Comparing Applications of Activated N® and UAN as a Superior Nitrogen Fertiliser for Increased Almond Growth and Yields

Dual Chelate Fertilizer Pty Ltd, 162 New Guinea Road, Robinvale, Victoria 3540, Australia
Corresponding author: Tel: +61 3 5026 4052, Email: info@dualchelate.com

Abstract

Nitrogen (N) is one of the most important macro elements associated with plant growth and as a result it is one of the core elements used in agricultural fertilisers 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 (Shah et al., 2016). This is what makes nitrogen fertiliser 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, root and fruit growth which has a direct correlation to potential yield. In this trial, Activated N® and a generic UAN fertiliser were compared to assess yield differences and potential nutrition differences and it was found that there was increased vegetative growth and nut development in trees treated with Activated N®, 5% increase in the quantity (kg) of nuts per tree on Activated N® treated trees and 4.3% increase in the out-turn percentage of nuts collected from Activated N® trees at harvest.

Keywords: Nitrogen, UAN, almonds, fertiliser, plant growth, yield, out-turn

1. Introduction

Nitrogen is often applied to crops via UAN (urea ammonium nitrate) fertilizer which is a highly concentrated nitrogen-based fertilizer containing approximately 39% - 42% nitrogen (w/v). However, with current technology, UAN fertilizers are now being enhanced with the use of chelation technology and added macronutrients to provide better nutrition and promote plan growth. 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 Sulphur (5.8%, 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 fertilizer when compared to a generic liquid UAN fertilizer.

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 (Silva and Uchida, 2000). 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 year is approximately 290-310 units/hectare. This is why it is necessary to provide nitrogen fertilizers 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 (Nitrogen deficiency in almonds, 2021). 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 and carbohydrates 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.

2. Objectives

The specific objectives of this trial were to:

1. Compare and contrast the effectiveness of Activated N® and generic UAN in improving almond yield parameters through the evaluation of whole nut, kernel and hull weights.
2. Analyse the physical growth and crop vigour of the trees through images and compare the ratio of green pixels in images to determine differences in canopy growth.
3. Compare leaf and soil nutrient analyses to show differences in nutrient concentration after applications of nitrogen fertilizer.
4. Determine out-turn differences between the 2 different treatments and almond blocks.

3. Materials and Methods

Site selection and Trial Design

This trial was conducted in an almond orchard within the Sunraysia region of Victoria. 2 blocks on this orchard were selected for separate applications of Activated N® and generic UAN. These blocks were separated and chosen based on their irrigation lines and programs so each block could be independently irrigated with the different treatment. Each block had measurements and observations taken from 3 rows with 10 trees/row. Each row and tree were used to collect data and nuts for sampling. The almond variety tested was Nonpareil. Table 1 shows the application times and rates of the Activated N® and Generic UAN. Applications rate of Activated N® and Generic UAN were matched against the farms nitrogen application program. Both liquid nitrogen fertilizers fertigated through the drip line.

Table 1: Application rates of Activated N® and generic UAN. Each Block was treated with the same rate of nitrogen fertilizer on the same day.

<table>
<tr><th colspan="2">Treatment</th><th>Application Date</th><th>Application rate (L/ha)</th></tr>
<tr><td rowspan="5">Activated N®</td><td rowspan="5">Generic UAN</td><td>21/09/20</td><td>34 L/ha</td></tr>
<tr><td>27/09/20</td><td>46 L/ha</td></tr>
<tr><td>13/10/20</td><td>34 L/ha</td></tr>
<tr><td>21/10/20</td><td>34 L/ha</td></tr>
<tr><td>09/11/20</td><td>15L/ha</td></tr>
</table>

4.Observations

Soil Nutrient Analysis

Soil samples (30cm deep) were taken in mid-January 2021 just prior to the beginning of almond harvesting as requested by the orchards technical agronomist following correct soil sampling techniques. Soil samples were then sent to the Australian Precision Ag Laboratory (APAL) for a full soil nutrient profile analysis. See figure 1 for images of soil samples collection. The results were then analysed using

GraphPad Prism software to determine any significant differences between the treatments.

Figure 1: Images of soil sampling for the Activated N® and generic UAN trial. Soil samples were taken 30cm deep and sent to APAL for analysis.

Leaf Nutrient Analysis

Leaf samples were taken in mid-January 2021 just prior to the beginning of almond harvesting as requested by the orchards technical agronomist following correct leaf sampling techniques. 10 leaves from each tree/row were collected and the samples were then expressed posted to APAL for a full leaf nutrient analysis. See figure 2 for images of leaf collection. The results were then analysed using GraphPad Prism software to determine any significant differences between the treatments.

Figure 2: Images of leaf sampling. Leaves were taken from non-fruiting spurs at the 3rd leaf. Samples were sent to APAL for analysis.

Whole Nut weight, hull weight and hull nuts from nuts collected before harvest

Before commercial harvest, 10 nuts per tree (100 nuts per row) were collected from the trial blocks to get whole nut weight, hull weight and kernel weights. This was done to compare the out-turns calculated from nuts collected on the tree and also nuts collected at harvest from the ground. This data was also collected to compare weight between each component of the nut.

Nut collection at harvest for field weight (kg of nuts/tree)

Once the trees had been shaken and the nuts were on the ground, all the nuts from 16 trees (8 trees from Activated N® block and 8 from generic UAN block) were raked into rows, sifted using a slatted shovel and then weighed. This provided data on the quantity of nuts per tree. Trees which have similar canopy densities were chosen to weight nuts from. Figure 3 shows the methods used to gather the field weight data. A small sample of approximately 500 grams of nuts were also collected from each tree to make final out-turn calculations.

Figure 3: Images of nuts collected from shaken trees. Nuts were sifted to remove leaves, sticks and dirt then weighed to provide kg of nuts/tree

Out-turn calculations

Out-turns are calculated to determine the percentage of kernel in a whole almond nut. The higher the percentage, the heavier the kernels are. Out-turns are crucial to determine profits made on almond orchards. In this trial, out-turns were calculated from almond nuts collected prior to harvest and also during harvest. Out-turns are calculated using the following equation:

Out-Turn% = (Kernel Weight/Whole Nut Weight) x 100

Statistical analysis

Statistical analyses (t-test and multiple t-tests) were done using GraphPad Prism 9. Significant difference ($P<0.15$) between treatments was determined by comparing the replicate means. Error bars were also used on graphs.

RGB (Red, Green, Blue) Statistics of drone images

Drone images were taken of the two different trial blocks after the applications of Activated N® and generic UAN were finished to compare visual differences. These drone images were also analysed using an image colour summarizer which determines the RGB colour in the drone images. The higher the G number, the more green pixels there are in the photo, suggesting higher canopy densities. (http://mkweb.bcgsc.ca/color-summarizer).

5. Results

Figure 4: A photo taken of almond trees treated with Activated N® before harvest.

Figure 5: A photo taken of almond trees treated with Generic UAN before harvest.

Figure 6: Almond tree treated with Activated N® before harvest

Figure 7: Almond tree treated with Generic UAN before harvest.

Figure 8: Drone image of the trees treated with Activated N®. The rows with red markers were the Nonpareil rows which were analysed.

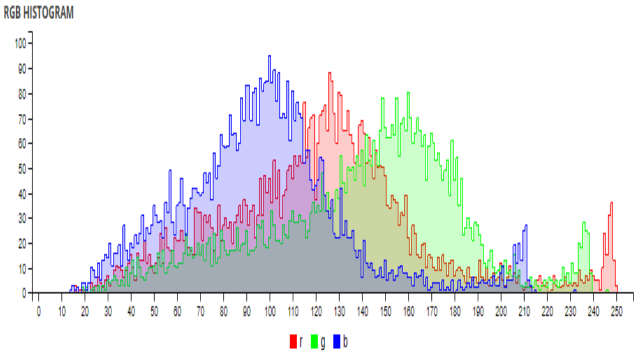

Figure 9: A RGB histogram of figure 8's drone image of the Activated N® sampling area. G = 140

Figure 10: Drone image of the trees treated with generic UAN. The rows with red markers were the Nonpareil rows which were analysed.

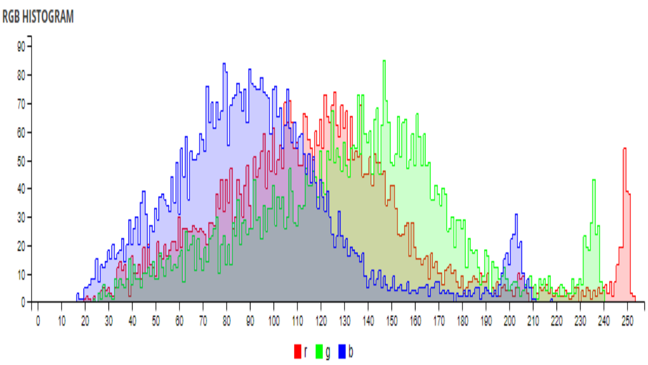

Figure 11: RGB histogram of figure 10's drone image of the generic UAN sampling area. G = 134

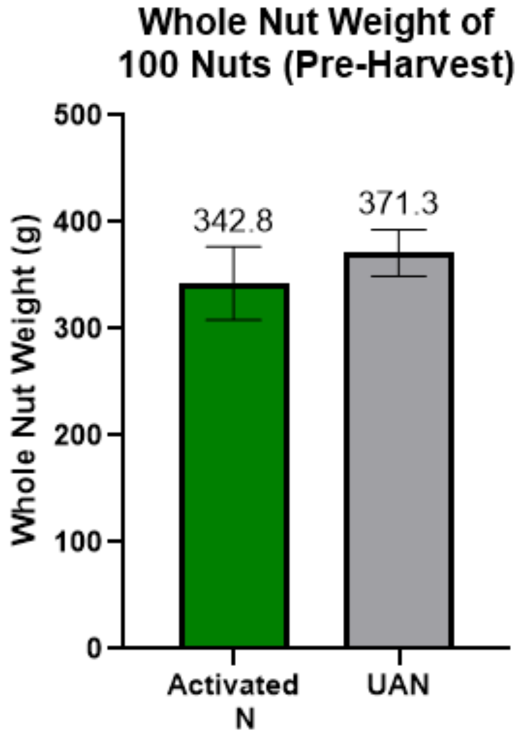

Figure 12: The average whole nut weight of 100 nuts collected from almond trees in the Activated N® and Generic UAN blocks. Nuts were picked randomly from the trees.

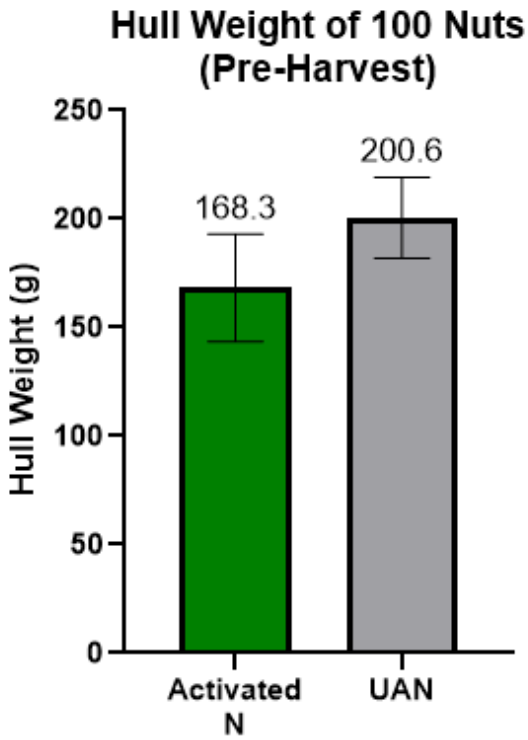

Figure 13: The average hull weight of 100 nuts collected from almond trees in the Activated N® and Generic UAN blocks. Nuts were picked randomly from the trees.

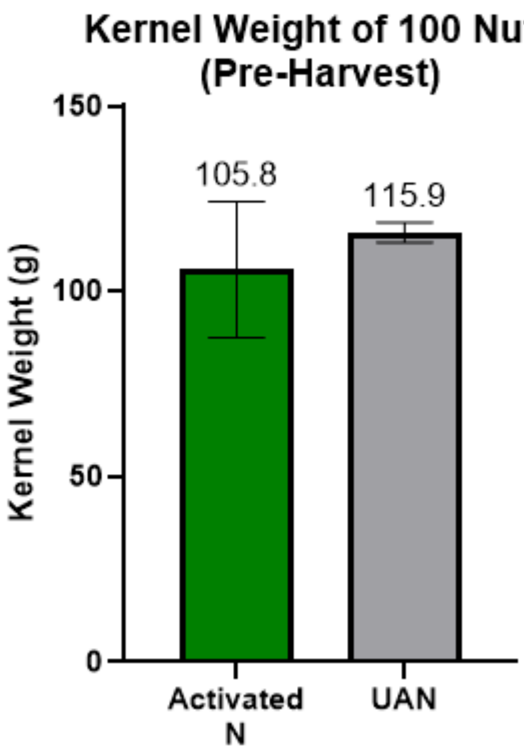

Figure 14: The average kernel weight of 100 nuts collected from almond trees in Activated N® and Generic UAN blocks. Nuts were picked randomly from the trees.

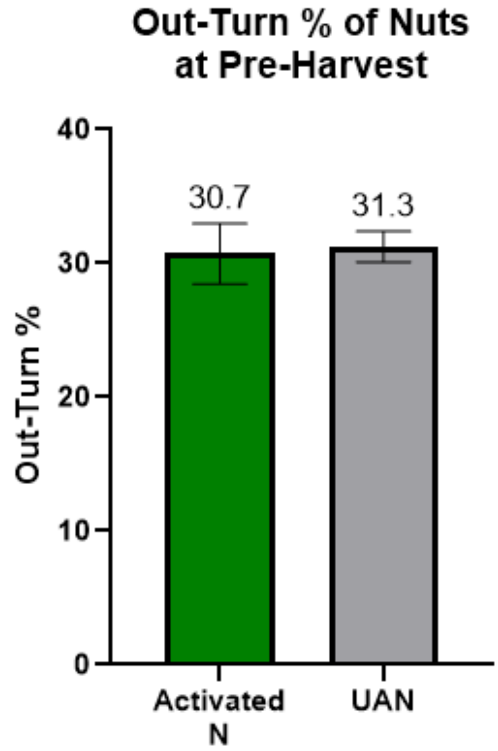

Figure 15: Out-turn % of nuts collected on the trees before harvest began.

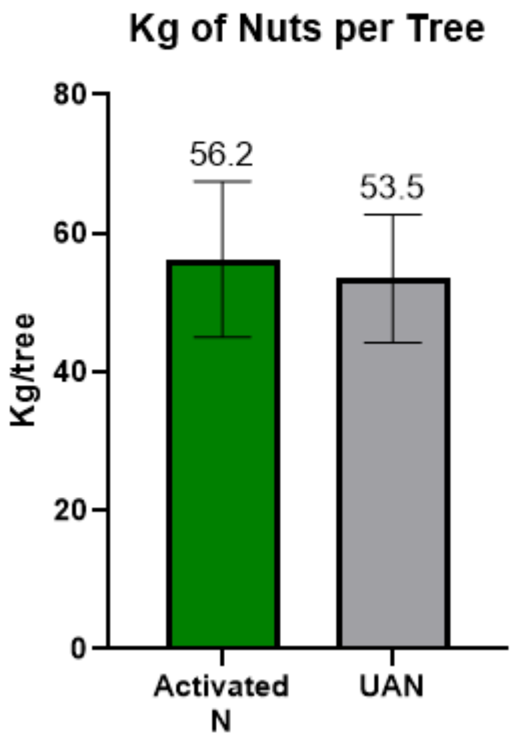

Figure 16: The average quantity of nuts per tree in Activated N® and Generic UAN blocks.

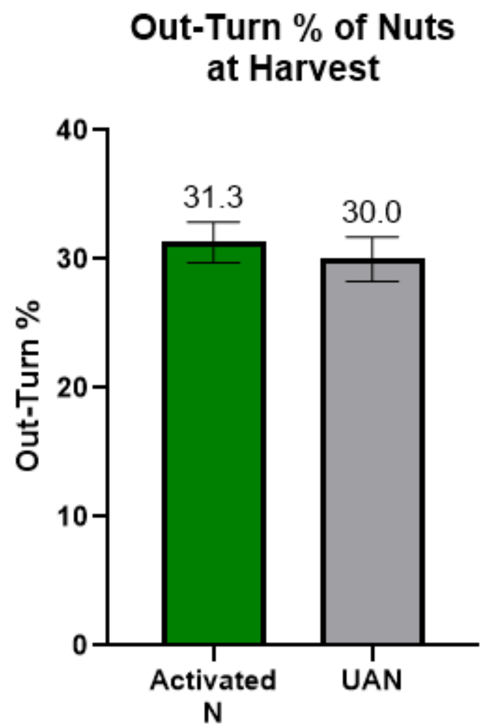

Figure 17: Out-turn % of almonds at harvest.

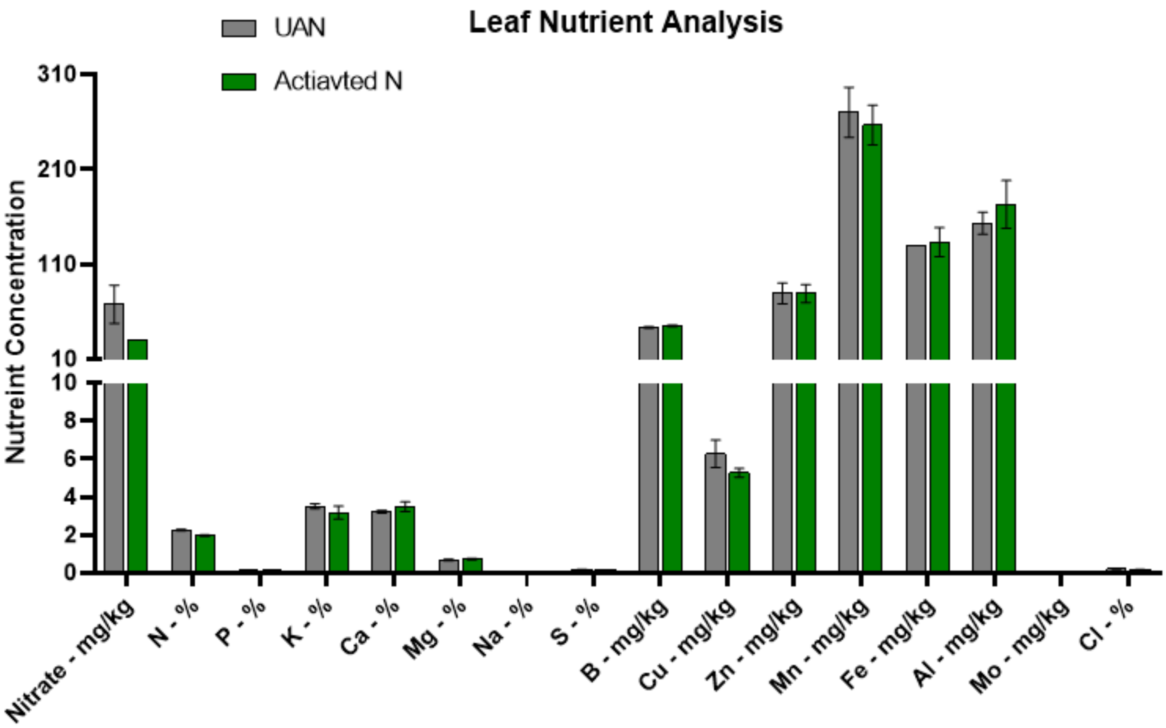

Figure 18: Leaf nutrient analysis of almond leaves treated with Activated N® and generic UAN. Leaf samples were taken in mid-January 2021 in accordance with correct leaf sampling times. Samples were analysed by APAL.

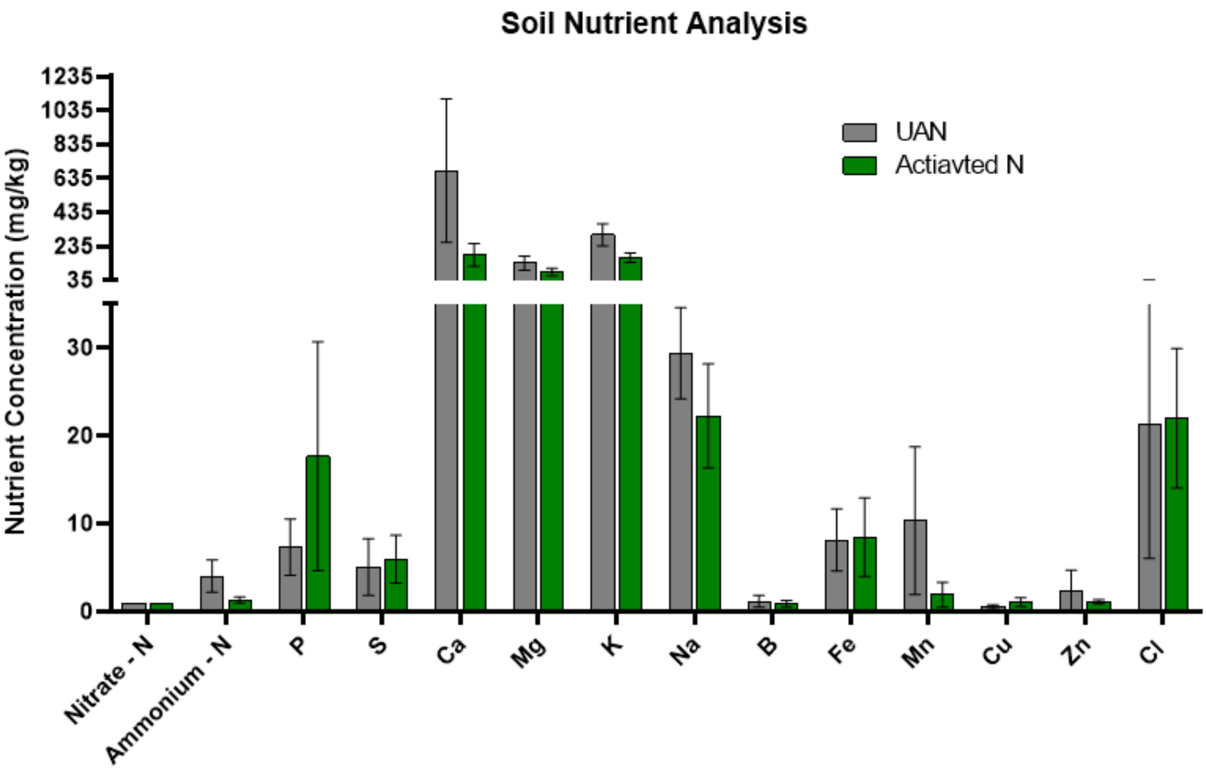

Figure 19: Soil nutrient analysis of soil treated with Activated N® and generic UAN. Samples were analysed by APAL

6. Discussion

Image Comparisons

Figure 4 and 5 shows images of a row treated with Activated N® and generic UAN respectively. These images were taken after the final application of the treatments. When comparing these images, there is little difference observed, however when looking closely, Activated N® treated trees have slightly longer branches resulting in a bushier look. This can also be seen when looking at figure 8 which shows a drone image of the Activated N® trial area. The rows treated with Activated N® have a higher tree canopy circumference compared to the generic UAN trees seen in figure 10 which have a smaller tree canopy circumference. The generic UAN trees are more rounded and look smaller compared to the Activated N® trees. When looking back at figure 5, which shows an individual row treated with generic UAN, the trees have less light interception within the canopy compared to the Activated N®. This suggests that Activated N® promoted the growth of more vertical and horizontal shoots which improved the light interception within the tree canopy creating a bushier appearance on the tree (Johnson, 2019). Activated N® contains traces of Zinc and Iron which are involved in chlorophyll production, hormone production and plant growth (Silva and Uchida, 2000). Zinc is the main element required to synthesise the plant growth promoting hormone auxin. Auxin is the hormone which is responsible for the development of new shoots and root tips (Balzan, Johal and Carraro, 2014). This could be the reason why Activated N® treated trees had more vertical and horizontal growth due to more Zinc being available for auxin synthesis. Iron also has a major role in plant growth with its major use being involved in the synthesis of chlorophyll which is necessary for photosynthesis (Silva and Uchida, 2000). Since traces of Iron is in Activated N®, it would be expected that the chlorophyll production in the tree would increase resulting in greener leaves and production of sugars and carbohydrates necessary to support growth. Figure 9 and 11 shows the ratio of red, green and blue pixels in the drone images captures. When running these drone pictures through a colour analyser, it was found that on average there was 140 green pixels in almond trees treated with Activated N® and 134 green pixels in almond trees treated with generic UAN. This slight increase in green pixel numbers observed in trees treated with Activated N® could be explained by the additions of iron added into the Activated N® formulation. This iron is also chelated using EDDHSA which is very effective chelating agent and stable from soil pH ranges from 3 to 10.

Due to more shoot growth from additions of Zinc in Activated N® there was greater light interception within the tree canopy observed in the Activated N® trees and therefore more nuts were able to form and mature. Trees treated with Activated N® had more nuts compared to trees treated with generic UAN and this difference can be seen when comparing figure 6 and 7. Figure 6 shows a tree treated with Activated N® and when looking closely there are more matured nuts on the tree in comparison to figure 7 which shows a tree treated with generic UAN and has a lower number of matured nuts.

Pre-Harvest Analysis of Nuts

Before commercial harvest, 100 nuts were collected from Activated N® treated rows and generic UAN treated rows. Each row has 10 trees and 10 nuts were picked from each tree making sure to sample nuts all around the tree. This was done to see how the fresh weight of almonds effected the out-turns in comparison to nut weights and out-turns at the time of commercial harvest.

Figure 12 shows the whole nut fresh weight of 100 nuts in both treatments. It was observed that in a sample of 100 nuts treated with generic UAN had an 8% increase in weight compared to Activated N® treated trees. Since the whole nut fresh weight was higher in the generic UAN treated trees, there were similar results seen between pre-harvest hull weight, kernel weight and out-turn. Figure 13 shows a 19% increase in hull weight from trees treated with generic UAN compared to Activated N® at pre-harvest. Figure 14 shows a 9% increase in kernel weight from trees treated with generic UAN compared to Activated N® at pre-harvest. Figure 17 shows 1.9% increase in out-turn from trees treated with generic UAN compared to Activated N® at pre-harvest.

When analysing these results through Prism, it was found that there was no significant difference (P<0.15) seen between generic UAN and Activated N® in whole nut weight of 100 nuts, kernel weight of 100 nuts and also the out-turn

% of nuts at pre-harvest. However, when comparing the hull weight of 100 nuts, it was found that generic UAN produced significantly heavier hulls compared to Activated N® treated trees.

These graphs previously mentioned shows that although the generic UAN produced heavier nuts, it can be assumed that more of the nitrogen was put into the formation of hulls compared to Activated N®. Although there was a significant difference between hull weight (which contributes to whole nut weight), there was very little difference (1.9% difference) in out-turn percentages of nuts at pre-harvest. Both out-turn percentages produced from generic UAN and Activated N® treated trees are above industry standards and produce excellent return on investment to the orchard.

Table 2: The composition differences between Activated

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%
Sulphur	5.8%	
BAOM	0.28%	
Synthetic Chelate	0.02%	
Total Carbon	8.9%	
Zinc	0.11%	
Iron (Fe) EDDHSA Chelated	0.11%	

N® and generic UAN. Concentrations are measured in W/V%

When comparing the total nitrogen content between Activated N® and generic UAN (table 2), it can be seen that there are slight differences in the total Nitrogen content with generic UAN containing approximately 4% more total nitrogen than Activated N®. However, it is important to note the added benefits which Activated N® provides, especially additions of BAOM and Sulphur. BAOM increase the mobility and translocation of Activated N® and other nutrients in the soil and plant tissue as it acts as an organic chelating agent. It is possible that the Activated N® nitrogen applied to the trees was translocated (due to the BAOM) to the new stem growth which was noticed in figure 8. This nitrogen may have been metabolised into creating more biomass.

It is important to note that these nuts were collected directly from the trees and therefore the differences seen in these pre-harvest graphs may be a result of changes in moisture content.

Harvest Analysis of Nuts

Once harvest began and trees had been shaken, all the nuts from 16 trees were collected and weighed. 8 trees from the Activated N® block and 8 trees from the generic UAN block. These trees were chosen randomly, however trees which looked significantly different such as small trees, trees with damage or trees which were significantly larger than the average almond tree was avoided.

Figure 16 shows the average quantity of nuts per tree. It was found that Activated N® treated trees produced a total nut quantity 5% higher than the generic UAN tree. This means that Activated N® trees produced more nuts or heavier nuts than generic UAN treated trees. This increase in nut production could be a result of the added Zinc and Iron which assist in chlorophyll production and plant growth (Silva and Uchida, 2000). With increases in chlorophyll production, there is increased photosynthesis which results in more sugar accumulation. These sugars can be used and converted into carbohydrates which are used for the production of nuts and also are used in a number of metabolic reactions to enhance plant growth. This could explain the 5% increase in nut weight per tree in the Activated N® treated block.

Samples of nuts per tree were then cracked, weighed and out-turn percentages were calculated. Figure 17 shows the out-turn percentages at harvest and it was calculated that Activated N® treated trees had an out-turn percentage 4% higher than the generic UAN trees. This difference was found to be statistically insignificant. When comparing the out-turn % at pre-harvest and during harvest the results are different. When collecting nuts at pre-harvest, nuts were selected at shoulder height, however once the trees had been shaken, a more randomised sample could be collected which provides a more accurate out-turn %. This is because once the trees had been shaken, nuts from all sections on the tree were combined.

This 4% increase in out-turn percentage seen in the Activated N® trees means that the kernel weight took up a larger ratio of the whole nut weight compared to the generic UAN nuts. Again, this increase in out-turn % is most likely due to the added beneficial components contained in Activated N® such as BAOM, Carbon, Sulphur, Zinc and EDDHSA cheated Iron. These nutrients and molecules greatly assist in the productivity and development of the almond trees.

Leaf and Soil Nutrient Analysis

1 month before harvest begun, leaf and soil samples were taken in accordance to the orchard's technical agronomist to assess the soil and leaf nutrition after application of Activated N® and generic UAN. It is important to note that these samples were taken 2 months after the final nitrogen application, so nutrition levels a quite low compared to levels during the growing season.

Figure 18 shows the almond leaf analysis between Activated N® and generic UAN treated trees. Trees treated with Activated N® had higher concentration levels of calcium, magnesium, boron, zinc and iron. However, there were lower levels of nitrate N and nitrogen in Activated N® treated leaves compared to the generic UAN results. This is likely due a higher nitrogen demand needed to increase the quantity of nuts per tree seen in figure 15 which showed a 5% increase in kilograms of nuts per tree in trees treated with Activated N®. Trees treated with Activated N® also showed a 2.3% increase in Iron concentrations in leaf tissue, most likely caused by the 0.11% iron (EDDHSA chelated) contained in Activated N®. Other macro and micro nutrients which showed higher concentration levels in trees treated with Activated N® were chelated by the Biologically Active Organic Molecules which act as a natural chelating agent assisting in the absorption of other nutrients in the soil and transporting them into and through the plant to where the nutrients are actively needed. For example, higher levels or iron was detected in Activated N® leaves since iron is actively used in the leaves for chlorophyll production.

Figure 19 shows the soil nutrition analysis between Activated N® and generic UAN treated blocks. When looking at the soil texture of both blocks, it was observed that the generic UAN block had a higher concentration of clay than the Activated N® block. This is important to note when looking at the concentration of cation elements in the nutrition analysis.

Soil treated with Activated N® had higher concentration levels of Phosphorus, Sulphur, Iron and Copper compared to the generic UAN soil. Interestingly, the generic UAN soil had higher concentrations of positively charged ions such as calcium, magnesium and potassium compared to the Activated N® treated soil. This may be due to the significantly higher clay concentration in the generic UAN block which was determined by APAL (Australian Precision Ag laboratory). Soil with a higher clay concertation has a higher cation exchange capacity compared to soil with less clay. This means that cations such as calcium, potassium and magnesium bind to the clay surface which can result in higher concentrations levels of the cations in the soil analysis.

Due to Activated N® containing BAOM, other elements in the soil can be chelated and become readily available in the soil. Plants are then able to uptake nutrients in the soil and move these nutrients around the plant system.

7. Conclusion

In conclusion this trial was conducted to evaluate the differences and determine the effectiveness of Activated N® in comparison to generic UAN and assess changes in almond yields and growth parameters such as whole nut weight, hull weight and kernel weight.

When studying the figures presented, it can be found that almond trees treated with applications of Activated N® had the following results:

- Increased vegetative growth with more shoots and larger tree canopies.
- The drone image of the Activated N® block had 4.5% more green pixels compared to the generic UAN block drone image.
- 5% increase in kilograms of nuts per tree compared to trees treated with generic UAN.
- 4.3% statistically significant increase in the out-turn percentage of nuts collected at harvest compared to generic UAN treated trees.
- Increased concentrations of iron and zinc in almond leaves treated with Activated N® which correlates to increased yields through improved photosynthesis and sugar translocation.

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7. **References**

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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	% Change
	Control (Activated N)	Treated (Generic UAN)			
Whole Nut Weight (g) (100 nuts) Pre-Harvest **Figure 9**	342.8 ± 34.36	371.3 ± 22.03	0.293	No	8.31
Hull Weight (g) (100 Nuts) Pre-Harvest **Figure 10**	168.3 ± 24.76	200.6 ± 18.66	0.146	Yes	19.20
Kernel Weight (g) (100 Nuts) Pre-Harvest **Figure 11**	105.8 ± 18.37	115.9 ± 2.68	0.401	No	9.55
Kg of Nuts per Tree (kg) Harvest **Figure 12**	56.24 ± 11.26	53.48 ± 9.27	0.601	No	4.91
Out-turn % of Nuts Pre-Harvest **Figure 13**	30.73± 2.26	31.26± 1.15	0.736	No	1.73
Out-turn % of Nuts Harvest **Figure 14**	31.32 ± 1.56	30.01 ± 1.73	0.132	Yes	4.18

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	% Change (Activated N® to Generic UAN)
	Activated N®	Generic UAN			
Nitrate N (mg/kg)	30.0	68.0	0.0305	Yes	-55.88
Nitrogen (%)	1.96	2.25	0.000838	Yes	-12.74
Phosphorus (%)	0.127	0.127	-	N/A	0
Potassium (%)	3.17	3.51	0.185	No	-9.60
Calcium (%)	3.48	3.22	0.165	No	8.07
Magnesium (%)	0.720	0.673	0.234	No	6.93
Sodium (%)	0.00777	0.00747	0.668	No	4.02
Sulphur (%)	0.157	0.177	0.0132	Yes	-11.32
Boron (mg/kg)	45.3	43.7	0.0241	Yes	3.82
Copper (mg/kg)	5.27	6.27	0.0847	Yes	-15.96
Zinc (mg/kg)	79.3	79.3	-	N/A	0
Manganese (mg/kg)	257	270	0.530	No	-4.94
Iron (mg/kg)	133	130	0.725	No	2.56
Aluminium (mg/kg)	173	153	0.279	No	13.04
Molybdenum (mg/kg)	0.0317	0.0513	0.0216	No	-38.31
Chloride (%)	0.157	0.210	0.0214	Yes	-25.40

Table 3: Analysis of different soil nutrient levels and properties between Activated N® and Generic UAN. P value <0.15 was considered to be statistically significant.

Nutrient	Treatment (Mean)		*P* Value	Significance	% Change (Activated N® to Generic UAN)
	Activated N	Generic UAN			
pH 1:5 Water	7.23	6.56	0.299	No	-9.27
pH CaCl2	6.61	5.59	0.217	No	-15.38
Organic C (%)	0.48	0.14	0.0492	Yes	-70.83
Nitrate – N (mg/kg)	1.00	1.00	-	N/A	0.00
Ammonium – N (mg/kg)	4.03	1.33	0.0684	Yes	-66.94
Colwell P (mg/kg)	7.33	17.70	0.253	No	140.91
Sulphur (mg/kg)	5.07	5.97	0.731	No	17.76
Calcium (mg/kg)	681.00	185.00	0.115	Yes	-72.79
Magnesium (mg/kg)	137.00	84.70	0.129	Yes	-38.20
Potassium (mg/kg)	304.00	168.00	0.0291	Yes	-44.74
Sodium (mg/kg)	29.40	22.30	0.192	No	-24.26
Boron (mg/kg)	1.18	0.88	0.549	No	-25.14
Iron (mg/kg)	8.17	8.47	0.932	No	3.67
Manganese (mg/kg)	10.30	1.93	0.162	No	-81.29
Copper (mg/kg)	0.53	1.07	0.167	No	102.52
Zinc (mg/kg)	2.28	1.13	0.464	No	-50.51
Ca:Mg ratio	3.70	1.33	0.307	No	-63.96
K:Mg Ratio	0.79	0.650	0.637	No	-18.07
ECEC (cmol/kg)	5.43	2.15	0.0458	Yes	-60.44
Chloride (mg/kg)	21.30	22.00	0.950	No	3.13
Salinity EC 1:5 (dS/m)	0.11	0.05	0.149	Yes	-53.54
(Ece dS/m)	2.50	1.13	0.138	Yes	-54.80
Clay %	5.73	1.97	0.00624	Yes	-65.70
Sand (+20 micron) %	91.30	94.30	0.0158	Yes	3.28
Silt (2-20 micron) %	2.97	3.73	0.0619	Yes	25.84