FINAL REPORT

Demonstration of the efficacy of Seasol on Citrus – 2016/17

SEED AND CROP SERVICES

EFFICIENCY IN AGRICULTURE

FROM INPUT R&D TO HARVESTING

Seasol International Pty Ltd

Report title: Demonstrate the efficacy of Seasol on Citrus – 2016/17.

This Final Report
has been prepared for

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Summary

SGS Australia was contracted by Seasol International to conduct a production scale, field trial on a commercial citrus orchard in north-west Victoria to demonstrate the efficacy of Seasol on citrus. The 2016/17 season is the first year of the trial. Two identical blocks were selected for the trial, one to be Treated and one left Untreated. Seasol was applied at 10L/ha to one block, six times at monthly intervals starting after harvest during flowering, through the fertigation system. Soil and leaf test were taken during the season and fruit size and yield were measured at harvest.

The Seasol treatment appears to have had no effect on yield but fruit circumference measurements show a slightly larger fruit and 11% more fruit in the preferred size range from Treated trees. The packing shed reports confirm this, with a slightly higher percentage of First Grade fruit and $11.55 higher return per tonne in the Treated block.

Although there is variability in tree productivity between the blocks, the trial site is easily treated and harvested as two separate blocks, with good past yield data so it is worth repeating the trial on this site to confirm the results.

Introduction

SGS Australia was contracted by Seasol International to conduct a production scale field trial on a commercial citrus orchard in north-west Victoria to demonstrate the efficacy of Seasol. SGS located an orchard at Cottrell Farms, Iraak, with two separate but similar blocks with identical trees for the trial. No kelp product was being used on the orchard. Farm management believed that the blocks had performed similarly in the past. SGS supervised the application of Seasol through the farms' fertigation system to ensure that the correct rate was applied and that the Seasol was fully discharged through the fertigation system. There was no other change in farm management between these two blocks of trees.

Aim

This study aims to demonstrate the efficacy of Seasol on citrus in a production scale, non replicated field trial in a commercial orchard.

Materials and Methods

The trial is a demonstration, production scale trial with one treatment and one untreated control. Two adjacent blocks were selected by SGS at the Cottrell Farms orchard, Iraak Lake Rd, Iraak, for this demonstration trial, Block W11, (1.8 ha's) the Treated block and Block W14 (1.8 ha's) the Untreated block. The trees were planted in 1973 add reworked to the variety Late lane in 1996. Drip irrigation is used to irrigate and fertigate the trees and the blocks are on separate irrigation valves.

See *Figure 1* for orchard location and *Figure 2* for block location. The Blocks appear to be similar in tree health and size and the soil type is believed to be similar across the two blocks. The soil is a sandy loam. The trees are planted in east-west rows and the blocks are both 15 rows wide.

Farm Management has advised tree numbers in the blocks and yields for the past 4 years, see Table 1. The Blocks are harvested separately by hand picking as per normal farm practice. The blocks will continue to be fertilized and managed as per the normal farm practice, with no other kelp product in the program.

Table 1. Past fruit yield on Cottrell Farms

Year	W11 750 trees			W14 760 trees		
	No of bins	Bins per tree	Approx. kgs/tree (415kg/bin)	No of bins	Bins per tree	Approx. kgs/tree (415kgs/bin)
2013	114	0.15	63.08	60	0.08	32.76
2014	158	0.21	87.43	166	0.22	90.64
2015	263	0.35	145.53	221	0.29	120.68
2016	239	0.32	132.25	209	0.275	114.13

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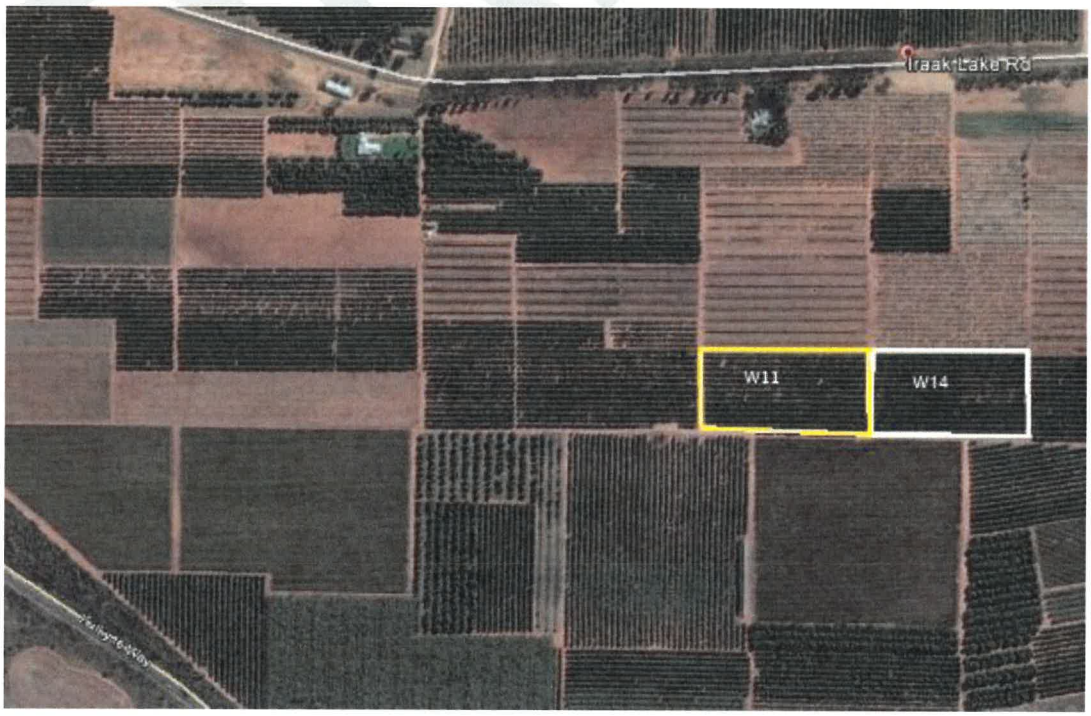
Figure 1. Google map showing the approximate location of the Cottrell Farms Iraak orchard on Lake Iraak Rd, Iraak, between Red Cliffs and Nangiloc, Victoria.

Figure 2. Google Earth image showing Blocks W11 & W14 of Cottrell Farms orchard, Iraak.



Treatments and trial design

There are only two treatments on two blocks, one Treated block and one Untreated block, with no replication of blocks.

Block W14 is the Untreated Control block and Block W11 was Treated with Seasol, applied from a 150L pressure tank connected into the irrigation line at the valve, see Photo below. To inject 10L/ha into Block W11, an area of 1.8ha, 18L Seasol was poured into the 150L pressure tank to mix with water and the taps opened slightly. Irrigation was started 2 hours before the application and then continued for another 2 hours after the Seasol was poured into the pressure tank. The colour of the irrigation water out of drippers was monitored to check for the Seasol application, see Photo in Appendix One.

Seasol was applied at 6 applications, 4 weeks apart, during the growing season, commencing after harvest, during flowering. The first application was done on 12th October 2016.

Table 2. Dates of activities in the Cottrell Farms Seasol citrus trial

Date	Stage of growth	Activity
6/10/2016		Soil sample
12/10/2016	Flowering	1st Seasol application
10/11/2016	Early fruit set (10mm)	2nd Seasol application
7/12/2016	20-25mm fruit	3rd Seasol application
5/1/2017		4th Seasol application
1/2/2017		5th Seasol application
1/3/2017		6th Seasol application
1/3/2017		Leaf sample
3/7/2017	Late season	Soil sample
5/7/2017		Fruit size measurements
28-29/8/2017		Fruit samples for post-harvest testing
30/8 – 31/8/2017	Harvest	Plot harvest
1/9-12/9/2017		Main harvest

Pressure tank piped into the irrigation line to inject Seasol into W11 at Cottrell Farms.

Soil and leaf samples

Soil samples were taken to a depth of 20-25cm within the influence of the drip line, in both blocks at the start of the trial and late season prior to harvest. Two samples were taken from each block and analysed separately for pH, organic matter, major and trace nutrients.

Leaf samples were taken at four sites in both blocks on 1/3/2017 as per NSW Agriculture guidelines of between mid-February to mid-March (Dept of Primary Industries, 2016). Healthy mature leaves from the middle of non-fruiting spring extension growth were sampled, as per Robinson (1986).

Fruit yield and size measurements

Six plots of six trees were identified within each of the Treated and Untreated blocks for fruit circumference and yield measurements. Harvest of the plots was done prior to the main harvest. Harvest is done by hand into bins by contract labor organized by the farm. The bins are labelled with the block name and trucked to the Mildura Fruit Company (MFC) packing shed for grading as part of normal farm harvest practice.

Prior to the farm harvest, fruit circumference was measured on 200 fruit per plot, 50 fruit on 4 trees from four corners of the tree, as per ACG (2003) recommendations. In addition, fruit was picked for post-harvest quality assessments, 8 fruit per plot for Mildura Fruit Company maturity testing and five fruit per tree in the 6 tree plots for other testing nominated by Seasol. The fruit was collected from the same height and orientation position on each tree.

Mildura Fruit Company advised that the preferred size range in the current market is 75-85mm (Justin Lane, Grower Services Technical Manager MFC, personal communication). ANOVA was performed on yield and fruit circumference data and on counts of fruit in the preferred size range.

Results

Maturity testing

Maturity tests done on fruit samples taken from each plot (8 fruit per plot), just prior to harvest, found the fruit to be mature but no differences between the blocks. The minimum acceptable values for navels are a Brix/Acid Ratio of 9.0:1 and an Australian Standard of 90 (See raw data in Appendix Three, Mildura Fruit Company Maturity Test Results report).

Table 3. Maturity tests

	%Juice	Acid	Brix	Ratio	Australian Standard	Colour
W11 Treated	0.49	0.82	12.60	15.40	153.66	100.00
W14 Untreated	0.48	0.85	12.47	14.83	150.10	98.33
LSD (P=0.05)	0.04	0.07	0.70	1.74	13.62	3.71

Fruit size and pack-outs

The Treated block was found to have produced fruit with a slightly larger average circumference and when divided and counted in the different size ranges, also 20% more in the preferred size range (Table 4). The difference in fruit size measurements was not statistically significant at the P=0.05 level when analysing average data from the 6 plots (df=11) but there was a significant difference between average diameter when the ANOVA was done on 1200 fruit per plot (df=2399, see ANOVA tables in Appendix Two; Raw fruit size and yield data and ANOVA tables).

The pack out reports from Mildura Fruit Company (MFC) (Table 6) confirm the plot data. They show that W11, the Treated block, produced 47.84% First Grade fruit compared to 46.28% in W14, the Untreated block. A slightly higher percentage of W11 fruit went to the (juice) factory but the payment per tonne and per ha is higher from W11 than from W14.

Table 4: Fruit circumference measured on 200 fruit per plot

	Fruit circumference	Counts (out of 200 fruit) in each size range				
	Average size (mm)	<75mm	75-85mm	>85mm	Count	%75-85mm
W11 Treated	77.18	60	130.67	9.33	200	65.33
W14, Untreated	75.78	85	108.83	6.17	200	54.42
LSD (P=0.05, df = 6)	1.96		25.42			
LSD (P=0.05, df = 1200)	0.39					

Fruit yield

Fruit yield was measured on the 6 tree plots and on the total block. Trees in the Treated plots produced a heavier crop than trees in the Untreated plots (Table 5). This is consistent with the yield results for the whole block reported in the Pack-out report (Table 6), although the difference is bigger, suggesting that there is a greater variability and poorer productivity in W14 the Untreated block than W11 the Treated block.

Table 5. Fruit yield from the 6 tree plots

	Average yield from 6 tree plots (kgs)	Average yield per tree (kgs/tree)
W11 Treated	894.26	149.04
W14 Untreated	854.64	142.44
LSD (P=0.05)	128.95	

A comparison of past yields for the blocks (Table 1) shows that W11 has produced 16-21% higher yield than W14 in the past 2 years. The 2016/17 yield of 297 bins for W11 and 260.5 bins for W14 is higher than previously recorded for these blocks and is a 14% difference which is consistent with past yield measurements and cannot be attributed to the Seasol treatment.

Table 6: Summary of 2016/17 Pack-out reports from Mildura Fruit Company for the trial blocks.

	Bins	1st grade other (kgs)	1st grade china, korea thai (kgs)	2nd grade (kgs)	3rd grade (kgs)	factory (kgs)	Total Yield (kgs)	kgs/tree	Part payment $/tonne*	Part payment $/ha*
W11 Treated (750 trees)										
	297.00	7082.40	50433.70	21448.30	18342.40	22925.00	120231.80	160.31	506.62	281.46
% of total weight		5.89	41.95	17.84	15.26	19.07	100.00			
%1st grade			47.84							
W14 Untreated (760 trees)										
	260.50	7565.70	41515.20	22602.70	16175.10	18194.00	106052.70	139.54	495.07	275.04
% of total weight		7.13	39.15	21.31	15.25	17.16	100.00			
%1st grade			46.28							

*The payments quoted are part payments only. Final payments are expected in December and are not included in this report

Leaf test results

Average leaf test results show that the blocks are similar in nutrient status and in adequate to above adequate supply when compared to the Standard (Robinson 1986), see Table 7. While nitrogen, phosphorus, potassium and copper levels are high in both blocks, they are not in the toxic or excessive range.

Table 7. Average leaf test results

Analyte	unit	Standard	W11 Treated	W14 Untreated
Phosphorus	%	0.12-0.16	0.18	0.19
Potassium	%	0.7-1.2	1.34	1.44
Calcium	%	3.0-6.0	3.18	3.04
Magnesium	%	0.26-0.6	0.30	0.36
Sodium	%	<0.16	0.01	0.01
Sulphur	%	0.21-0.4	0.25	0.22
Zinc	mg/kg	25-100	96.25	88.25
Iron	mg/kg	60-120	94.75	90.50
Copper	mg/kg	5.1-10.0	11.25	15.00
Manganese	mg/kg	24-100	88.00	76.50
Boron	mg/kg	31-100	65.00	70.25
Molybdenum	mg/kg	0.10-3.0	1.10	1.10
Nitrogen	%	2.4-2.6	2.95	2.85

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Soil test results

Soil analysis results from samples taken at the start of the trial show no difference between the blocks with low levels of nitrogen, potassium, magnesium, boron and sulphur and high levels of copper and zinc in both blocks, see Table 8. Soil analysis at the end of the season show little change in the nutrient levels other than an increase in chloride levels from the irrigation water.

Table 8. Average soil test results

Analyte	units	Standard for bearing citrus (Nutrient advantage)	Early Season		Late Season	
			W11 Treated	W14 Untreated	W11 Treated	W14 Untreated
pH	pH Units	6.0-8.0	6.2	6.2	6.9	7.0
Conductivity of Extract (1:5 dry sample basis)	µS/cm	<1700	75.0	65.0	70.0	95.0
Chloride (water extractable 1:5)	mg/kg	<120	8.5	18.0	20.5	35.5
Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	40-50	2.5	1.5	2.6	4.0
Colwell Phosphorus	mg/kg	75-100	94.5	75.0	69.5	68.0
Total Organic Carbon	%w/w	1.5-2.5	n/a	n/a	0.6	0.6
Organic Matter	%w/w	2.6-4.3	0.9	0.9	1.0	1.0
Exchangeable Sodium, Na	mg/kg	n/a	25.5	27.5	20.0	20.0
Exchangeable Sodium, Na	meq/100g	<1.0	0.1	0.1	0.1	0.1
Exchangeable Sodium Percentage	%	n/a	3.5	2.9	1.9	1.8
Exchangeable Potassium, K	mg/kg	n/a	158.5	220.0	185.0	215.0
Exchangeable Potassium, K	meq/100g	>0.72	0.4	0.6	0.5	0.6
Exchangeable Potassium Percentage	%	n/a	12.7	13.5	10.2	10.9
Exchangeable Calcium Percentage	%	n/a	60.9	61.2	65.3	64.3
Exchangeable Calcium, Ca	mg/kg	n/a	407.0	517.0	605.0	650.0
Exchangeable Calcium, Ca	meq/100g	>5.0	2.0	2.6	3.1	3.3
Exchangeable Magnesium, Mg	mg/kg	n/a	89.5	113.5	125.0	145.0

Exchangeable Magnesium, Mg	meq/100g	>1.6	0.7	0.9	1.0	1.2
Exchangeable Magnesium Percentage	%	n/a	23.0	22.5	22.6	23.2
Cation Exchange Capacity	meq/100g	12-25	3.3	4.2	4.6	5.1
Cation Exchange Capacity (soluble salts removed)	meq/100g	n/a	n/a	n/a	n/a	n/a
Sodium Adsorption Ratio	No unit	n/a	n/a	n/a	n/a	n/a
Exchangeable Calcium/Exchangeable Magnesium Ratio	No unit	>2.5	2.7	2.7	2.9	2.8
Exchangeable Aluminium, Al	cmol (+)/kg	n/a	n/a	n/a	n/a	n/a
Copper, Cu	mg/kg	0.3-10	13.5	15.5	11.7	9.3
Zinc, Zn	mg/kg	2.5-10	18.5	20.5	17.5	15.0
Manganese, Mn	mg/kg	4-50	10.5	10.5	6.1	4.3
Iron, Fe	mg/kg	>4.0	23.5	27.0	16.0	15.5
CaCl2-extractable Boron, B	mg/kg	1.0-2.0	0.5	0.5	0.3	0.4
KCl-40-extractable Sulphur, S	mg/kg	>12	5.8	7.5	3.5	4.5

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Discussion and Conclusions

Harvest results for the 6 tree plots showed a slightly higher yield in the Treated block compared to the Untreated block but the total yields from the whole blocks did not reflect this. According to Cottrell Farms yield data, W11, the Treated block, is usually a higher yielding block than W14, the Untreated block, although W14 has more trees than W11. Yield results from the whole block 2016/17 harvest season confirm that there is variability in tree productivity between the blocks and a higher yield was harvested than previously recorded from these blocks but the difference between the blocks is consistent with past yield differences. The high yields are more likely to be caused by a seasonal effect and cannot be attributed to the Seasol treatment.

Fruit size is often smaller than preferred in high yielding years (ACG 2003) and fruit size appears to have been influenced by the Seasol treatment. Fruit circumference measured in the 6 tree plots showed a slightly larger fruit in the Treated block compared to the Untreated block with 11% more fruit in the preferred 75-85mm size range. The pack out reports confirm this. W11, the Treated block, packed a slightly higher percentage of First Grade fruit than W14 and returned $11.55 per tonne more on first payments.

No difference in soil or tree nutrient status has been measured between the Treated and Untreated blocks but it is possible that the Seasol treatment has had some effect on the trees and the 2017/18 season fruit set and yield. The Cottrell orchard has proved to be a suitable site for this trial, with good yield data from past years. It is easily treated and harvested as two separate blocks while all other farm management practices are the same. The trial should be repeated on this site in 2017/18 to confirm the results.

References

ACG (2003) Fruit Size Management Guide Part 2. An Australian Citrus Growers Publication.

Department of Primary Industries (2016) Citrus Leaf Nutrient Analysis: leaf sampling guide. February 2016 Primefact 1449 first edition. Steve Falivene, Citrus Development Officer, Southern Horticulture Dareton, www.dpi.nsw.gov.au/factsheets

Nutrient Advantage (1997), Interpretation Chart No 756. Effective September 1997. Analysis Systems Citrus (Bearing) Sunraysia and Riverland Sandy loams and sandy clay loams

Robinson J.B. (1986) Fruits, Vines and Nuts. Citrus, pgs 128-129, *In* D.J. Rueter & J.B. Robinson, Plant Analysis. An Interpretation Manual.

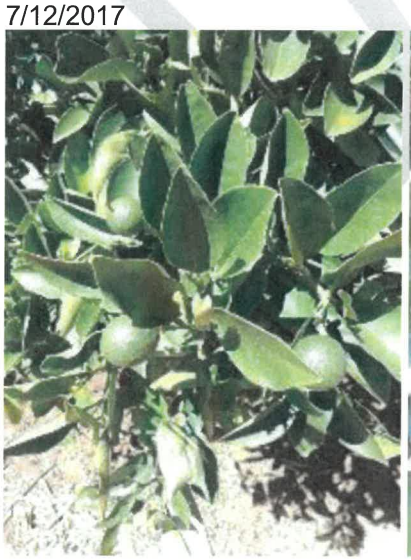
Appendix One; Photos

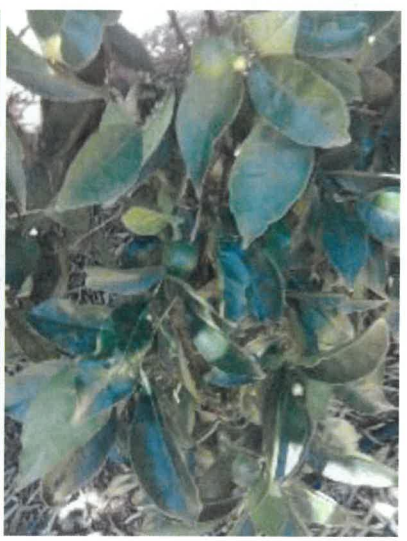
12/10/2016





7/12/2017





5/1/2017

1/2/2017



Measuring fruit diameter, 5/7/2017.

Harvest