Project Catalyst Trial Report

Evaluating N Rates on High Organic Carbon Contrasting Soils

Grower Information	
Grower Name:	Tony Bugeja
Entity Name:	BUGEJA J & J PTY LTD ATF J & J BUGEJA & SONS
Trial Farm No/Name:	MKY-04074B & MKY-04074D
Mill Area:	Mackay
Total Farm Area ha:	324
No. Years Farming:	50
Trial Subdistrict:	Palmyra & Rosella
Area under Cane ha:	256

Trial Status

Completed

Author: Zoe Eagger (Farmacist). For further information contact Zoe on Mb. 0436 004 437.

Background Information

Aim: To improve nitrogen use efficiency on soils with high yield and moderate organic carbon levels.

Background:

The Walkley-Black wet oxidation technique is the most widely used commercial assay to report soil organic carbon. For the sugar industry, the use of Walkley-Black organic carbon analysis is of significance as the results inform growers of their maximum legal nitrogen (N) rate.

The industry endorsed best management practices utilise the SIX EASY STEPS (6ES) nutrient management program. This program provides the industry with a set of soil and district-specific guidelines to manage N inputs based on a combination of district yield potential (DYP) and Walkley-Black organic carbon (WBOC%).

In the current 6ES framework, the contribution of N mineralised from soil organic matter available to the crop is based on the soil WBOC%. High organic carbon soils often occur low in the landscape, making them prone to water logging in some seasons. This limits the amount of N that may be mineralised by these soils and made available to the crop. Growers with high yielding sites, where investment has been made in drainage and improved irrigation management, have sought to investigate if reduced N application rates limit yield and whether their current management regime is resulting in poor N use efficiency (NUE). There is apprehension among grower about lowering their N rates to 6ES rates on these soil types.

The trial was established to provide confidence to growers that current 6ES recommended N rates are appropriate to support high yield potentials.

The two sites where the trial has been conducted are consistently high yielding over several years. The trial compares different rates of N application compared to the 6ES requirements for yields and NUE.

Potential Water Quality Benefit:

Reduction in applied inorganic N fertiliser mitigates the risk of potential loss to local catchments.

Expected Outcome of Trial:

The 6ES calculated nutrient rates will provide adequate N without compromise to yield.

Service provider contact: Farmacist Pty Ltd

Where did this idea come from: Tony Bugeja in consultation with Farmacist

Plan - Project Activities		
	Date:	**Activities:**
Stage 1	**August 2018**	Harvest paddocks to collect normal paddock yield
Stage 2	**September 2018**	Apply fertiliser treatments
Stage 3	**April 2019**	Conduct biomass sampling to assess nitrogen uptake
Stage 4	**August 2019**	Harvest trials
Stage 5	**September 2019**	Reapply fertiliser treatments
Stage 6	**September 2020**	Harvest trails
Stage 7	**October 2020**	Reapply fertiliser treatments

Project Trial site details	
Trial Crop:	Sugar Cane
Variety: Rat/Plt:	2R Q 208 & 1R KQ 228
Trial Block No/Name:	12-01 & 03-01
Trial Block Size Ha:	7.1 & 7.4
Trial Block Position (GPS):	-21.237854, 149.127842 -21.230092, 149.079841
Soil Type:	Sandiford

Trial Design

The trial design consists of three treatments with five replicate plots (Figure 1):

- Treatment 1 – 6ES (150 kg/ha Nitrogen, 0 kg/ha Phosphorous)
- Treatment 2 – 6ES + 15% (170 kg/ha Nitrogen, 0 kg/ha Phosphorous)
- Treatment 3 – 6ES + 25% (190 kg/ha Nitrogen, 0 kg/ha Phosphorus)

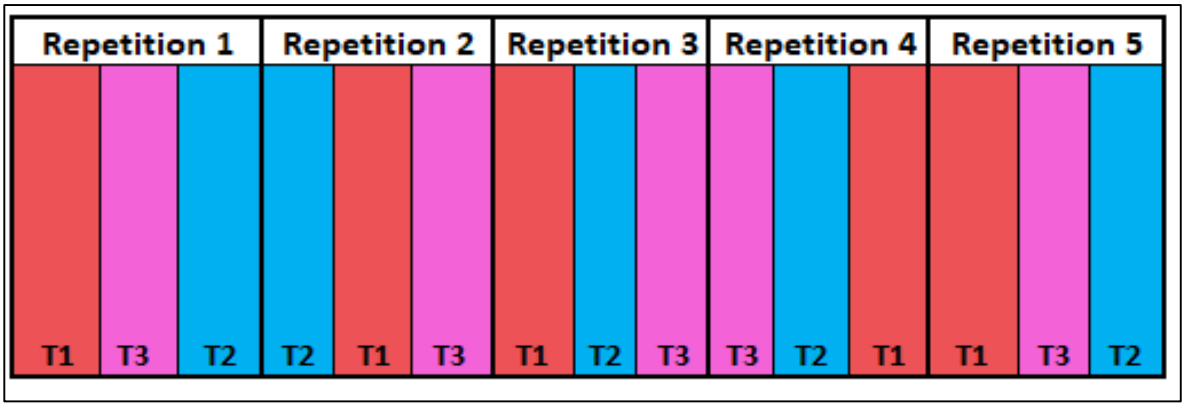


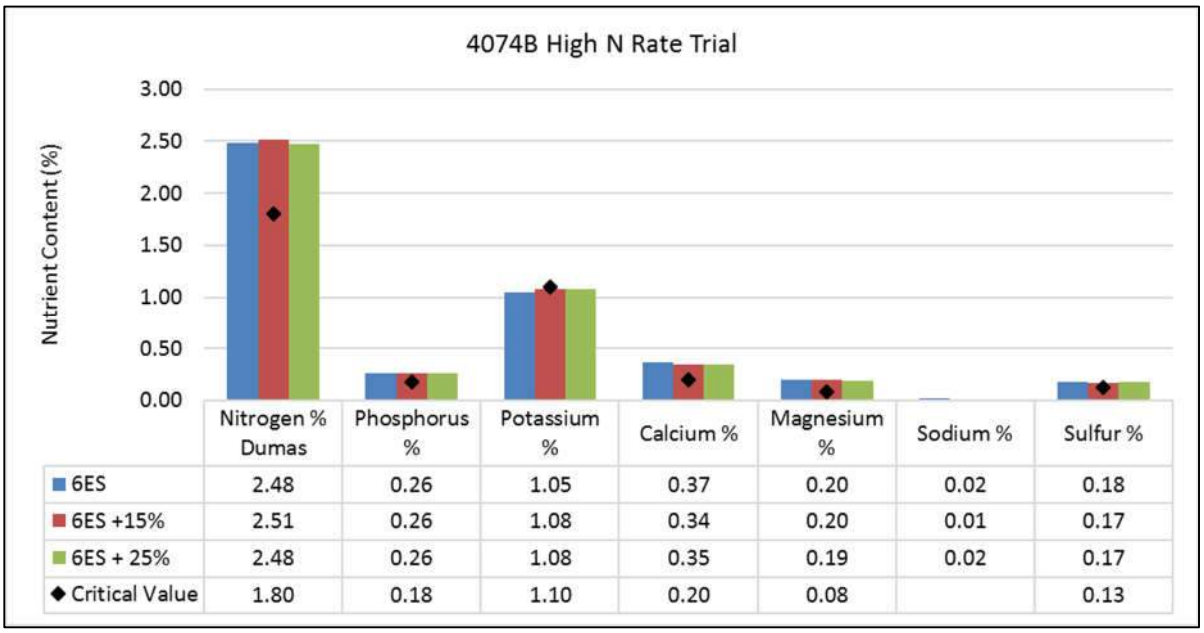
Figure 1 Trial design of both sites

Results

Leaf Sample Results 2019

Leaf samples were taken in March 2019, following the third leaf sampling protocol.

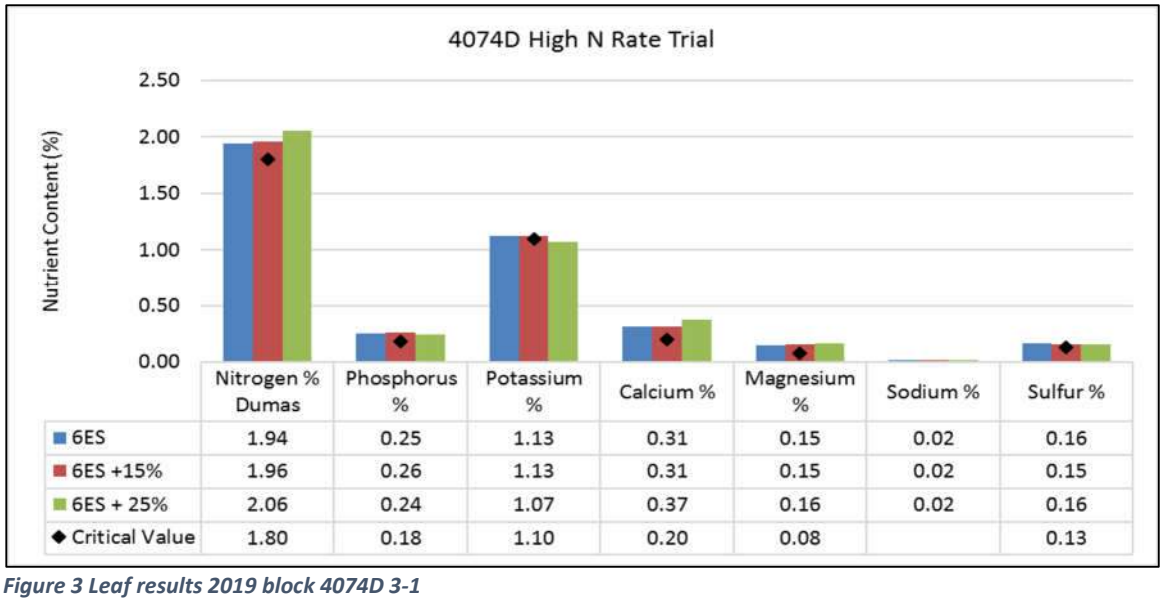
Results for Block 4074B 12-1 indicate all nutrients, except for potassium (K), were above critical value and therefore were considered adequate for optimal growth (Figure2). There were no significant differences across treatments.



	Nitrogen % Dumas	Phosphorus %	Potassium %	Calcium %	Magnesium %	Sodium %	Sulfur %
6ES	2.48	0.26	1.05	0.37	0.20	0.02	0.18
6ES +15%	2.51	0.26	1.08	0.34	0.20	0.01	0.17
6ES + 25%	2.48	0.26	1.08	0.35	0.19	0.02	0.17
Critical Value	1.80	0.18	1.10	0.20	0.08		0.13

Figure 2 Leaf results 2019 block 4074B 12-1

Results for Block 4074D 3-1 showed all nutrients were close to or above the critical values (Figure 3). N content in the plant increased as the N fertiliser rate increased, however, this may not necessarily have an impact on final cane yield. All other nutrients remained the same across all treatments.



	Nitrogen % Dumas	Phosphorus %	Potassium %	Calcium %	Magnesium %	Sodium %	Sulfur %
6ES	1.94	0.25	1.13	0.31	0.15	0.02	0.16
6ES +15%	1.96	0.26	1.13	0.31	0.15	0.02	0.15
6ES + 25%	2.06	0.24	1.07	0.37	0.16	0.02	0.16
Critical Value	1.80	0.18	1.10	0.20	0.08		0.13

Figure 3 Leaf results 2019 block 4074D 3-1

PROJECT CATALYST

2019 Trial Results

Farm 4074B

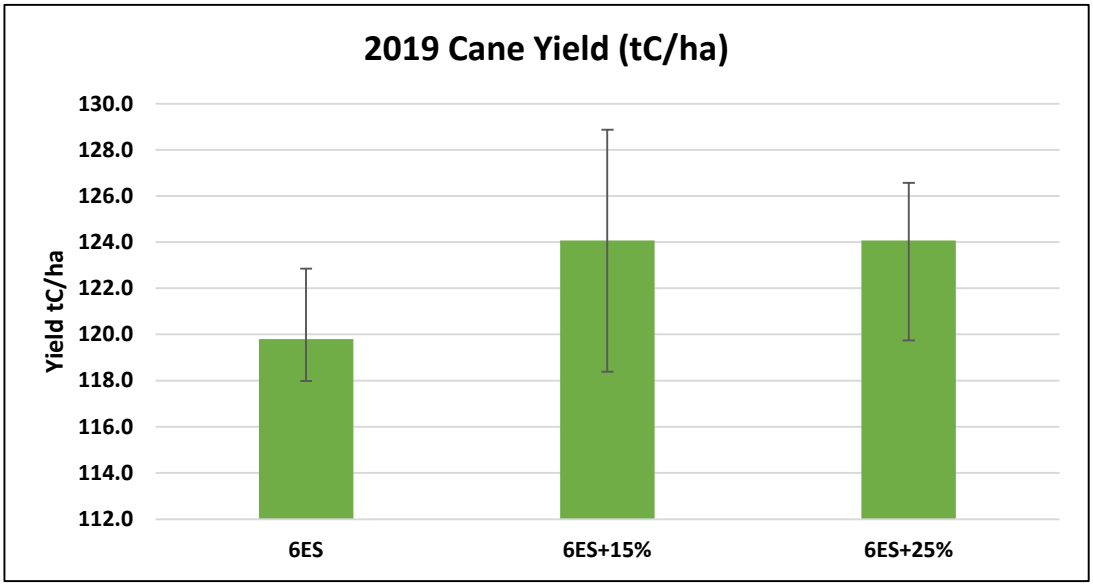


Figure 4 Tonnes of cane per hectare from site 4074B 12-1

Results indicated that both Treatment 2 (+15% 6ES) and Treatment 3 (+25% 6ES) yielded 124 tonnes of cane per hectare (tc/ha), a 4.2 tc/ha increase when compared to Treatment 1 (6ES) (Figure 4).

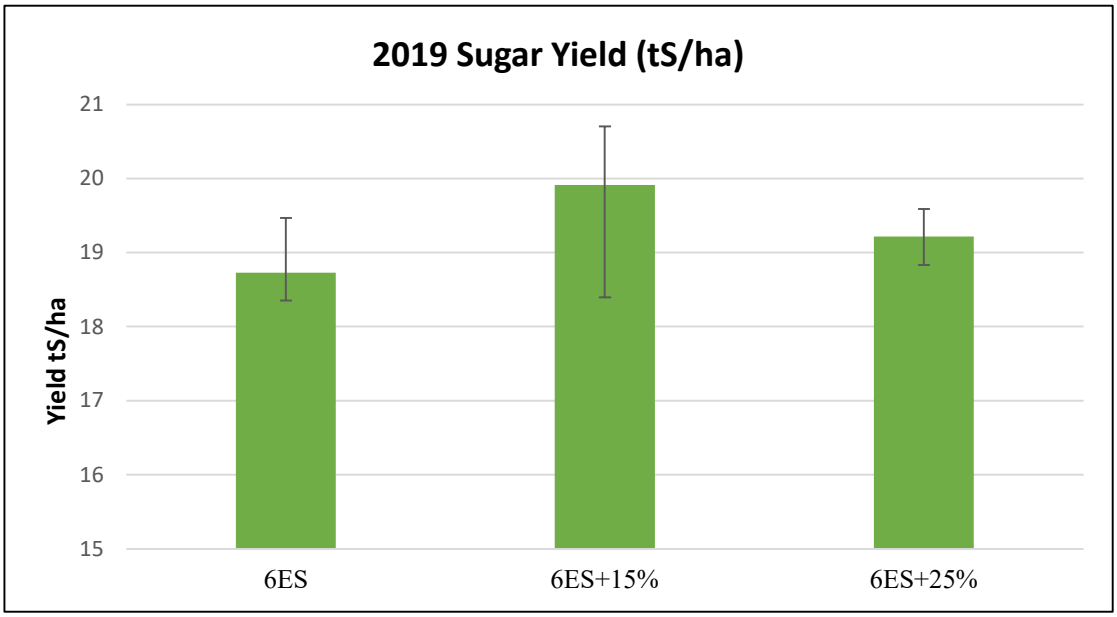


Figure 5 Tonnes of sugar per hectare from site 4074B 12-1

Treatment 2 yielded the highest sugar (tS/ha), followed by Treatment 3, again Treatment 1 yielded the lowest (Figure 5).

Farm 4074D

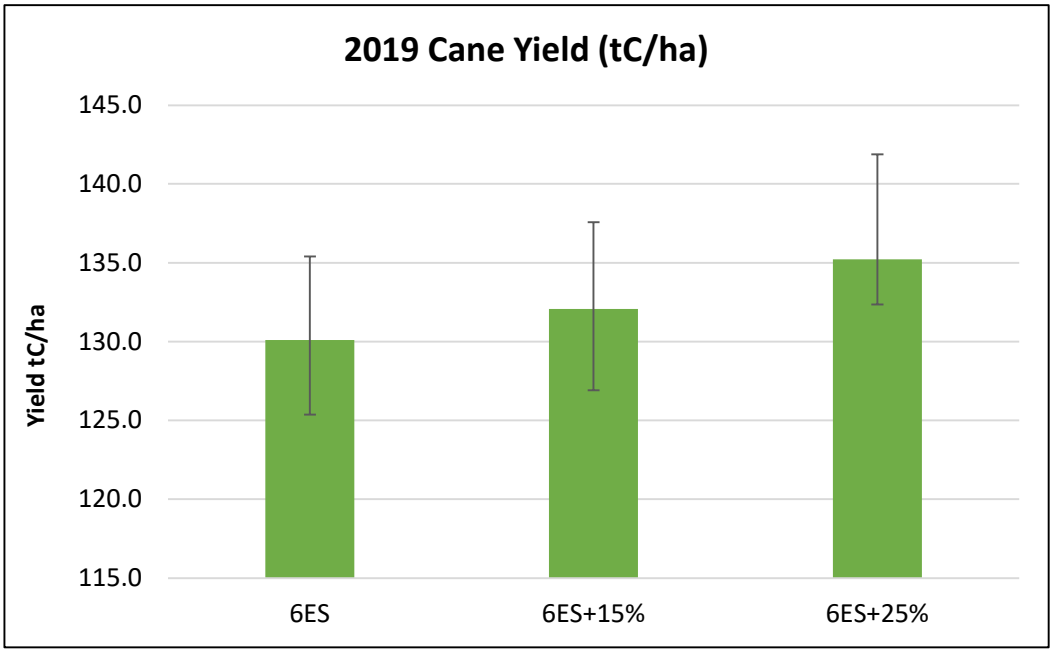


Figure 6 Tonnes of cane per hectare from site 4074D

Treatment 3 yielded the highest followed by Treatment 2, Treatment 1 in both cane and sugar yield (Figures 6 & 7). Further work is still be conducted to conclude if this increase in yield is statistically significant.

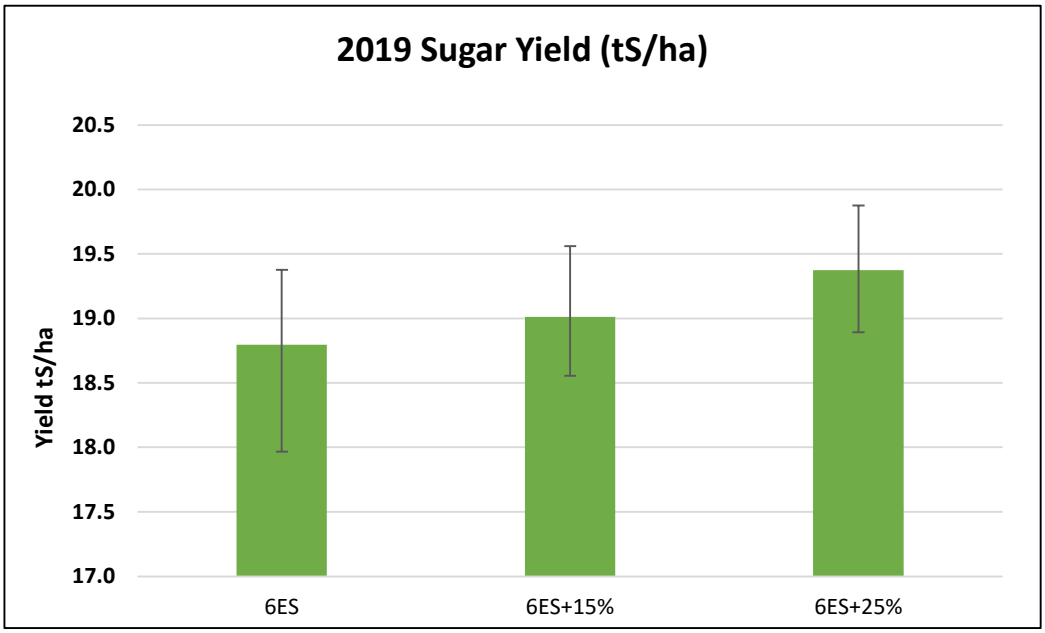
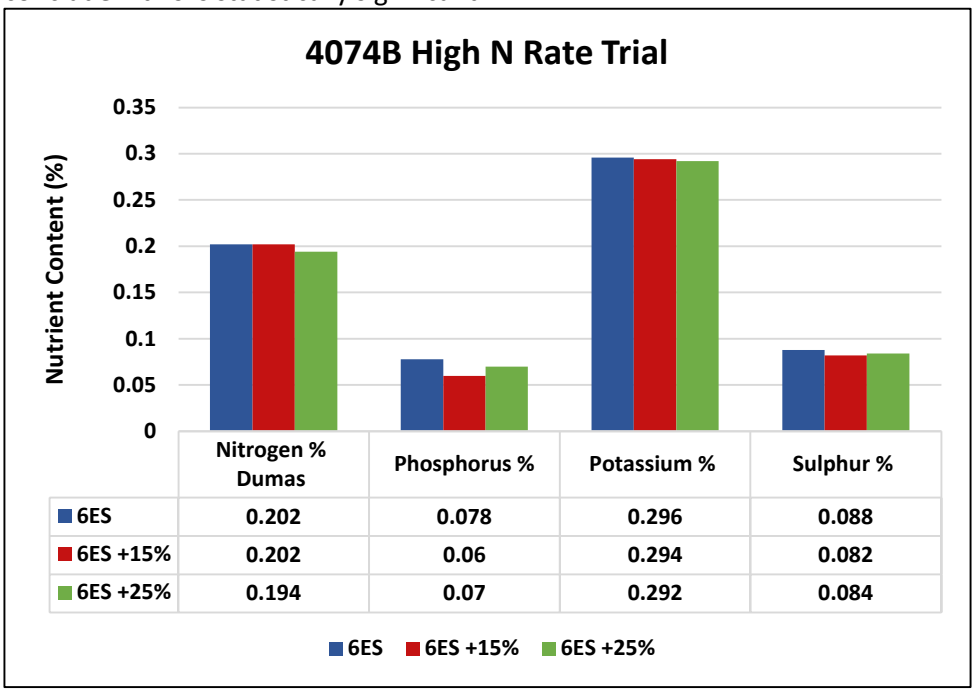


Figure 7 Tonnes of sugar per hectare from site 4074D

Leaf Sample Results 2019

Nutrient results were only taken at harvest for block 12-1 4074B. Results indicate that between treatments there was no significant difference in nutrient percentage in plant. Treatment 1 showed the highest levels across tested nutrients apart from N. Further work is still be conducted to conclude if this is statistically significant.



	Nitrogen % Dumas	Phosphorus %	Potassium %	Sulphur %
6ES	0.202	0.078	0.296	0.088
6ES +15%	0.202	0.06	0.294	0.082
6ES +25%	0.194	0.07	0.292	0.084

Figure 8 Nutrient percentage in leaf

2020 Trial Results

Farm 4074B

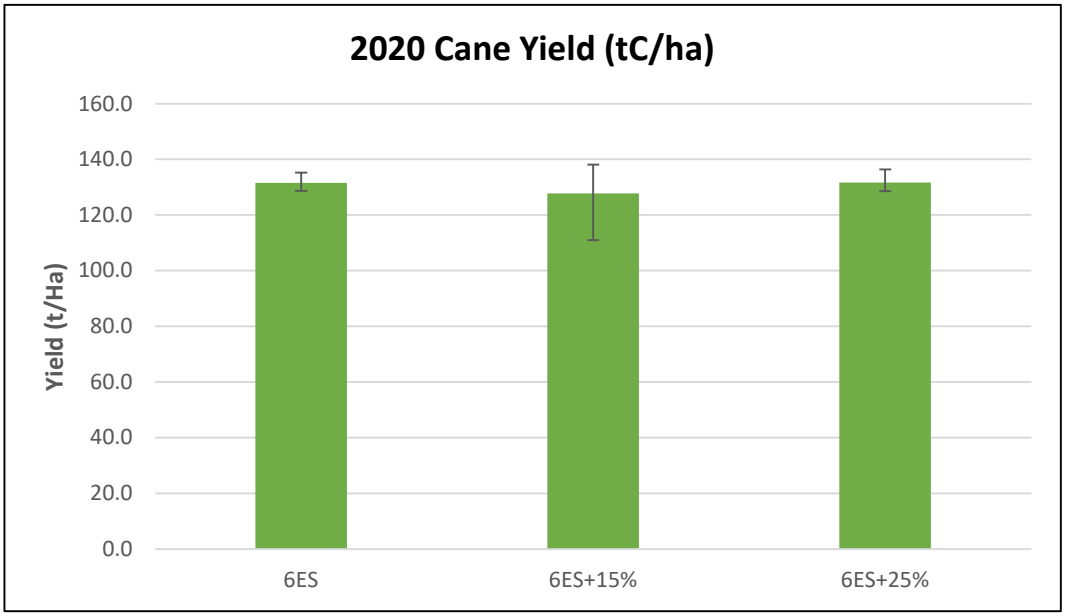


Figure 9 Tonnes of cane per hectare from site 4074B

The 2020 harvest results indicate that there was no difference in harvest yield between Treatment 1 and 3 (Figure 9). On average Treatment 2 had a 4 tc/ha decrease in yield. Results show there was an increase in yield from 2019 to 2020.

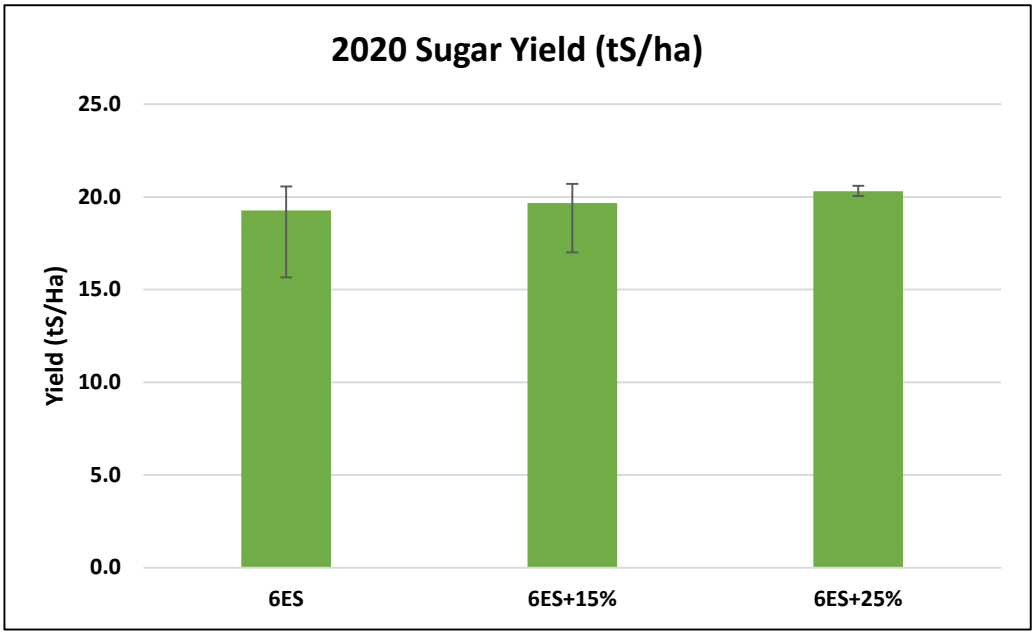


Figure 10 Tonnes of sugar per hectare from site 4074B

Results indicated a steady increase in tS/ha with each treatment (Figure 10). Treatment 1 was the lowest at 19.3 tS/ha and Treatment 3 was the highest at 20.3 tS/ha. This increase is only 1tS/ha so statistics will need to be run to test whether this a significant result between treatments.

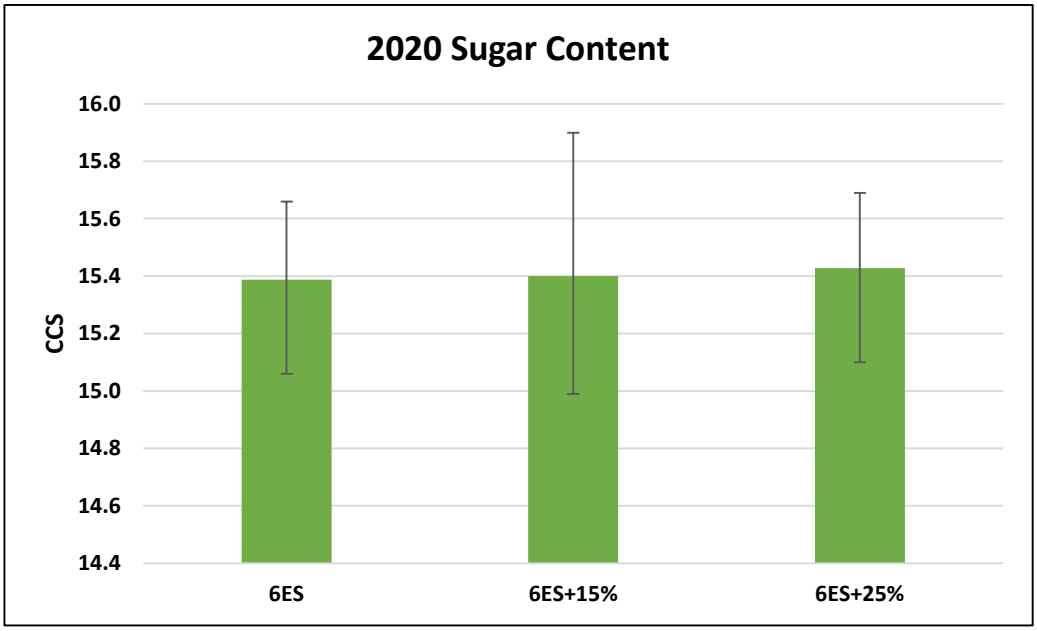


Figure 11 Sugar content from site 4074B

There were no significant differences between treatments for sugar content (Figure 11), although Treatment 3 had the highest CCS across all treatments.

Farm 4074D

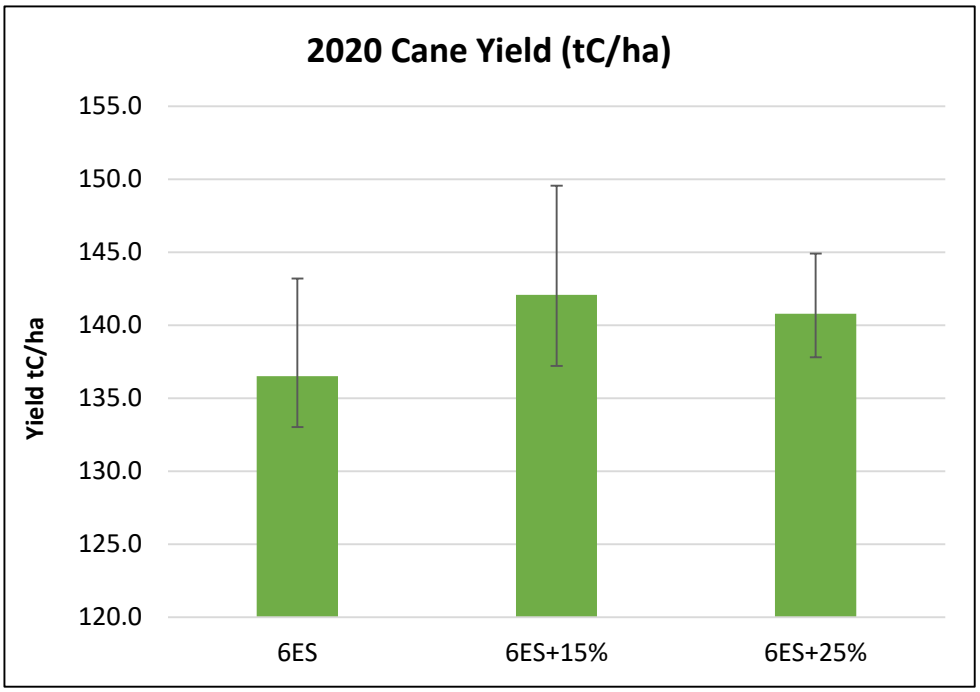


Figure 12 Tonnes of cane per hectare from site 4074D

The 2020 cane yield results show that Treatment 1 had the lowest yield, while Treatment 2 had the highest yield on average with a 6tc/ha difference (Figure 12). 2020 yield data also showed an increase in total yield compared to 2019.

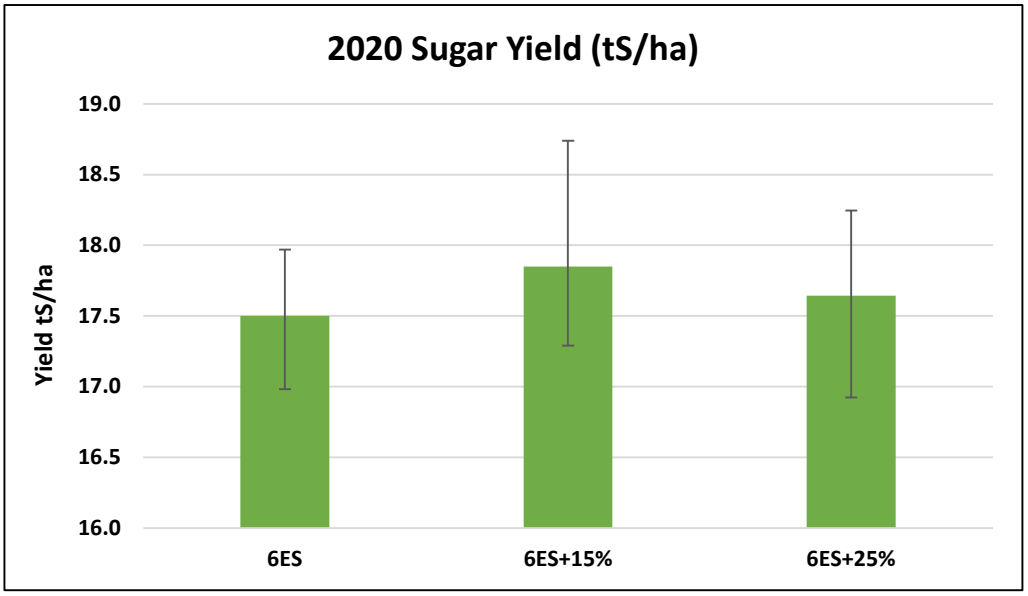


Figure 13 Tonnes of sugar per hectare from site 4074D

The sugar yield results indicate that Treatment 1 had the lowest yield compared to the other treatments, with Treatment 2 having the highest yield.

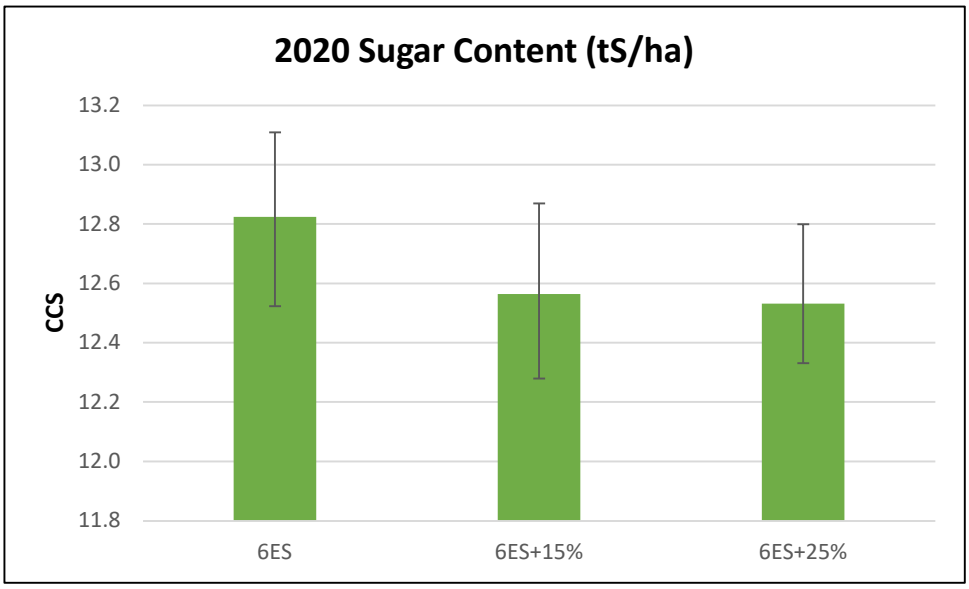


Figure 14 Sugar content from site 4074D

Figure 14 demonstrates that Treatment 1 had the highest amount of sugar content while Treatment 3 had the lowest amount of sugar.

Figure 15 Tony Bugeja with his fertiliser box.

Economics review

A full economic evaluation was undertaken by Brendon Nothard, Senior Agricultural Economist From the Department of Agriculture and Fisheries. He concluded the following.

"Although higher N rates gave statistically significant improvements in yield, they also showed significantly lower CCS results when compared to the 6ES treatment. Overall, sugar yields were not significantly different.

Given similar sugar yields, the marginally higher variable costs to apply more N gave a slightly higher mean gross margin for the 6ES treatment. This was also due to lower costs related to lower yields (e.g. harvesting and levies), and the higher marginal grower revenue benefit of a CCS improvement relative to yield. However, the difference in gross margins were not statistically significant.
To-date, results from the trial follow previous research outcomes where N rates above industry recommendations produced higher yields offset by lower CCS values. Incorporating results from the 4th ratoon would confirm whether the full crop cycle follows this trend but unfortunately due to grub and pig infestation the block sustained severe damage and requires replant.
Results from the second crop cycle is required to determine longer-term effects as Tony anticipates mineralisation to play a role in later crops."

Figure 16: **Average gross margins 2019-2020**

Conclusions and comments

This trial has indicated that in the case of Tony Bugeja, applying higher nitrogen rates equated to an increase in cane yield but not sugar content. It should be noted that Tony consistently produces higher than the district yield potential of 130 tC/ha, which the Six Easy Steps are tailored to match. In other nitrogen trials conducted in the region an increase in nitrogen rates did not equate to an increase in yield.

This trial has indicated that there was no economic advantage from applying a higher rate of nitrogen (above the Six-Easy-Steps rate), as despite the significantly higher cane yield in the higher nitrogen rates, the sugar content decreased, though the economics indicated that if the sugar price increased to $531/t , applying 15% above six easy steps would not only produce more cane but increase profitability.

Unfortunately grub damage was found during the 2020 harvest and Tony has decided to plough in the crop in 2021. He will replant this trial and continue the work himself.

Advantages of this Practice Change:

The advantages of this practice on high yielding blocks is the potential for increased yield. It is important to note that since the trial was only in its early phase, the crop would still be utilising the available nitrogen in the soil. Tony predicts that high yielding crops such as these will show a yield decrease as time goes on in the low nitrogen treatment, due to mining of the soil nitrogen reserves.

Disadvantages of this Practice change:

Currently the price of sugar does not support the increase of nitrogen rates despite the correlation between increased yield at this site.

Will you be using this practice in the future?

Tony will be using this practice in the future once he has more trial data. Tony will be continuing this trial outside of Catalyst with Farmacist for his own interest.

"It's going to be interesting to see how 6ES compares over a longer-term trial given the effect mineralisation and farming practice has on yields. This will be important when considering vertical expansion and the impact on our industry." – Tony Bugeja

% of farm you would be confident to use this practice:

If data proves there is a strong consistent correlation between increased nitrogen rates and high yields on paddocks that produce over the district yield potential on these properties, it would be a farm wide implementation on appropriate blocks**.**