • Percentage increase of **9%** in the **fresh weight** of almonds (figure 5). • Significant percentage increase of **31%** in the **dry weight** of almonds (figure 6). • Significant percentage increase of **42%** in the **hull weight** of 100 almonds (figure 7). • Significant percentage increase of **14%** in the **kernel weight** of 100 almonds (figure 8).
Activated N treated trees had an out-turn of **27.91%** and **Generic UAN** trees had an out-turn of **26.39%.**	When comparing the out-turn differences between the Activated N and Generic UAN trees, the treated trees resulted in a higher out-turn (figure 11).
Activated N had a higher percentage increase of **Nitrate levels** in the leaves of almond trees compared to the Generic UAN trees.	Trees treated with Activated N had a Nitrate concentration percentage increase of **1251%** in their leaves from before Activated N applications to shortly after the second application. Generic UAN had a percentage increase of **928%** in the Nitrate concentration of almond leaves (figure 10).
Trees treated with Activated N had higher concentrations of **iron** and **zinc** in their leaves compared to Generic UAN.	Leaves collected from trees treated with Activated N had a percentage increase of **4% in iron** and **3% in zinc** which correlated to the added iron and zinc in Activated N (figure 11).

Appendix 1. Statistical Analysis of Results

Table 1: Analysis of yield parameters with reference to control (Activated N) and treated (Generic UAN) 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 (Activated N)	Treated (Generic UAN)			
Fresh Whole Nut Weight (kg) **Figure 5**	0.933 ± 0.0351	0.857 ± 0.0555	0.264	No	8.87
Dry Whole Nut Weight (g) (100 Nuts) **Figure 6**	454.3 ± 15.63	346.0 ± 23.52	0.0027	Yes	31.30
Hull Weight (g) (100 Nuts) **Figure 7**	237.0 ± 15.72	167.7 ± 8.62	0.0026	Yes	41.32
Kernel Weight (g) (100 nuts) **Figure 8**	126.0 ± 5.00	110.7 ± 10.02	0.077	Yes	13.82
Whole Nut weight - 1m transect (kg) **Figure 9**	3.700 ± 0.482	2.437 ± 1.466	0.229	No	51.83

Table 2: Analysis of different nutrient levels in the leaves with reference to Control (Activated N) and Treated (Generic UAN). P value <0.15 was considered to be statistically significant.

Nutrient	Treatment (Mean)		*P* Value	Significance	% increase
	Control (Activated N)	Treated (Generic UAN)			
Total Carbon (%w/w)	42.3	42.7	0.519	No	-0.78
Total Nitrogen (%w/w)	3.63	3.83	0.386	No	-5.22
Phosphorus (%w/w)	0.223	0.220	0.893	No	1.20
Potassium (%w/w)	3.21	3.52	0.371	No	-8.80
Sulphur (%w/w)	0.177	0.190	0.374	No	-5.66
Calcium (%w/w)	1.99	1.88	0.584	No	5.67
Magnesium (%w/w)	0.580	0.563	0.857	No	3.38
Sodium (%w/w)	0.0100	0.0100	N/A	N/A	0.00
Aluminium (PPM)	100	100	N/A	N/A	0.00
Boron (PPM)	47.2	49.2	0.640	No	-4.00
Copper (PPM)	8.83	8.83	N/A	N/A	0.00
Manganese (PPM)	162	154	0.610	No	4.97
Molybdenum (PPM)	0.500	0.500	N/A	N/A	0.00
Silicon (PPM)	227	207	0.101	Yes	9.68
Iron (PPM)	92.9	89.6	0.666	No	3.68
Zinc (PPM)	61.4	59.6	0.631	No	2.96
Nitrate N (PPM)	338	775	0.0327	Yes	-56.41
Chloride (%w/w)	0.113	0.127	0.230	No	-7.75