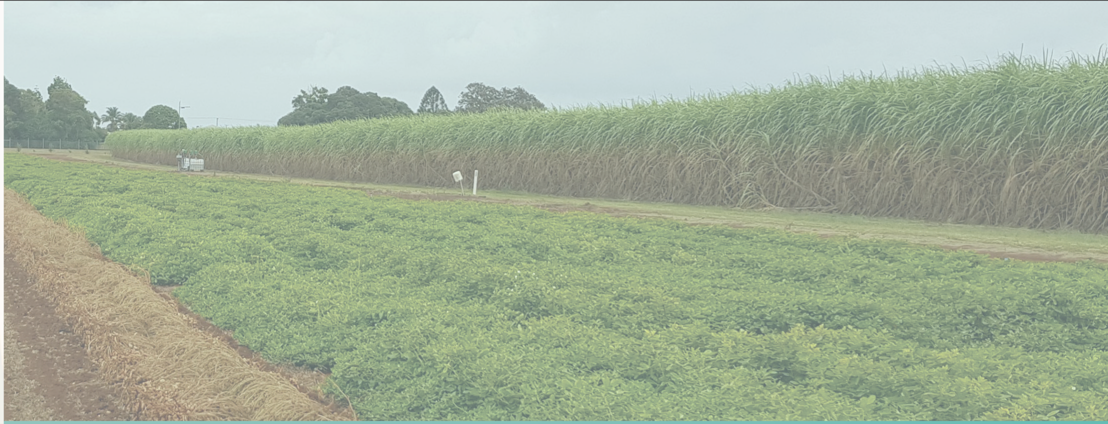

Sugarcane Field Trial Compendium

A collection of research trial reports from 2012-2019

Department of Agriculture and Fisheries

Queensland Government

This publication has been compiled by Isabel Bryce of Rural Economic Development, Department of Agriculture and Fisheries.

Contents

Foreword

Welcome to the very first edition of this Sugarcane Field Trial Compendium – a collection of research reports from trials conducted by the Department of Agriculture and Fisheries (DAF) Coastal Farming Systems team over several years. Team members are based in Bundaberg, Mackay, Townsville, South Johnstone and Cairns and continue to work with Queensland's sugarcane industry to help drive innovation and productivity as well as promote environmental sustainability. Their research, development and extension collectively aims to improve sugarcane productivity whilst also reducing the impact of agriculture on the environment thereby improving water quality for the Great Barrier Reef.

Research is vital and underpins the critical extension and communication work we deliver to the producer and agronomist community. Our trial reports are structured to provide the information in an easily digestible format that gives background, trial methodology and a summary of the results as well as a section on the implications of these results for the producer. We welcome questions and discussion around the research, and value any feedback to enable us to continually improve the way we undertake and report our trial work.

We sincerely thank the growers, advisers and agricultural supply chain businesses who have contributed to the success of these trials.

Mark Hickman

A/ General Manager
Crop and Food Science
Department of Agriculture and Fisheries

Executive Summary

By Neil Halpin
Coastal Farming Systems Team Leader

This compendium captures a large body of work carried out by the Coastal Farming Systems team in an effort to assist sugarcane growers adopt more sustainable practices.

There have been some 11 trials implemented to demonstrate to producers that nitrogen application rates based on the Six-Easy-Steps (6ES) to nutrient management guidelines produced the same cane yield as more traditional application rates. The reduction in nitrogen had the advantage of reduced input costs thereby improving grower profitability. Better matching nitrogen application to crop demand has the potential to reduce losses to the environment thereby improving water quality.

The field trial activity also evaluated a range of enhanced efficiency fertilisers, like polymer coated and nitrification inhibitor products. The trials also highlighted that 6ES guidelines for fertiliser application after soybean and mill mud applications offer significant fertiliser and cost savings.

Trials have also been conducted that address soil health, acidity and sodicity. Strategies and tools to address herbicide application are also highlighted.

These trials have been conducted from Bundaberg to the Wet Tropics on a range of soil types using a wide range of sugarcane varieties.

Nutrition Research

1

Nutrition Research
Introduction

By Derek Sparkes

With increasing pressure being placed on agriculture to improve its agricultural footprint, farmers have had to look more closely at the inputs they apply to their crops. This is particularly applicable to the sugarcane industry which is located between World Heritage listed rainforest and the Great Barrier Reef (GBR).

Research has shown that pollutants such as dissolved inorganic nitrogen (DIN), have been getting into the waterways which wind their way to the coast and into the GBR lagoon. One of the sources of DIN is from nitrogenous fertilisers applied in the field, either in amounts exceeding the crops' requirements, or applied at times where weather events increase the loss pathways. It is critical to reduce the DIN loss, as DIN has been shown to increase the survival of Crown of Thorns (COTs) larvae, thereby increasing the number of coral-eating adults infesting the reef

In an attempt to reduce this loss of DIN and the impacts thereof, the sugar industry developed a program called the Six Easy Steps (6ES)[1] which included extensive research to enable growers to better match their nitrogen (N) inputs to the cane plants requirements. The 6ES became regulated in 2010 and it became compulsory for growers to have a soil test done before a new crop cycle and all the nutrient requirements were calculated from this soil test.

There has been reluctance by some growers to adopt the 6ES process, which may be due to a lack of data or knowledge. In response to this the Department of Agriculture and Fisheries (DAF) established a series of trials across the Wet Tropics to demonstrate to growers that the 6ES N recommendations were sufficient to grow the best crop that the season would allow.

Two major factors effecting N loss from paddocks are rate and form. N is usually applied in the form of urea but there are other options such as organic N (e.g. legume residue, compost, mill mud) or Enhanced Efficiency Fertilisers (EEFs) which use techniques such as polymer or carbon coats for the urea or the application of a nitrification inhibitor to the Urea.

Since 2012 DAF have been running a series of trials over a number of ratoons to look at: the 6ES rates versus traditional grower rates; EEFs at different rates; and N rate reduction following legume crops. These trials are detailed in the following section.

The major findings are:

- 6ES N rates were as productive as higher traditional rates
- in the trial years, rates 20% less than 6ES were as productive as 6ES rates
- after a reasonable legume crop, (greater than 5t Dry Matter/ha), there was no need for N topdressing after 30 – 60 kgN/ha was applied at planting
- there was no positive or negative yield response to any of the EEF fertilisers.

This work is continuing, with some extra work looking at alternating 6ES rates with a lower rate in alternate years. DAF is also collaborating with Sugar Research Australia (SRA) who are running similar trials looking at N rates after legumes in the Mulgrave area of north Queensland.

Additionally, precise management of the variability that exists within the field is also being investigated by DAF through the use of drones. DAF has been mapping paddocks to identify high and low production areas and overlaying the use of variable rates to better match N application across the paddock to the requirement of the crop. This has real potential for step change for the industry and work is continuing in this space.

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1. 6ES method explained in appendix, see page 74.

Agromaster controlled release 25:75 trial

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Can controlled release urea improve the productivity of sugarcane by better matching the supply of nitrogen (N) to the plant's requirements?

Key Findings

1. Over two years of results there was no response to the controlled release product
2. Over two years of results there was no response to the different nitrogen rates applied

Background

The Department of Agriculture and Fisheries undertakes a number of research trials every year in our quest to reduce agricultural run-off entering the Great Barrier Reef and to work towards improved reef water quality. Nitrogen is a key contributor to poor reef water quality as it increases the populations of Crown of Thorn Starfish (COTS) which eat coral. The Wet Tropics has been identified as the source of the COTs outbreaks, so reducing N runoff in this region is of paramount importance.

One of the potential methods of reducing dissolved inorganic nitrogen (DIN) is through using enhanced efficiency fertilisers. One such product applies a polymer coating to urea, which protects the fertiliser, so that it becomes available later in the crop. This type of fertiliser is known as controlled release urea (CR) and it is more expensive, due to the coating process.

Theoretically, given the plant will be provided N with increased efficiency due to delayed release, then the rates of the CR can be reduced, when compared to the same as higher rates of urea? Different proportions of polymer-coated urea are available and this trial examined a blend with 25% controlled release product.

Treatments

This trial was established to investigate the effect of controlled release urea mixed 25:75 with standard urea on cane productivity at : 110 kgN/ha (below Six Easy Steps (6ES)[2] compared to standard urea at 110 kgN/ha (below Six Easy Steps (6ES) and 140 kgN/ha (6ES).

The treatments used in the trial were:

1. Controlled release urea (25% CR and 75% urea mix) 110 kgN/ha (< 6 Easy Steps)
2. Urea 140 kgN/ha (6 Easy Steps)
3. Urea 110 kgN/ha (< 6 Easy Steps)

In the first year of the trial the fertiliser was applied to a crop of first ratoon (R1) Q241 using a stool splitter. The cane was on 2m beds with dual rows and each row was individually stool split with the fertiliser. The box was split so a constant rate of potassium (100 kg K/ha) was applied to the whole block and the N rates and products were varied for the strips and were applied randomly to allow for statistical analysis.

In both years the fertiliser was applied in late October / early November, close to the wet season, to give the controlled release product the best chance to work.

The three treatments were replicated four times and the results were analysed using a GenStat ANOVA package.

Results

There was no treatment (urea rate or nitrogen source) effect on cane yield for the 2015 harvest, see Figure 1. Similarly there was no treatment effect on CCS content or sugar yield (t/ha) (Table 1).

2. *6ES method explained in appendix, see page 74.*

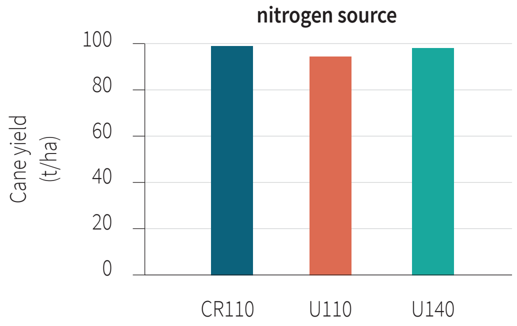


Figure 1: Nitrogen source and rate effect on the productivity of sugarcane Q241 in the 2015 season (p=0.271)

Table 1. Nitrogen rate and source effect on CCS and sugar yield of R1 Q241.

Treatment	CCS	Sugar yield (t/ha)
CR Urea 110	10.45	10.3
Urea 110	10.93	10.3
Urea 140	10.32	10.1
p value	0.35	0.853

This result was repeated with the 2016 harvest where neither nitrogen application rate or nitrogen source had any measurable impact on cane yield, CCS or sugar yield, see Table 2.

Table 2. Nitrogen rate and source effect on CCS and sugar yield of R2 Q241 (2016 Results)

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
CR Urea 110	95	10.36	9.8
Urea 110	96	10.55	10.1
Urea 140	95	10.36	9.9
p value	0.796	0.741	0.503

The results show that in both years there was no response to either the controlled release product or the rates. Applying a lower rate than 6ES did not significantly decrease cane or sugar yields.

The lack of treatment effect is made even more evident when the treatment yields are added together for the 2015 and 2016 seasons and expressed as cumulative cane yield (Figure 2) and sugar yield (Table 3)

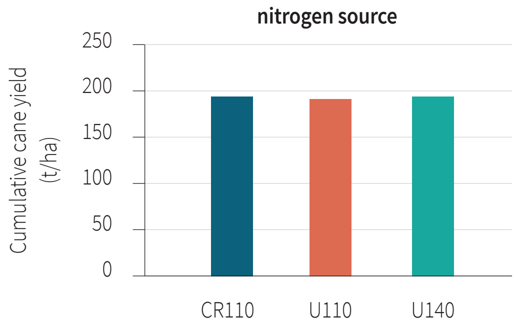


Figure 2: Nitrogen source and rate effect on the cumulative cane yield of R1 + R2 of Q241 in the 2015 and 2016 seasons

Table 3. Cumulative Sugar Yield for the two years combined

Treatment	Cumulative sugar yield (t/ha)
CR Urea 110	20.1
Urea 110	20.4
Urea 140	20

There was no difference in productivity for any of the treatments when the two years were combined.

Implications for growers

The results show that, for the two years of the trial, there was no response by Q241 to the controlled release fertiliser mixed as a 25%:75% blend with urea.

More work is being done to see if controlled release products have a role in the sugar industry. Growers should not make large investments in the technology before we have a better understanding of which situations might best suit the product.

It also showed that there was no response to the lower rate than 6ES (110 kgN/ha), giving the same productivity.

Does it pay?

As there was no significant difference in cane or sugar yield due to product or rate the most cost effective treatment was the lowest rate of the cheapest product. In this case it was 110 kgN/ha of standard urea.

Acknowledgements

These trials are supported by the Department of Environment and Science.

Trial details

Location:	Silkwood, Wet tropics
Crop:	Sugarcane
Variety:	Q241

Black urea trial

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Can lower rates of black urea produce the same amount of sugar as higher rates of standard urea?

Key Findings

1. The results showed that there was no response to the black urea product.
2. Also, there was no response to the different nitrogen rates.

Background

The Department of Agriculture and Fisheries undertakes a number of research trials every year in our quest to reduce agricultural run-off entering the Great Barrier Reef and to work towards improved reef water quality.

There are a number of options available to sugarcane growers which may reduce nitrogen losses. But will these alternative products also maintain cane productivity?

Black urea has a carbon coat around the urea granule, which claims to reduce nitrogen losses compared to standard urea products.

Treatments

This trial was established to investigate the effect of black urea on cane productivity at 120 kgN/ha (20% below Six Easy Steps (6ES) compared to urea at 120kgN/ha and 150 kgN/ha (6ES).

The treatments used in the trial were:

1. Black urea 120 kgN/ha (20% < 6 Easy Steps)
2. Urea 150 kgN/ha (6 Easy Steps)
3. Urea 120 kgN/ha (20% < 6 Easy Steps)

The fertiliser products were applied to a crop of first ratoon (1R) Q241 using a stool splitter. The cane was on 1.8m rows. A constant rate of potassium (100 kg K/ha) was applied to the whole block and the N rates and products were varied for the replicated strips.

The three treatments were replicated four times and the results were analysed using a GenStat ANOVA package.

Results

The results obtained from the trial demonstrate there was no response to either the black urea product, or the varying rates of nitrogen. Applying a lower rate than 6ES did not significantly decrease cane yield as shown in Table 1.

Table 1: Treatments and cane yield

Treatment	Cane yield (t/ha)
U120	87.98
U150	88.93
BU120	89.64
	p=0.661

Due to issues with the Mossman Mill a CCS value for each plot was not provided. Several plots were grouped together for one CCS value which was not ideal. Anecdotally, there was not a big difference in the CCS values that were obtained.

Implications for growers

The results show that there was no response by Q241 to the black urea fertiliser in the 2014 -15 season in Mossman. -

It also showed that there was no response to the lower rate than 6ES (120 kgN/ha), giving the same productivity. -

More trials are required to see if black urea has a viable role in the sugar industry, but growers should not make - large investments in the technology before we have a better understanding of which situations might best suit the product.

Does it pay?

As there was no significant difference in cane yield (and probably sugar yield) due to product or rate the most cost effective treatment was the lowest rate of the cheapest product. In this case it was 120 kgN/ha of standard urea.

Acknowledgements

Funded through the Queensland Government Reef Water Quality Program.

Trial details

Location:	Mossman, Wet Tropics
Crop:	Sugarcane
Variety:	Q241
Soil Type:	Red granite sand

Controlled release 50:50 trial

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Can controlled release urea improve the productivity of sugarcane by matching the supply of nitrogen (N) to the plant's requirements?

Key Findings

1. Over three years of results there was no response to the controlled release products.
2. Over three years of results there was no response to nitrogen rates in cane yields.
3. In two years there was better CCS in the 80 kgN/ha rate but it didn't give a significant difference in tonnes of sugar/ha

Background

One way of reducing dissolved inorganic nitrogen (DIN) levels in runoff water is through the use of enhanced efficiency fertilisers, which claim to reduce excess nitrogen entering waterways.

Controlled release urea products make N available to the plant at a later stage in the crop cycle, when the crop has the highest demand for nitrogen.

Can controlled release products still produce the same productivity as standard urea products on sugarcane?

Treatments

This trial investigated the effect of controlled release urea mixed 50:50 with standard urea on cane productivity at three different rates.

The treatments used in the trial were:

1. Controlled release urea (50% CR and 50% urea mix) 120 kgN/ha (6 Easy Steps)
2. Controlled release urea (50% CR and 50% urea mix) 80 kgN/ha (< 6 Easy Steps)
3. Controlled release urea (50% CR and 50% urea mix) 160 kgN/ha (> 6 Easy Steps)
4. Urea 120 kgN/ha (6 Easy Steps)
5. Urea 80 kgN/ha (< 6 Easy Steps)
6. Urea 160 kgN/ha (> 6 Easy Steps)

In the first year of the trial the fertiliser was applied to a crop of first ratoon (R1) Q219 using a stool splitter. The cane was on 2m beds with dual rows and each row was individually stool split with the fertiliser. The box was split so a constant rate of potassium (100 kg K/ha) was applied to the whole block and the N rates and products were varied for the strips.

In all three years the fertiliser was applied in November, close to the wet season, to give the controlled release product the best chance to work.

The six treatments were replicated three times and the results were analysed using a GenStat ANOVA package.

Results

In 2014 there was no treatment effect on cane yield (Figure 1); CCS or sugar yield, see Table 1.

Figure 1: Nitrogen source (U = urea, CR = controlled release) and rate (kgN/ha) effect on cane yield of Q219

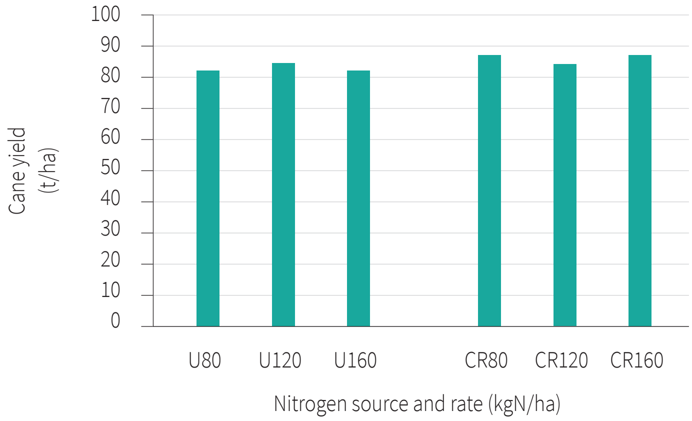


Table 1. Nitrogen source and application rate effect on cane yield, CCS and sugar yield of Q219 - 2014 Results

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
U80	82.71	12.67	10.48
U120	84.86	12.55	10.65
U160	82.66	12.53	10.36
CR80	86.88	12.70	11.03
CR120	84.04	12.60	10.59
CR160	86.88	12.57	10.92
Rate	p=0.979	p=0.202	p=0.846
Product	p=0.126	p=0.529	p=0.120

There was no product (urea or controlled release) effect on cane yield, CCS or sugar yield in 2015, (Table 2). However, there was a significant nitrogen application rate effect on CCS content, with CCS declining with elevated nitrogen application rate (Table 3). Nitrogen application rate had no effect on cane or sugar yield.

Table 2. Nitrogen source and application rate effect on cane yield, CCS and sugar yield of Q219 -2015 Results

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
U80	105.6	13	13.7
U120	111.8	12.77	14.3
U160	107.3	12.48	13.4
CR80	106.9	13.03	13.9
CR120	107.8	12.7	13.7
CR160	111.3	12.48	13.9
Rate	p=0.193	p=0.037	p=0.410
Product	p=0.785	p=0.939	p=0.828

Table 3: Nitrogen application rate effect on CCS.

Nitrogen application rate (kgN/ha)	CCS
160	12.48 [b]
120	12.73 [ab]
80	13.02 [a]

Values followed by the same letter are not statistically different (P=0.05)

Similarly, there was no product effect on cane yield, CCS or sugar yield in 2016, (Table 4). However, there was a significant nitrogen application rate effect on CCS content, with CCS declining with elevated nitrogen application rate (Table 5). Nitrogen application rate had no effect on cane or sugar yield.

Table 4. Nitrogen source and application rate effect on cane yield, CCS and sugar yield of Q219 -2016 Results

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
U80	80.2	12.4	10.0
U120	82.4	12.33	9.9
U160	80.3	11.9	9.8
CR80	82.0	12.73	10.4
CR120	80.5	12.17	9.8
CR160	82.9	12.13	10.1
Rate	p=0.127	**p=0.010**	p=0.261
Product	p=0.383	p=0.434	p=0.232

Table 5: Nitrogen application rate effect on CCS.

Nitrogen application rate (kgN/ha)	CCS
160	12.02 [b]
120	12.25 [b]
80	12.57 [a]

Values followed by the same letter are not statistically different (P=0.05)

The results show that in 2014 (Table 1) there was no response to either the controlled release product or the rates. This was surprising as the 80 kgN/ha rate is 30% lower than the recommended 6ES rate of 120 kgN/ha. Applying a higher N rate did not increase cane or sugar yield.

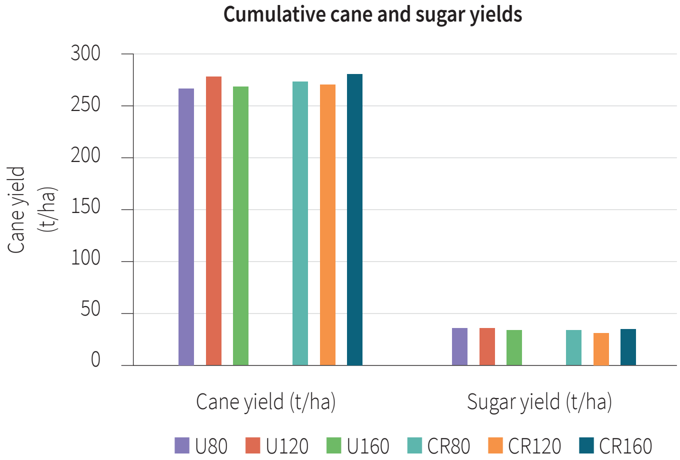
Similar results were seen in the R2 and R3 crops (Tables 2 & 4) although the nitrogen rate did have a significant effect on CCS in both years. In both years the 80 kgN/ha gave a better CCS than the 160 kgN/ha and in 2016 it was significantly better that the 120 kgN/ha too.

There was a cane yield improvement in the region of 20 t/ha and a sugar yield of 4 t/ha in 2015 but this could be due to seasonal conditions rather than fertiliser applications. The cumulative cane yields and sugar yields for the three years of this trial are shown in Table 6 and Figure 2.

Table 6. Cumulative Cane and Sugar Yields for the three years combined

Treatment	Cumulative cane yield (t/ha)	Sugar yield (t/ha)
U80	268.5	34.2
U120	279.1	34.8
U160	270.3	33.6
CR80	275.8	35.4
CR120	272.3	34.1
CR160	281.1	34.9

Figure 2: The effect of 80 kgN/ha, 120 kgN/ha and 160 kgN/ha of urea and controlled release 50:50 fertiliser application rates for Q219 with the 2014, 2015 and 2016 crops are combined.



Implications for growers

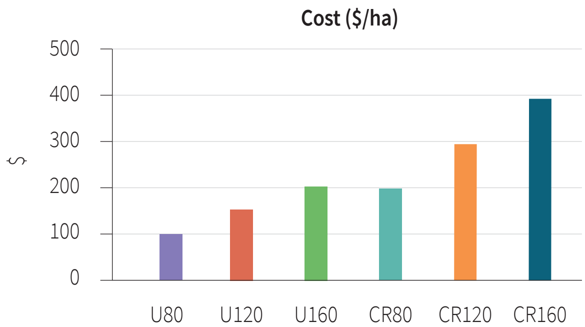
The results show that, for the three years of the trial, there was no response by Q219 to the controlled release fertiliser mixed as a 50% blend with Urea. More work is being done to see if controlled release products have a role in the sugar industry but growers should not make large investments in the technology before we have a better understanding of which situations might best suit the product.

It also showed that there was no response to rate; both higher and lower rates than 6ES (120 kgN/ha) gave the same productivity.

Does it pay?

As there was no significant difference in cane or sugar yields due to product or rate the most cost effective treatment was the lowest rate of the cheapest product. In this case it was 80 kgN/ha of standard urea at $100/ha as demonstrated in Figure 3.

Figure 3: Nitrogen costs per ha based on fertiliser pricing of urea at $578/t and Agromaster urea 50:50 at $1100/t.



Acknowledgements

Funded through the Queensland Government Reef Water Quality Program.

Trial details

Location:	Silkwood, Wet Tropics
Crop:	Sugarcane
Variety:	Q219
Soil Type:	Silkwood Jaffa

Controlled release 50:50 urea trial

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Can controlled release urea improve the productivity of sugarcane by matching the supply of nitrogen (N) to the plant's requirements?

Key Findings

1. In the 2014-15 season of the trial there was no response to the controlled release product and 20% less than 6ES gave the same productivity as the full 6ES rate.

Background

One way of reducing dissolved inorganic nitrogen (DIN) levels in runoff water is through the use of enhanced efficiency fertilisers, which claim to reduce excess nitrogen entering waterways.

Controlled release urea products make N available to the plant at a later stage in the crop cycle, when the crop has the highest demand for nitrogen.

Can controlled release products still produce the same productivity as standard urea products on sugarcane?

Treatments

The trial investigated the effect of controlled release urea mixed 50:50 with standard urea on cane productivity at two different rates: 110 kgN/ha (below Six Easy Steps (6ES)) and 140 kgN/ha (6ES); compared to urea only at 110kgN/ha..

The treatments used in the trial were:

1. Urea 140 kgN/ha (6 Easy Steps)
2. Controlled release urea (50% CR and 50% Urea mix) 110 kgN/ha (20% less than 6 Easy Steps)
3. Urea 110 kgN/ha (20% less than 6 Easy Steps)

The fertiliser was applied to a crop of first ratoon (1R) Q208 using a stool splitter. The cane was on 1.65m rows and each row was individually stool split with the fertiliser. The crop received a constant rate of potassium (100 kg K/ha) across all plots.

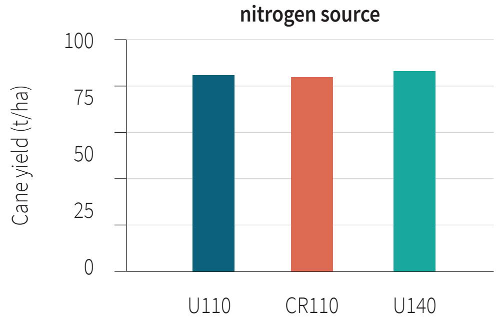
The fertiliser was applied near the wet season (October 2014) to give the controlled release product the best chance to work.

The treatments were replicated three times and the results were analysed using a GenStat ANOVA package.

Results

The results from the trial showed there was no treatment effect from either the nitrogen rate or nitrogen product on cane yields as seen in Figure 1.

Figure 1: The effect of nitrogen application rates and nitrogen sources on sugarcane yield (tonnes/ha) of a 1st ratoon block of Q208 (p=0.215)



There was no treatment effect, from the product or the rate, on CCS or sugar yields as shown in Table 1.

Table 1. Nitrogen application on rate and nitrogen source effect on CCS and sugar yield

Treatment	CCS	Sugar yield (t/ha)
U110	*13.82*	*11.59*
CR110	*13.76*	*11.37*
U140	*13.76*	*11.82*
	p=0.916	*p=0.475*

Implications for growers

The results show that, for the year of the trial, there was no response by Q208 to the controlled release fertiliser mixed as a 50% blend with urea. More work is being done to see if controlled release products have a role in the sugar industry but growers should not make large investments in the technology before we have a better understanding of which situations might best suit the product.

It also showed that there was no response to rate and both 6ES (140 kgN/ha) and lower rates than 6ES (110 kgN/ha) gave the same productivity.

Does it pay?

As there was no significant difference in cane or sugar yields due to product or rate, the most cost effective treatment was the lowest rate of the cheapest product. In this case it was 110 kgN/ha of standard urea.

Acknowledgements

Funded through the Queensland Government Reef Water Quality Program.

Trial details

Location:	Aloomba, Wet Tropics
Crop:	Sugarcane
Variety:	Q208
Soil Type:	Alluvial

Controlled release potash trial

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Can controlled release potassium improve the productivity of sugarcane by matching the supply of potassium (K) to the plant's requirements?

Key Findings

1. In the first year there was no response to the controlled release product but there was a significant response to rate with the zero and 50 kgK/ha rates of both products yielding less tonnes cane per ha.
2. In the second year there was a significant response in cane yield to all plots with applied K compared to the untreated although there was no difference between the 3 rates.
3. In the second year there was significantly lower CCS in the 150 kgK/ha rate.
4. In the second year there was a significant difference in the sugar yield with rate, with the 100 kgK/ha being higher than both the zero K and 150 kgK/ha.

Background

Potash is an important nutrient required by cane. This trial was designed to look at controlled release potassium to see if slowly releasing K into the soil pool for cane growth, would have an effect on productivity. Four rates were used to see if above and below the recommended 6ES rates had any effect.

The theory behind the controlled releases of K is the nutrient is made available to the plant over a longer duration which will then match the uptake requirements of the plant but reduce the losses to the environment. This technology means fertiliser products with this functionality are more expensive but often smaller in application rates. Can lower rates of the controlled releases products produce the same productivity as higher rates of muriate of potash (MOP)?

Treatments

The trial looked at the effect of controlled release potassium on cane productivity at four different rates: Zero, 50 kgK/ha (below Six Easy Steps (6ES), 100 kgK/ha (6ES) and above 6ES (150 kgK/ha)

The treatments used in the trial were:

1. Zero potassium
2. Controlled release potassium 100 kgK/ha (6 Easy Steps)
3. Controlled release potassium 50 kgK/ha (< 6 Easy Steps)
4. Controlled release urea potassium 150 kgK/ha (> 6 Easy Steps)
5. Muriate of potash (50kgK/ha)
6. Muriate of potash (100kgK/ha)
7. Muriate of potash (150kgK/ha)

In the first year of the trial the fertiliser was applied to a crop of first ratoon (R1) Q208 using a stool splitter. The cane was on 2m beds with dual rows and each row was individually stool split with the fertiliser. The box was split so a constant rate of nitrogen (140 kg N/ha) was applied to the whole block and the K rates and products were varied for the strips.

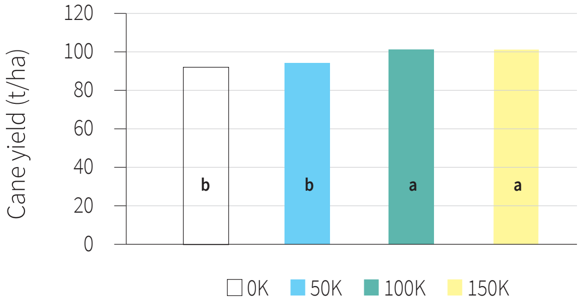
In both years the fertiliser was applied in November, close to the wet season, to give the controlled release product the best chance to work.

The seven treatments were replicated three times and the results were analysed using a GenStat ANOVA package.

Results

Potassium product (source) had no effect on cane yield in the R1 crop (p=0.807), however there was a significant effect of potassium rate on cane yield (Figure 1, Table 1) with the zero K and 50 kgK/ha producing significantly less cane than the 100 and 150 kgK/ha. There was no difference between the zero K and the 50 kgK/ha or the 100 and 150 kgK/ha.

Figure 1: R1 Cane (Q208) yield response to applied potassium fertiliser in 2015.



Treatments with the same letter are NOT statistically different (p=0.05)

Table 1. Potassium rate and product effect on cane yield, CCS and sugar yield of a 1st ratoon block of Q208 (2015 Results)

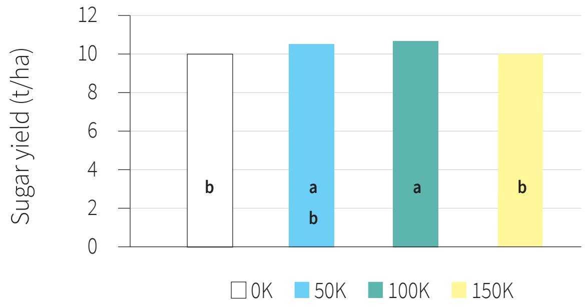
Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
0K	92	13.17	12.1
50K	94	13.3	12.4
100K	101	12.83	13
150K	100	12.9	13
CR50	94	13.33	12.6
CR100	100	12.75	12.7
CR150	102	13.13	13.4
Product	0.807	0.748	0.693
Rate	<0.001	0.11	0.147
Product x Rate	0.557	0.785	0.515

Interestingly, there was no effect of potassium product (source) or rate on cane yield in the second ratoon as shown in Table 2; although there was a significant difference (p=0.009) for decreased CCS for the 150 kgK/ha treatment. There was also a significant potassium rate effect on sugar yield (Figure 2); with 100 kgK/ha being better than both zero K and 150 kgK/ha but not better that 50 kgK/ha.

Table 2. Potassium rate and product effect on cane yield, CCS and sugar yield of a 2nd ratoon block of Q208 (2016 Results)

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
0K	87	11.47	10
50K	94	11.43	10.7
100K	97	11.27	10.9
150K	94	10.67	10
CR50	93	11.2	10.4
CR100	93	11.3	10.5
CR150	95	10.67	10.1
Product	0.293	0.682	0.299
Rate	0.501	0.009	0.048
Product x Rate	0.194	0.761	0.482

Figure 2: The effect of potassium fertilisation on sugar yield of Q208 in R2.



Treatments with the same letter are not statistically different (p=0.05)

When combining the two years of data and analysing the cumulative cane and sugar yields it demonstrates significant effects of potassium rate on cane yield (Table 4). However, there was no statistical effect on sugar productivity.

Table 4. Cumulative Cane and Sugar Yields for the two years combined

Treatment	Cumulative cane yield (t/ha)	Cumulative sugar yield (t/ha)
0K	*179[c]*	*22.1*
50K	*188[b]*	*23.1*
100K	*198[a]*	*23.9*
150K	*194[a]*	*23*
CR50	*187[b]*	*23*
CR100	*193[ab]*	*23.2*
CR150	*197[a]*	*23.5*
P Value	*<0.001*	*0.237*

Treatments with the same letter are not statistically different (p=0.05)

Implications for growers

The results show that, for the two years of the trial, there was a response by Q208 to the rates of potassium but not the form it was applied in (MOP or CR MOP). The zero K rate produced significantly less cane yield (t/ha).

The zero K plots did produce around 1 tonnes sugar per hectare (TSPH) less over the two year period than most of the other treatments. The 100 kgK/ha rate produced around 1 TSPH more than most of the other rates.

More work is being done to see if controlled release products have a role in the sugar industry but growers should not make large investments in the technology before we have a better understanding of which situations might best suit the product.

Does it pay?

There has been no detailed economic analysis of the trial but general assumptions are:

There was no significant difference in cane yield or sugar yield due to controlled release product so there would be a cost disadvantage in using the controlled release product in 2015 and 2016 seasons.

There was a response in both years to applying some K over zero so it would not pay to not apply potassium.

High rates of 150 kgK/ha do not appear to give any extra production so would not be cost effective. The 6ES rate of 100 kgK/ha gave optimum production and therefore would be the most economic.

Acknowledgements

This trail was funded through the Queensland Government Reef Water Quality Program.

Trial details

Location:	Silkwood, Wet Tropics
Crop:	Sugarcane
Variety:	Q208
Soil Type:	Silkwood Jaffa

Entec nitrification inhibitor trial

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Can Entec urea improve the productivity of sugarcane at lower rates of product compared to higher rates of standard urea?

Key Findings

1. There was no response to the Entec product or rate in the first year.

Background

Entec™ is urea coated with a nitrification inhibitor, which keep nitrogen in the ammonium form longer; thereby reducing the risk of losses to the environment. This could potentially improve the nitrogen use efficiency of the fertiliser, allowing for reduced application rates to off-set the increased cost of the product.

Treatments

This trial was established to investigate the effect of Entec nitrification inhibitor on cane productivity at two different rates: 110 kgN/ha (below Six Easy Steps (6ES) and 140 kgN/ha (6ES) compared with standard Urea at the same rates.

The treatments used in the trial were:

1. Entec treated N at 140 kgN/ha (6ES)
2. Entec treated N at 110 kgN/ha (20% < 6ES) -
3. Urea 140 kgN/ha (6ES) -
4. Urea 110 kgN/ha (20% < 6ES) -

In the trial the fertiliser was applied to a crop of ratoon Q208 using a stool splitter. The cane was on 1.8m beds with a single row. Muriate of potash was used to apply a flat rate of potassium (100 kg K/ha) to the whole block and the N rates and products were varied for the strips.

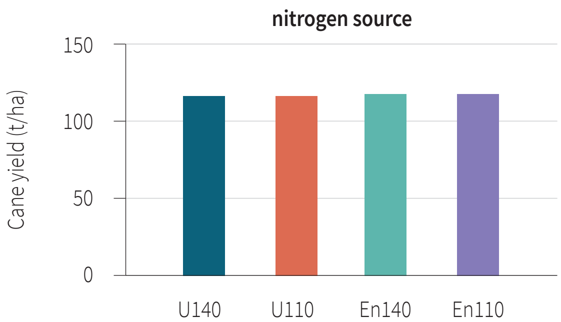
The fertiliser was applied in late October / early November 2015, close to the wet season, to give the nitrification inhibitor product the best chance to work.

The four treatments were replicated four times and the results were analysed using a GenStat ANOVA package.

Results

There was no significant treatment (urea rate or nitrogen source) effect on cane yield for the 2016 harvest, as indicated in Figure 1. Similarly there was no treatment effect on CCS or sugar yield (t/ha) as seen in Table 1.

Figure 1: Nitrogen source and rate effect on the productivity of sugarcane in the 2015/16 season (p=0.678)



Treatments with the same letter are not statistically different (p=0.05)

Table 1: Nitrogen rate and source effect on CCS and sugar yield.

Treatment	CCS	Sugar yield (t/ha)
U140	9.67	11.3
U110	9.24	10.8
En140	9.48	11.3
En110	9.16	10.8
Product	0.667	0.983
Rate	0.253	0.36
Product x Rate	0.869	0.925

The 2015/16 wet season was relatively dry and there may not have been very high losses from the urea. There was also a warm, wet dry season and the cane kept growing, giving a relatively high yield with low CCS. This was a common scenario across the Wet Tropics in this growing season.

Implications for growers

The results show that there was no response by the cane to the Entec product applied at the two rates. More work is being done to see if nitrification inhibitor products have a role in the sugar industry but growers should not make large investments in the technology before we have a better understanding of which situations might best suit the product.

It also showed that there was no response to the lower rate than 6ES (110 kgN/ha), producing similar sugar yields.

Does it pay?

As there was no significant difference in cane or sugar yields due to product or rate the most cost effective treatment was the lowest rate of the cheapest product. In this case it was 110 kgN/ha of standard urea.

Acknowledgements

This trial was funded through the Queensland Government Reef Water Quality Program.

Trial details

Location:	Cairns, Wet Tropics
Crop:	Sugarcane
Variety:	Q208

Entec nitrification inhibitor trial

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Questions

1. *Can Entec urea improve the productivity of sugarcane by keeping the nitrogen (N) in the ammonium form for a longer period of time?*
2. *Can lower rates of Entec urea produce the same amount of sugar as higher rates of standard urea?*

Key Findings

1. There was no response to the Entec urea or rate of Entec urea in the first year.

Background

Entec™ is urea coated with a nitrification inhibitor, which keep nitrogen in the ammonium form longer; thereby reducing the risk of losses to the environment. This could potentially improve the nitrogen use efficiency of the fertiliser, allowing for reduced application rates to off-set the increased cost of the product.

Treatments

The trial was designed to look at the effect of an Entec urea (with nitrification inhibitor) compared to normal urea on cane productivity at two different rates.

The treatments used in the trial were:

1. Entec urea at 140 kgN/ha (6ES)
2. Entec urea at 110 kgN/ha (20% <6ES)
3. Urea at 140 kgN/ha (6ES)
4. Urea at 110 kgN/ha (20% < 6ES)

In the 2015-16 trial, the fertiliser was applied to a crop of 1st ratoon Q251 using a stool splitter. The cane was on 1.65m single row. A custom blend was used to apply a flat rate of potassium (100 kg K/ha) to the whole block and the N rates and products were varied for the strips.

The fertiliser was applied in late October / early November, close to the wet season, to give the nitrification inhibitor product the best opportunity to work.

The four treatments were replicated three times and the results were analysed using a GenStat ANOVA package.

Results

The results generated from the harvest data suggested there was no yield response to nitrogen rate, in either cane yield or sugar yield, but there was a reduction in cane yield and sugar yield to product, with the Entec urea giving lower yields for both as shown in Table 1. This result is difficult to explain as both products should have provided N to the crop at the same amounts. There were no product by rate interactions

Table 1. Harvest data and analysis 2016

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
Entec	86.0 [b]	9.9	8.55 [b]
Urea	95.5 [a]	9.95	9.50 [a]
P Value	0.042	0.763	0.028
140	90.5	9.9	9.0
110	91.0	9.95	9.05
P Value	0.960	0.763	0.824
P x R	0.224	0.618	0.127

Treatments with the same letter are not statistically different (p=0.05)

The 2015–16 wet season was a relatively dry and there may not have been very high losses from the urea. There was also a warm, wet dry season and the cane kept growing giving a relatively high yield with low CCS. This was a common scenario across the Wet Tropics in this year.

Implications for growers

There is a statistical difference with the product type (urea and Entec) on cane yield and sugar yield as the P value is less than 0.05, but no effect on CCS. The results show that there was a negative response by the cane to the Entec urea applied. More work is being done to see if nitrification inhibitor products have a role in the sugar industry but growers should not make large investments in the technology before we have a better understanding of which situations might best suit the product.

It also showed that there was no response to the lower rate than 6ES (110 kgN/ha), giving the same productivity in sugar yield.

Does it pay?

As there was a negative response in cane yield and sugar yield due to the Entec product, the most cost effective treatment was the lowest rate of the standard urea. In this case it was 110 kgN/ha of standard urea. This data demonstrates that more experimentation is required to determine where and when growers would benefit from enhanced efficiency fertiliser usage.

Acknowledgements

This trial was funded through the Queensland Government Reef Water Quality Program.

Trial details

Location:	Mourilyan, Wet Tropics
Crop:	Sugarcane
Variety:	Q251

Nitrogen Six Easy Steps v grower rate

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Can the Six Easy Steps (6ES) recommended nitrogen rate match the productivity of traditional higher grower rates?

Key Findings

1. Over three years the 6ES nitrogen rate produced the equivalent tonnes of cane and tonnes of sugar as the higher traditional rate used by growers
2. The very high rate of 190 kgN/ha did not yield significantly more cane or sugar than the 6ES. In fact in total 180 kgN/ha (430 kgUrea/ha) extra that was applied in the highest rate over three ratoons only grew 2t cane/ha more than the 6ES rate

Background

In 2010 the Six Easy Steps (6ES) method of calculating nutrients in sugar cane was regulated. Since then, growers have to use a soil test to calculate their nitrogen (N) and phosphorus application (P) rates.

The recommendations from the 6ES rates are usually lower than the traditional rates that growers were used to applying, giving rise to concerns that the new regulated rates may not be sufficient to maintain production.

In light of the concerns raised by growers, the Department agreed to run a trial comparing the 6ES nitrogen rate with the more traditional (and higher) grower rates. The trial ran over three years and included three application rates.

Treatments

The treatments used in the trial were:

1. Urea at 130 kgN/ha (6ES)
2. Urea at 160 kgN/ha (Grower's rates)
3. Urea at 190 kgN/ha (Father's rates)

Results

None of the years showed a difference in productivity between the N rates. See Figure 1 and Tables 1, 2 and 3.

The 2014 crop was first ratoon and therefore had good potential for high yield producing around 12 tonnes of sugar per ha (TSPH). This dropped off over subsequent years to 10 TSPH in 2015 to 9 TSPH in 2016. The paddock was then fallowed and planted to soybeans.

There is a tendency for the CCS to be higher with the lower N rates but not significantly different.

Figure 1: Cane yield response to three different N rates over the crop cycle.

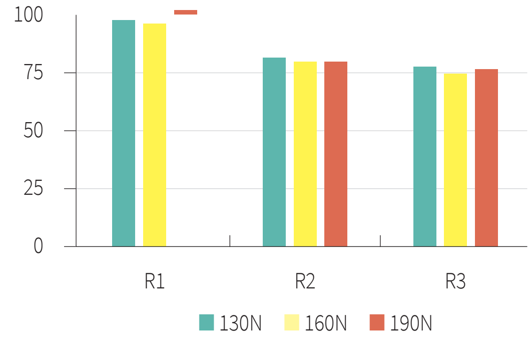


Table 1. Nitrogen rate on cane yield, CCS and sugar yield of a 1st ratoon block.

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
130N	98	12.08	11.9
160N	96	12.04	11.6
190N	102	11.95	12.2
p value	0.367	0.688	0.559

Table 2. Nitrogen rate on cane yield, CCS and sugar yield of a 2nd ratoon block.

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
130N	81	12.45	10.1
160N	80	12.74	10.2
190N	80	12.66	10.1
p value	0.519	0.28	0.856

Table 3. Nitrogen rate on cane yield, CCS and sugar yield of a 3rd ratoon block.

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
130N	77	12.42	9.5
160N	74	12.20	9.1
190N	76	11.88	9.1
p value	0.639	0.168	0.315

Does it pay?

As there is no significant difference in cane yield or sugar yield, the savings for the grower will be a direct result of applying less fertiliser. By applying nitrogen at the 6ES rates provides a financial saving of $75 /ha over the 190 kgN/ha and $40 over the 160 kgN/ha. These savings are conservative as it doesn't take into account the growers time or ha/hr; as the higher application rates require more fills/ha.

	130N	160N	190N
Urea (kg/ha)	280	350	410
Urea ($/ha)*	$162	$202	$237
Extra cost ($/ha)	$0	$40	$75

** based on price of Urea $578/t*

Implications for growers

Over the three years of this trial, the results have demonstrated that the 6ES rate of 130 kgN/ha sustainably matches the productivity of the traditional higher rates without any rundown over subsequent crops.

The lower rate not only saves the grower money, but there is less product to handle and potentially less nutrients being lost to the environment.

Acknowledgements

The trial was funded through the Queensland Government Reef Water Quality Program.

Trial details

Location:	Freshwater, Cairns, Wet Tropics
Crop:	Sugarcane
Variety:	Q208
Soil Type:	Alluvial

Six Easy Steps v grower rate - Bellenden Ker

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Can the Six Easy Steps (6ES) recommended nitrogen rate match the productivity of traditional higher grower rates?

Key Findings

1. In the year of the trial the 6ES nitrogen rate produced the equivalent tonnes of cane and tonnes of sugar as the higher traditional grower rate.

Background

The 6ES nitrogen application rate is generally lower than growers traditional nitrogen application rates, leading to concerns that reduced N input will result in reduced cane yield and lower profitability.

Treatments

To address the concerns over a decrease in production, a replicated field trial was established in a crop of ratoon cane that had just been harvested. The trial investigated the recommended Six Easy Steps (6ES) nitrogen rate compared to the higher traditional grower rate.

Two rates of nitrogen were applied in strips that were 6 cane rows wide and the treatments were replicated 4 times to a block located at Bellenden Ker in 2013.

The treatments were as follows:

1. Urea at 120 kgN/ha
2. Urea at 150 kgN/ha

Results

Table 1: Nitrogen application rate effect on cane yield for the 2013-14 season

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
120 kgN/ha	79	10.80	8.5
150kgN/ha	80	10.60	8.4

The mean of the four replicates for each treatment came to very similar cane yields at 80 t/ha (Table 1). The CCS values were very similar giving similar sugar yields per ha.

The trial clearly shows that there is no difference in crop performance under the two nitrogen rates.

Implications for growers

The results show that the 6ES rate of 120 kgN/ha sustainably matches the productivity of the traditional rate. The lower rate not only saves the grower money but there is less product to handle, there is less re-filling of the fertiliser box and less nitrogen is lost to the environment.

Does it pay?

As there is no response to additional N input it is more cost effective to use the lower 6ES N rate.

Acknowledgements

This trial was funded through the Queensland Government Reef Water Quality Program.

Trial details

Location:	Bellenden Ker
Crop:	Sugarcane
Variety:	KQ228
Soil Type:	Alluvial

Six Easy Steps v grower rate trial - Mossman

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Will the 6 Easy Steps (6ES) nitrogen rate match the productivity of traditional grower nitrogen application rates?

Key Findings

1. In the year of the trial the 6ES nitrogen rate, which was 30kgN/ha lower than the traditional nitrogen application rate, produced the equivalent tonnes of cane and sugar.

Background

To maintain productivity and minimise environmental harm the industry has developed the 6ES to nutrient management program.

However, some growers have been reluctant to adopt the 6ES rate as it is generally lower than their traditional nitrogen application rates and they are concerned that reduced N input may result in reduced cane yield and lower profitability.

Treatments

To address the concerns over a potential decrease in production, a replicated field trial was established in a crop of ratoon cane of Q208 that had just been harvested. Two rates of nitrogen (130 and 160kgN/ha) were applied in strips. The strips were 9 cane rows wide and the treatments were replicated 4 times. The alluvial soil paddock was located 5kms north of Mossman and the trial was conducted in 2013.

Results

The results from this replicated strip trial demonstrated that there was no difference in cane yield, CCS or sugar produced between 130 and 160kgN/ha (See Table 1).

Table 1: Nitrogen application rate effect on cane yield, CCS and sugar productivity for Q208 grown in an alluvial soil near Mossman in the 2013-14 season

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
130kgN/ha	83	11.47	9.6
160kgN/ha	83	11.38	9.5

The trial clearly shows that there was no difference in crop performance under the two nitrogen application rates.

Implications for growers

This trial clearly demonstrates that growers can have faith in the 6ES application rates as the 6ES rate of 130 kgN/ha matched the productivity of the traditional grower rate of 160 kgN/ha. The lower rate not only saves the grower money but there is less product to handle and therefore less re-filling of the fertiliser box, representing a field efficiency gain (ha/day) and less nitrogen is lost to the environment.

Does it pay?

As there is no response to additional N input it is more cost effective to use the (lower) 6ES recommended N rate.

Trial details

Location:	Mossman, Wet Tropics
Crop:	Sugarcane
Variety:	Q208
Soil Type:	Alluvial

Six Easy Steps v grower rate trial on plant cane after soybeans

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Will the Six Easy Steps (6ES) recommended nitrogen rate for sugarcane after legumes match the productivity of traditional grower rates?

Key Findings

1. After a reasonable soybean crop (4t Dry Matter/ha,) zero N (6ES for a good legume crop) gave significantly less TCPH and TSPH
2. There was no significant different in production between 50 kgN/ha (6ES for poor legume crop) and 100 kgN/ha (grower rate)

Background

Legume rotations are a key component of a sustainable farming system as they break the sugarcane monoculture, reduce cane-specific pathogens, fix atmospheric N and provide valuable ground cover to reduce rain drop impact during summer rainfall events.

A fallow legume crop can contribute a considerable nitrogen contribution to the soil, however there is often no allowance made for the N present in the soil after a legume crop when advisors are calculating the correct 6ES rate. Advisors may not be aware there was a fallow crop present, or the size of the crop, and make recommendations on the assumption that it was a bare fallow.

Treatments

A replicated field trial was established in a crop of plant cane of Q208 that was grown after a moderate soybean fallow crop. The soybean biomass production (4t/ha) was determined by sampling the crop just prior to tillage. Three rates of nitrogen were applied in strips. The rates were:

1. N0 – the 6ES rate for a good legume crop;
2. N50 – 6ES rate for a poor legume crop and
3. N100 – traditional grower application rate. The strips were 4 single cane rows wide and the treatments were replicated 4 times on an alluvial soil in the Aloomba region in 2013.

Results

Applying no nitrogen (N0) significantly reduced cane and sugar yield compared to the N50 and N100 treatments. However, there was no difference between the 6ES recommended application rate (N50) and the traditional grower practice (N100); see Table 1. The reduced yield of the N0 treatment is obvious in Figure 1.

Table 1: Nitrogen application rate effect on cane yield, CCS and sugar yield.

Treatment	Cane yield (t/ha)	CCS	Sugar yield (t/ha)
N0	84 b	14.94	12.5 b
N50	91 a	14.89	13.4 a
N100	91 a	14.84	13.7 a
	p=0.005	p=0.763	p=0.01

Treatments with the same letter are not statistically different (p=0.05)

Implications for growers

This would suggest that some N needs to be applied in the drill at planting even after a reasonable legume crop. When N is applied at the 6ES rate for a poor legume crop (50 kgN/ha) it produced the same amount of cane and sugar as the higher rate of 100 kgN/ha.

The lower 50 kgN/ha rate not only saves the grower money but there is less product to handle, there is less re-filling of the fertiliser box and less nitrogen is potentially lost to the environment.

Figure 1: Sugarcane Q208 response to applied nitrogen; LHS 4 rows at 100 kgN/ha, RHS 4 rows at zero N.

Acknowledgements

This trial was funded through the Queensland Government Reef Water Quality Program.

Trial details

Location:	Aloomba, Wet Tropics
Crop:	Sugarcane
Variety:	Q208
Soil Type:	Alluvial

Six Easy Steps v grower rate trial on plant cane after soybeans

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Is there a difference in productivity between the Six Easy Steps (6ES) recommended nitrogen rate and traditional higher grower rates following soybeans?

Key Findings

1. After a good soybean crop (6t Dry Matter/ha,) 50, 100 and 150 kgN/ha (regulated rate) gave no significant difference in Cane yield, CCS and sugar yield.

Background

Legume rotations are a key component of a sustainable farming system as they break the sugarcane monoculture, reduce cane-specific pathogens, fix atmospheric N and provide valuable ground cover to reduce rain drop impact during summer rainfall events.

A fallow legume crop can contribute a considerable nitrogen contribution to the soil, however there is often no allowance made for the N present in the soil after a legume crop, when advisors are calculating the correct 6ES rate. Advisors may not be aware there was a fallow crop present and the size of the crop, so they make recommendations on the assumption that is was a bare fallow.

Treatments

A replicated field trial was established in a crop of plant cane (Q200) that was grown after a good soybean fallow crop. Three rates of nitrogen were applied in strips as urea. The strips were 6 cane rows wide and the treatments were replicated 4 times on an alluvial soil in the Highleigh region, Gordonvale in 2014.

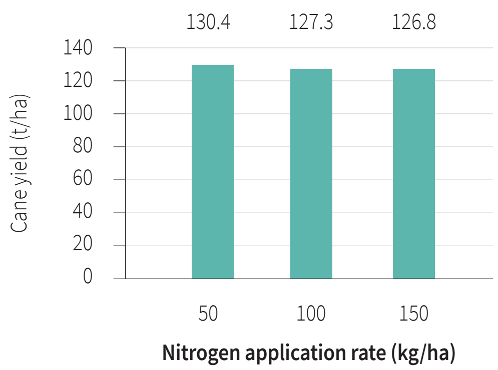
The treatments included are as follows

1. 50 kgN/ha
2. 100 kgN/ha
3. 150 kgN/ha

Results

There was no effect on cane yield with nitrogen application rates from 50 – 150kgN/ha, see Figure 1 (P value =0.401).

Figure 1: Plant cane (Q200) yield response from applied nitrogen following a soybean fallow



As with cane yield, there was no significant effect on CCS and sugar yield between any of the rates either as demonstrated in Table 1.

Table 1: Nitrogen application rate effect on cane yield, CCS and TSPH

Treatment	CCS	Sugar yield (t/ha)
50 kgN/ha	14.42	18.8
100 kgN/ha	14.4	18.32
150 kgN/ha	14.46	18.33
p value	0.832	0.38

This indicates that there was sufficient nitrogen supplied by the legumes to meet the cane crop's requirements at the lowest rate. In the trial the cane yields were high at around 130 t/ha with excellent CCS. The higher N rates can sometimes suppress CCS but this did not happen in this case and CCS values were very similar.

Implications for growers

The lower rate of 50 kgN/ha not only saves the grower money but there is less product to handle, there is less refilling of the fertiliser box and potentially less nitrogen being lost to the environment.

There can be an issue of legume N being lost after incorporation, before the cane requires it in the summer months. If there is enough winter or spring rain to cause waterlogging N can be lost through leaching or denitrification and a topdressing may be required. This was not the case in 2014.

Does it pay?

The results suggest that N applied at planting at 50 kgN/ha would be the most economic as, at higher rates the costs would be more for no extra productivity.

Acknowledgement

This trial was funded through the Queensland Government Reef Water Quality Program.

Trial details

Location:	Highleigh, Gordonvale
Crop:	Sugarcane
Variety:	Q200
Soil Type:	Alluvial

Six Easy Steps v grower rate trial on plant cane after soybeans

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Will the Six Easy Steps (6ES) nitrogen rate match the productivity of higher grower rates following soybeans?

Key Findings

1. After a good soybean crop (7t Dry Matter/ha), 0 (6ES), 30 and 90 kgN/ha (regulated rate) gave no significant difference in CCS or sugar yield per ha, but there was significantly less cane produced from the zero N application

Background

Legume rotations are a key component of a sustainable farming system as they break the sugarcane monoculture, reduce cane-specific pathogens, fix atmospheric N and provide valuable ground cover to reduce rain drop impact during summer rainfall events.

A fallow legume crop can contribute a considerable nitrogen contribution to the soil, however there is often no allowance made for the N present in the soil after a legume crop when advisors are calculating the correct 6ES rate. Advisors may not be aware there was a fallow crop present, or the size of the crop and make recommendations on the assumption that is was a bare fallow.

Treatments

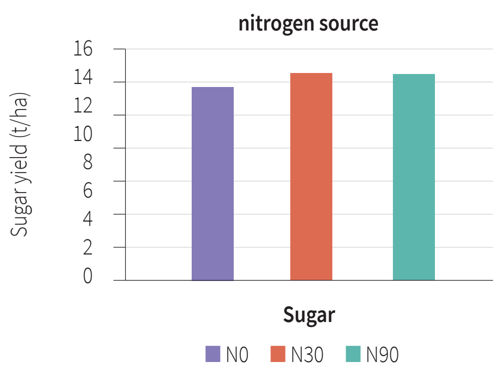
To address these concerns a replicated field trial was established in a crop of plant cane that was grown after a good soybean fallow crop. Three rates of nitrogen were applied in strips. The Nitrogen was applied as Urea. The strips were 6 cane rows wide and the treatments were replicated 3 times on a paddock in Innisfail in 2013.

1. N0 – No nitrogen fertiliser
2. N30 kgN/ha
3. N90 kgN/ha

Results

There was a trend for reduced sugar productivity with the N0 treatment despite no significant difference (p=0.304) see Figure 1.

Figure 1: Nitrogen application effect on sugar productivity following a 'good' soybean fallow.



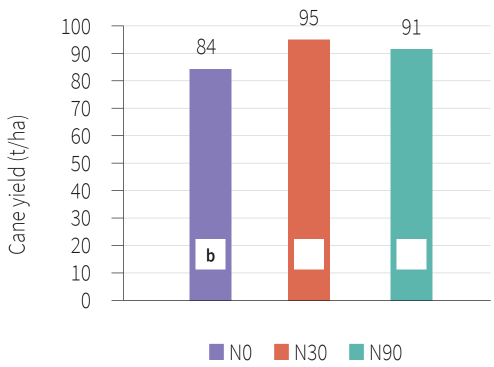
Similarly there was no nitrogen application effect of CCS despite the range on N inputs from 0 to 90 kgN/ha; see Table 1

Table 1: Nitrogen application rate effect on CCS

Nitrogen application rate (kgN/ha)	CCS
N0	15.83
N30	15.17
N90	15.67
	p=0.219

Despite the lack of responsiveness to applied fertiliser nitrogen to CCS content and sugar yield, there was a significant yield response to applied nitrogen fertiliser to cane yield. There was a 13% yield increase by applying 30kgN/ha compared to the N0 treatment. However, applying a nitrogen fertiliser rate in excess of 30kgN/ha offered no yield increase; Figure 2. This indicates that some nitrogen is required at planting, despite the large soybean crop, but 30kgN/ha is sufficient.

Figure 2: Nitrogen application rate effect on cane productivity following a good soybean fallow.



Treatments with the same letter are NOT statistically different (p=0.05)

Implications for growers

The lower rate of 30 kgN/ha not only saves the grower money but there is less product to handle, there is less re-filling of the fertiliser box and less nitrogen reduces potential adverse environmental outcomes.

There can be an issue of legume N being lost after incorporation, before the cane requires it in the summer months. If there is enough winter or spring rain to cause waterlogging N can be lost thought leaching or denitrification and a topdressing may be required. This was not the case in 2013.

Does it pay?

The results suggest that N applied at planting at 30 kgN/ha would be the most economic as at higher rates there would be extra costs with no extra productivity.

Acknowledgements

This trial was funded through the Queensland Government Reef Water Quality Program.

Trial details

Location:	Innisfail, Wet Tropics
Crop:	Sugarcane
Variety:	Q200
Harvested:	2014
Soil Type:	Alluvial

Six Easy Steps v grower rate trial with mill mud

Derek Sparkes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Will the 6 Easy Steps (6ES) recommended nitrogen rate with a deduction for mill mud match the productivity of traditional grower rates?

Key Findings

1. In the season of the trial the 6ES nitrogen rate with a deduction for Mill Mud (70 kgN/ha) produced the equivalent tonnes of cane and tonnes of sugar as the 6ES without mud allowance (110 kgN/ha) and the higher traditional rate (140 kgN/ha).

Background

Some growers have expressed reluctance to adopt the 6ES rate (which is generally a lower rate of nitrogen application than their traditional rates) as they are concerned that reduced nitrogen input may result in reduced cane yield and lower profitability.

The 6ES also recommends that nitrogen rates be reduced when mill mud is being applied. The recommendations are to reduce by 40 kgN/ha in 1st Ratoon (R1) when mill-mud is applied in the fallow, although this recommendation has often been ignored in the past.

Treatments

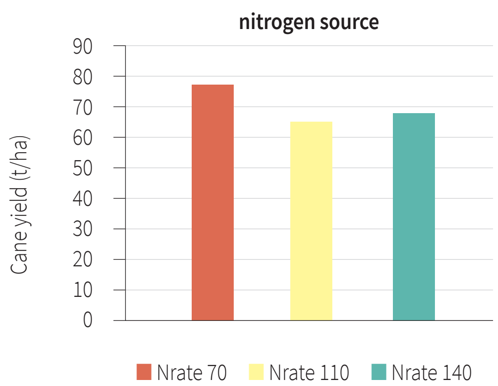
This trial investigates the recommended 6ES nitrogen rate compared to the traditional grower rate and a reduced rate based on deductions allowing for Mill Mud. A replicated field trial was established in a crop of ratoon cane that had just been harvested. Three rates of nitrogen were applied in strips.

1. Traditional growers rate (140 kgN/ha);
2. 6ES rate NOT accounting for the mill-mud application (110 kgN/ha);
3. the 6ES rate accounting for the mill-mud application in the fallow (70 kgN/ha). The strips were 5 cane rows wide and the treatments were replicated 3 times, to a block of Q183 on a red soil in the South Johnstone region in 2013.

Results

Statistical analysis of the trial results demonstrated no significant difference ($p=0.066$) in sugar cane yield from nitrogen application rates from 70 to 140kgN/ha, see Figure 1:

Figure 1: The effect of nitrogen application rates on sugarcane yield (tonnes/ha) of a 1st ratoon block of Q183



The analysis of variance showed no significant different between the rates in relation to cane yield, CCS or sugar yield but there was a trend showing the lower rate of 70 kgN/ha gave higher Cane (10 t/ha) and sugar (1t/ha) yield as shown in Table 1.

Table 1: Nitrogen application rate effect on cane yield for the 2013 - 14 season

Treatment	CCS	Sugar yield (t/ha)
70N	15.1	11.7
110N	15.7	10.2
140N	15.6	10.7
P Value	0.238	0.283

One of the 70 kgN/ha plots yielded higher than all other plots (82 t cane/ha) which affected the overall mean.

Implications for growers

These results show that the 6ES rate of 70 kgN/ha (allowing for mud) matches the productivity of the traditional and 6ES rate (without mud allowance). The lower rate not only saves the grower money but there is less product to handle, there is less re-filling of the fertiliser box. This reduction in re-filling equates to better field efficiency; meaning that a grower can fertilise more hectares in a day. The reduction in nitrogen application also reduces the chance of off-site impacts. The reduced nitrogen fertiliser additions will also go towards offsetting the cost of the mud application.

Does it pay?

The results show that you can reduce N rates in 1R cane following an application of mud in the plant cane by 40 kgN/ha without effecting productivity. As the lower rate will allow the grower to make a saving it is more economic than not allowing for the mill mud, or applying a higher rate of 140 kgN/ha.

Acknowledgements

This trial was funded through the Queensland Government Reef Water Quality program.

Trial Details

Location:	South Johnstone
Crop:	Sugarcane
Variety:	Q183
Soil Type:	Red Ferrosol

Sugarcane response to block yield potential rates and controlled release products

Jodie Tubb
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Is there a difference in sugar yields and CCS response to nitrogen applied at different rates and using a controlled release product in the Herbert?

Key Findings

1. The block yield potential rates produced equivalent tonnes of sugar and CCS as the Standard Grower rate.
2. There was no significant difference across all the treatments when comparing yield and CCS

Background

Environmental concerns with the amount of nitrogen leaving farms and entering waterways and ultimately entering the Great Barrier Reef has become a major focus for the broader community and growers alike. This is resulting in growers considering ways to make more efficient use of the nitrogen being applied to the sugarcane throughout the growing period. In this trial, the grower was interested in investigating the use of lower nitrogen rates based on yields previously achieved on this paddock. He was also interested in looking at alternative fertiliser products to determine if these would help to improve his nitrogen use efficiency.

Treatments

Soil tests for this paddock showed an organic carbon level of 1.15%, Phosphorous (BSES) of 37.4 mg/kg and a Nitric K of 0.87 meq/100g.

Based on soil tests, a 6 Easy Steps (6ES) rate of 140N: 15P: 100K: 0S was recommended to be applied to ratoons following a managed bare fallow.

The trial was established in a second ratoon crop of Q208. It was intended to use the grower standard fertiliser rates as well as 6ES and a block yield potential rate. As the 6ES rate was close to the grower standard rate, we used the grower rate in this trial.

The block yield potential (BYP) rate of the block was determined by using the harvest data from the previous two crop cycles. Over the past two seasons this paddock averaged 90tc/ha. Current wisdom is that sugarcane needs 1.4kgN/ha per tonne of cane (up to 100t/ha then only 1kgN/ha after that). Using this calculation a block yield potential rate of 126 kg N/ha was calculated, based on a 90 tc/ha yield.

Four nitrogen treatments (including the controlled applications) were replicated three times and subsequently applied as follows

1. Block yield potential – standard urea
2. Block yield potential – controlled release urea
3. Grower standard rate – standard urea
4. Grower standard rate – controlled release urea

A base fertiliser application of 41N: 31P: 115K: 18S was applied across the entire block. Urea was then applied at the varying levels across the treatments.

The total amount of nutrient applied to the two rates are

1. Block yield potential 126: 31: 115: 18
2. Grower standard rate 155: 31: 115: 18

Results

The results received from harvest data in the first year suggested there were no significant effects of rate or treatment and no significant interaction for any of the variables analysed as demonstrated in Figure 1 and Table 1.

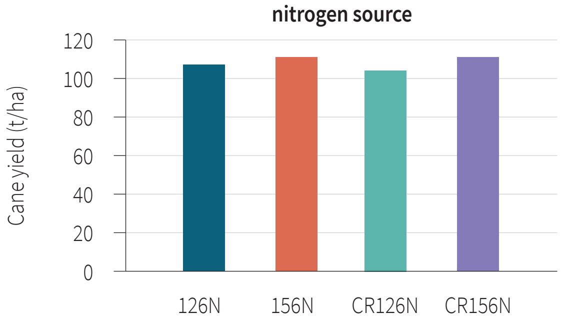


Figure 1: The effect of nitrogen application rates and source on cane yield (p=0.217) in 2015.

Table 1. Statistical analysis of harvest data 2015

Treatment	CCS	Sugar yield (t/ha)
126	15.42	16.6
156	15.30	17.0
CR126	15.42	16.1
CR156	15.33	17.0
p-value	0.432	0.386

The results received from the harvest data in the second year again resulted in no significant difference between the four treatments (Figure 2 and Table 2).

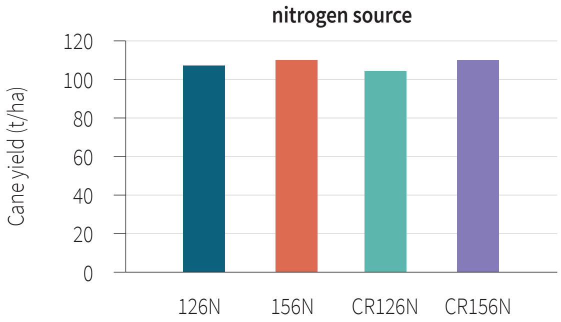


Figure 2: The effect of nitrogen application rates and source on cane yield (p=0.342) 2016.

Table 2. Statistical analysis of harvest data 2016

Treatment	CCS	Sugar yield (t/ha)
126	14.033	14.9
156	14.083	15.1
CR126	14.033	14.7
CR156	13.933	15.0
p-value	0.776	0.499

Combining the results from the 2015 and 2016 trials found no significant effects of treatment, no significant effects of product and no significant effects of the treatments with year ($p>0.05$). However, there was a significant effect between the years, with mean yield (t/ha) ($p=0.004$), CCS ($p<0.001$) and sugar yield (t/ha) ($p<0.001$) significantly lower in 2016 compared to 2015.

Does it pay?

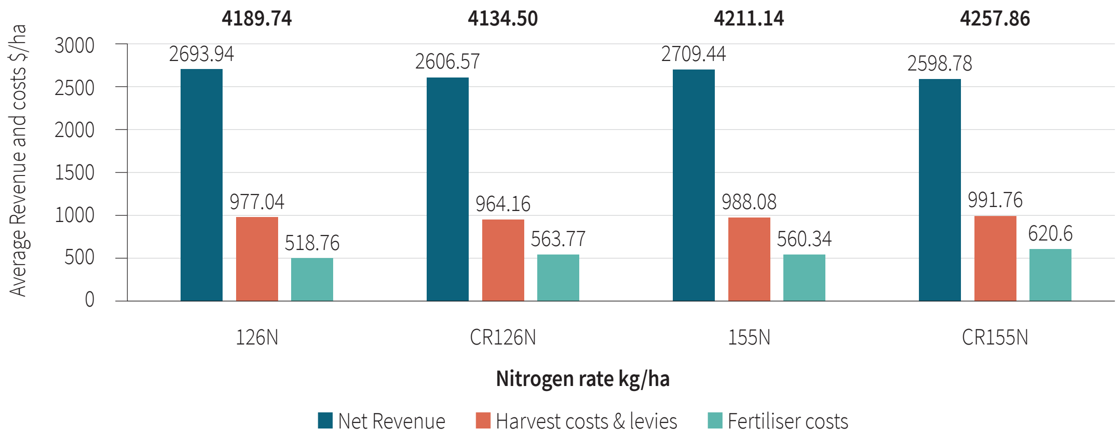
A comparison of the four treatments using a partial economic analysis to calculate the net revenue (gross revenue – harvesting costs, levies and fertiliser costs) show the profitability of the four treatments.

The gross revenue spread is around $123 between the lowest (CR126N) and highest (155N) treatments as shown in - Figure 3. The gross revenue is calculated using the five year average sugar price of $430/t, in the following equation: -

Gross Revenue = [sugar price ($/tonne) x 0.009 x (CCS – 4) + 0.6353] x tonnes cane/ha

There is a $15/ha difference between the average net revenue of the standard treatments of 126N and 155N. The CR126N and CR155N treatments have lower average net revenue than their standard urea equivalents by $87 and $110 respectively.

Figure 3: Comparison of revenues and costs between treatments – 3rd Ratoon Q208



Implications for growers

An important point to note with this trial is that the area experienced drier than average years while the trial has been in operation. Historical weather data indicates that this region experienced approximately 70% of its average annual rainfall. This trial demonstrated the grower is able to apply a fertiliser to target a specific yield that is achievable on a block level without sacrificing production in dry weather conditions. It has also demonstrated that there has been no benefit gained by applying a controlled release form of nitrogen in 2015 and 2016.

As a result, if you were expecting a drier than average season it would be desirable to decrease nitrogen rates to target a specific yield potential when fertilising.

Acknowledgements

This trial was funded through the Queensland Government Reef Water Quality program. Special thanks go to Carole Wright, Senior Biometrician at Department of Agriculture and Fisheries, for analysing raw data received from the trial.

Trial details

Location:	Helen's Hill, Herbert
Crop:	Sugarcane
Variety:	Q208
Soil Type:	Alluvial

Soil Research

Soil Research
Introduction

By John Hughes

The Sugar Yield Decline Joint Venture (SYDJV) project commenced in 1993 and continued for the next ten years. The results from this research show that yield decline in a sugarcane production system is largely associated with poor soil health issues. Productivity loss through soil degradation and poor soil health is attributed to a number of management practices which include excessive tillage, uncontrolled traffic from heavy machinery and a sugarcane monoculture system which promotes an increase in sugarcane specific pathogens.

Excessive tillage of sugarcane paddocks results in the rapid depletion of organic matter. Conservation of organic matter through reduced tillage is critical in maintaining soil biota diversity which supports the nutrient cycling process, including the all-important mineralisation process. Adequate organic matter levels contribute significantly to the water holding capacity of the soils and the ability to hold nutrients. The widespread adoption of green cane trash blanketing by the sugar industry has resulted in a reduction of mechanical tillage and the improved conservation of organic matter. Industry uptake of zonal tillage systems and permanent beds will further enhance the conservation of organic matter.

Soil compaction through uncontrolled traffic and a miss-match of machinery wheel spacing (particularly mechanical harvesters and haul-out machinery) and sugarcane row spacing is a significant contributor to productivity losses and poor soil health. Increased soil bulk density from compaction limits both water infiltration, soil biota activity, crop root extension and the effective uptake of nutrients and soil moisture. The advent of GPS technology and matching row-spacing to machinery wheel centres provides growers with a systems option to better manage soil compaction and the associated soil health issues.

The introduction of fallow rotational crops is an integral component for interrupting sugarcane disease cycles and addressing the soil health issues associated with a sugarcane monoculture. SYDJV fallow legume trials aimed at breaking the sugarcane monoculture showed improved productivity in subsequent sugarcane crops attributed to improvements in chemical, physical and biological soil properties, particularly the latter. Legume fallow break crops provide a different root system to sugarcane to manage root pathogens (parasitic nematodes) and provide a source of biologically fixed nitrogen.

A systems approach to address soil health issues and arrest yield decline include the adoption of reduced tillage, controlled traffic and fallow rotational break cropping. The adoption of the agronomic principles that underpin the systems approach are a fundamental component in improving the quality of water entering the Great Barrier Reef lagoon. The systems approach should in no way be regarded as prescriptive with ongoing research and trial work required to encompass the environmental diversity inherent in the various sugarcane growing regions.

A well-managed fallow legume break crop… an important component of a systems approach to improve soil health and interrupt a monoculture production system

Amelioration of acidic and low calcium soils

John Hughes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Questions

1. *Determine the effects of lime amelioration on soil mineralisation capacity and final yield.*
2. *Can nitrogen rates be manipulated on ameliorated soils to better manage sugarcane lodging, CCS and improved nitrogen use efficiency?*

Key Findings

1. Lime amelioration provided a significant reduction in aluminium concentration with a unit increase in soil pH
2. Improved nutrient cycling (particularly N) through liming increased crop uptake of N resulting in early season lodging in the plant cane crop with detrimental impacts on CCS and yield
3. Potential to reduce N rates following fallow lime amelioration to better manage early season crop lodging (N rate reduction possibly restricted to 1st and 2nd ratoon and influenced by access to irrigation)
4. Reduced aluminium concentrations and adequate calcium levels improve root functionality uptake of soil moisture
5. The results from this trial are not necessarily applicable to the amelioration of other soil types

Background

Results from the Sugar Yield Decline Joint Venture (SYDJV) research project emphasised the need to preserve or improve organic carbon (OC) levels which influence a number of biological processes such as nutrient cycling through mineralisation, water and nutrient holding capacity and suppression of soil borne diseases through soil biota diversity. One of the recommendations of the SYDJV was to reduce tillage with a permanent bed system to minimise OC losses in a sugarcane production system.

This trial was established to determine the effects of different tillage intensities during the fallow period on organic carbon (OC) levels following a 10 year green harvested sugarcane ratoon cycle.

Treatments

Soil testing, using the Walkley-Black wet oxidation technique, before and after the various tillage intensity treatments during the fallow period showed little variation in OC levels between the most intensive tillage treatments and the zero till treatment (glyphosate spray-out).

The early results from this trial indicated that the Walkley-Black assay is inadequate for accurately measuring changes in labile carbon.

Soil sampling during the fallow period showed that pH levels across the tillage plots were too acidic to sustain diverse microbial populations with negative implications for soil mineralisation and nutrient cycling.

Lime was applied over half the trial site to determine the effects of ameliorating acidic soils on yield, soil mineralisation and altered nutrient cycling capacity.

The paddock was EC mapped with a Veris 3100 soil mapper in late 2012. A krigged deep EC surface mapping layer was produced and the trial area positioned according to mapping patterns to ensure minimal variability in the physical soil properties across the trial design (Figure 1).

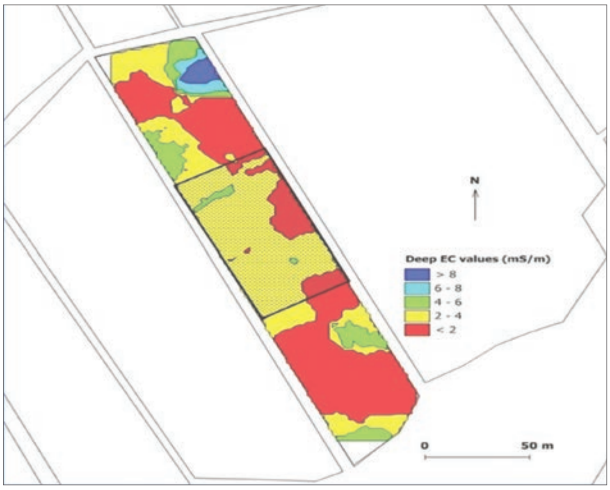


Figure 1: Deep EC soil survey mapping layer with trial site (hatched area) positioned to minimise variability in soil properties.

The original trial design incorporated four tillage treatment intensities with four replications. Lime was applied to half of the trial in February 2013 during the fallow phase of the crop cycle see Figure 2.

The applicator was calibrated to apply lime at 5 tonnes/ha and incorporated according to the tillage treatments over the fallow period as demonstrated in Figure 3.

Figure 2: Original trial design amended to determine the effects of the amelioration of acid soils on yield and nutrient cycling.

Plot no	Nil lime	Lime @ 5ton/ha (18/02/2013)
1	R1	↓
2	R1	Row direction
3	R1	
4	R2	
5	R2	
6	R2	
7	R1	
8	R3	
9	R2	
10	R3	
11	R3	
12	R4	
13	R3	
14	R4	
15	R4	
16	R4	

Width - 6m

Length - 45m

Treatments

T1: Chemical sprayout (glyphosate)
T2: Disc x2
T3: Disc x2 – rip x1 – hoe x1
T4: Disc x4 – rip x2 – hoe x2

Figure 3: Agricultural lime being applied at 5 tonnes/ha to half of the trial area.

Following the completion of the tillage treatments, full range soil analysis (to 20cm) were taken from the limed and un-limed zones of plot 11 in July 2013 to determine the effects of amelioration on soil pH, calcium and aluminium saturation.

The trial was planted to Q240 with a total applied fertiliser of 150N: 30P: 100K: 15S based on the Six Easy Steps (6ES) guidelines.

Plots were hand harvested, yield determination was confined to the limed and un-limed counterpart plots 1, 5, 7, 8 and 9 providing 5 replicates for each treatment. Harvested cane was stripped of trash and cabbage removed and was weighed on a mobile weigh trailer. Stalk counts and lodging assessments were conducted on all hand harvested plots. Six stalks were randomly selected from the harvested rows for each plot for CCS determination (NIR analysis). Mulched plant material from millable stalks and leaf cabbage was extracted from limed and un-limed plots 1, 5 and 8 to ascertain differences in the uptake and storage of N in ameliorated zones as compared to un-limed areas.

Lodging assessments and leaf N concentrations of the plant cane crop indicated that excessive lodging in the limed plots as compared to the un-limed resulting in both reduced yield and CCS.

Nitrogen (N) rates were reduced in the R1 crop to determine if lodging and reduced CCS could be better managed in the ameliorated plots (115N: 11P: 86K: 127S). Applied macronutrient levels were based on the 6ES apart from the N rates which were reduced from 160 kg N/ha to 115 kg N/ha. The block was irrigated twice receiving 50mm/ha each time. Two further irrigations of 50mm/ha were applied. No evidence of lodging was evident during field observations. Stalk counts and lodge assessments were conducted on hand harvested plots immediately prior to harvesting. Plots were stripped and topped prior to hand harvesting. Mulch sampling for N concentrations (leaf and stalk) were conducted at harvest.

Soil moisture samples were taken from all harvested plots post-harvest of trial. From each plot ten cores (to 20cm) were amalgamated mixed, weighed and oven dried to determine soil moisture percent.

The reduced N rate of 115 kg N/ha was maintained in the nutrient program for the R2 crop on limed and un-limed plots 1, 5, 7, 8 and 9. An additional treatment was incorporated into the trial with plots 2, 6, 11 and 12 receiving zero N. Field observations showed that limed and un-limed were plots were generally erect however some crop 'sprawliness' was evident in the limed plots. The zero N treatments in the limed plots were erect with no evidence of sprawl. Stalk counts and lodging assessments were conducted on all plots prior to hand harvesting. In contrast to the previous plant and R1 crops the 2nd ratoon was stripped but not topped due to the significant lodging that occurred in the limed plots following unseasonal rain in late June. Six stalk CCS samples were extracted from all plots. Soil samples were taken from plot 11 (limed and un-lined) to monitor changes in pH, calcium and aluminium saturation over the three year trial period.

Results

Comparative soil test results from the limed and un-limed sections of Plot 11 (139 days post application of lime) showed a significant response to lime with a 1.2 unit increase in pH, a 4 fold increase in calcium levels and a large reduction in aluminium saturation (57% to 4.3%). Subsequent soil testing post-harvest in 2016 (3 years and 4 months post application of lime) showed that pH levels of the ameliorated zone of Plot 11 had been maintained while calcium levels increased by 75.5% over the 3 year and 4 month timeframe (2 to 3.51 meq/100g respectively). Aluminium saturation remained largely unchanged over the timeframe in the lime treatment (Table 1).

Table 1: Comparative analysis between un-limed and limed counterparts in Plot 11 over a three year and 4 month period.

	Sample date	pH 1.5 water	Calcium (cmol (+)/kg	Al sat.	Calcium % CES
	July 13	4.7	0.46	57	23.9
Un-limed	Nov 16	4.8	4.6	53	
Limed	July 13	5.9	2	4.3	86.1
	Nov 16	5.8	3.51	2.7	

Field observations during the fallow phase of the trial in 2013 showed a marked variability in weed germination between the limed and un-limed sections of the spray-out plots and tillage plots where recent tillage operations had not destroyed weed growth (Figure 4 and 5).

Figure 4: Enhanced weed germination on ameliorated section of trial plots – Nil lime (left) and lime (right)

Figure 5: Weed germination restricted to the limed (bottom) section of plot 16 (2 discing treatment) compared to the un-limed (top) section.

Field observations also showed significant differences in the decomposition of surface cane trash between the lime and un-limed sections of the spray-out treatment plots (Figure 6). This variation in trash breakdown indicates the positive response of soil biota to improved pH conditions, calcium levels and reduced levels of aluminium saturation.

Figure 6: Enhanced decomposition of surface cane trash (foreground) in the limed section of Plot 1(spray-out treatment).

It is of interest to note that the surface applied lime had not been incorporated in the spray-out plots; changes in soil pH and calcium levels can be attributed to the incorporation of the fine fraction of the lime product through rainfall events over the five month period. The limed sections of the spray-out treatments also showed a enhancement of earthworm activity compared to the un-limed zones of the replicate plots (Figure 7).

Figure 7: Proliferation of earthworm casts in the limed sections of spray-out treatments (top) compared to the sparse earthworm activity in the un-limed section of spray-out plots (bottom)

Mulched plant samples collected at the harvest of the plant cane crop from limed and un-limed treatments of Plots 1, 5 and 8 showed higher levels of N in both millable stalks (MS) and leaf cabbage (LC) in the limed zones indicating improved mineralisation and/or increased root biomass better able to extract nutrients and utilise moisture (Figure 8).

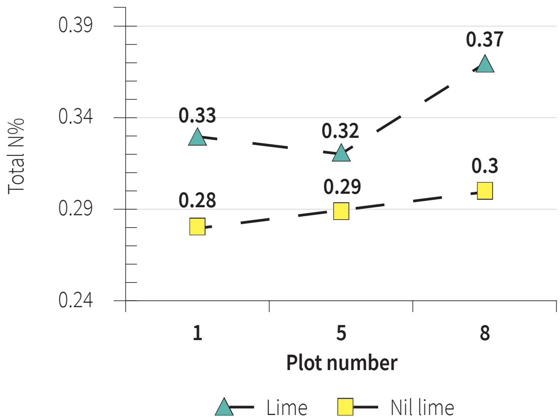


Figure 8: Mulched millable stalk sampling showed higher N concentrations in the limed section of selected plots compared to the un-ameliorated zones in the plant cane crop.

Lodging assessments conducted at harvest of the plant cane confirmed that greater lodging occurred in the lime treated plots compared to non-limed treatments (2.9 and 1.8 respectively). Mid-season lodging of limed plots was attributed to the enhanced functionality of the crop roots system facilitating increased N uptake and utilisation of available moisture. Although not statistically significant, the average cane yield of the un-limed plots out yielded the limed plots (121 t/ha and 109 t/ha respectively). In addition the average CCS values of the un-limed plots were 1.5 units higher than the limed counterparts (16.1 and 14.6 respectively) and this was reflected in the higher sugar yield for the un-limed plots (19.5 and 16.6 t/ha respectively). The relatively poor yield and CCS performance of the ameliorated plots was attributed to mid-season lodging associated with crop access to additional mineralised N.

Lodging assessments conducted at the harvest of R1 showed that both limed and un-limed counterparts had remained erect with no evidence of crop lodging. Mulch sampling for N content for leaf cabbage and millable stalk was conducted at harvest of R1 crop. The N concentrations of leaf cabbage were higher in all the limed plots compared to the un-limed counterparts as seen in Figure 9.

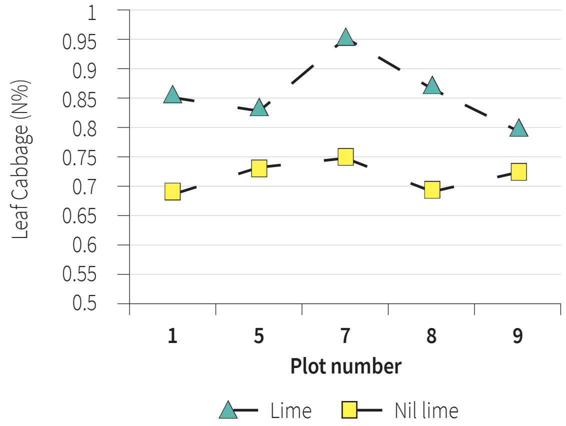


Figure 9: R1 leaf cabbage nitrogen concentration was higher in all limed plots compared to un-limed plots.

Similar results were achieved for N concentration of millable stalk except for plots 1 and 5 where the un-limed plots had marginally higher N concentrations in Figure 10.

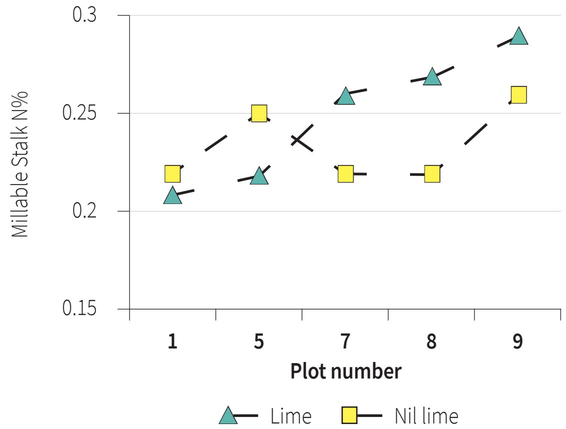


Figure 10: R1 millable stalk nitrogen concentration were generally higher in limed plots compared to the un-limed plots.

Moisture sampling in the root zone of all plots was conducted at the conclusion of the trial. In all cases, the soil moisture content of the limed plots was below that of the un-limed plots as demonstrated in Figure 11.

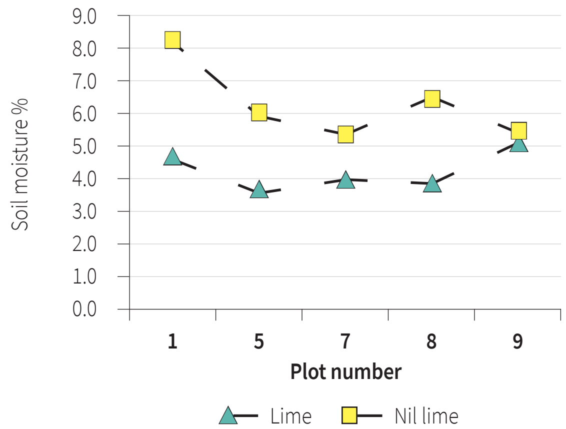


Figure 11: Improved soil moisture utilisation in limed plots attributed to enhanced root functionality.

Soil moisture analysis results indicate that amelioration of acidic soils and addressing low calcium levels improve the functionality of root systems thereby enhancing the utilisation of soil moisture and nutrients.

A reduction in N rates (115 kg N/Ha) to offset improved nitrogen mineralisation and enhanced moisture and nutrient uptake in lime ameliorated plots reduced crop lodging and had a statistically significant influence in cane yield with the limed out-yielding un-limed plots by over 16% (136 and 117 t/ha respectively). Despite the reduced N rate the un-limed plots had significantly higher CCS values than limed counterparts (14.8 and 13.9 respectively). The limed plots had an average sugar yield of 18.9 t/ha compared to 17.2 t/ha for the non-ameliorated plots.

N application rates were maintained at 115 kg N/ha with an additional zero N treatment incorporated into the trial (Plots 2, 6, 11 and 12) for limed and un-limed counterpart plots in the R2 crop. No mid-season lodging was observed however, improved canopy closure was evident in the 115 kg N/ha limed plots compared to the un-limed treatments. Lodging assessments undertaken at harvest showed that significant late lodging had occurred in the limed plots (Figure12a). Average lodge ratings for lime treated plots were 3.2 compared to un-ameliorated plots ratings of 1.2

Figure 12a: Late season lodging of lime treated plots in R2. Erect growing, Zero N lime treated plot indicated by arrow.

T

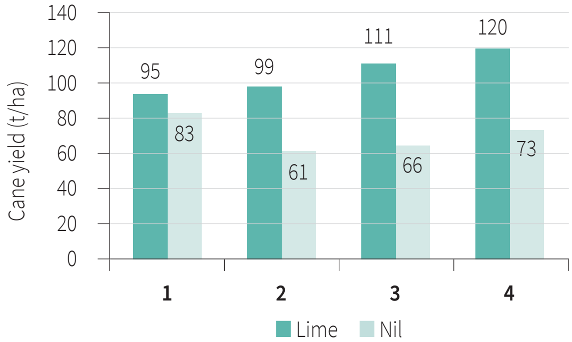
Figure 12b: Un-limed plot counterparts displayed no lodging issues.

The late season lodging in the limed plots was attributed to unseasonal rainfall mid-June and July. The late season lodging is unlikely to have unduly influenced the yield potential of the limed plots.

Although statistical analysis showed no significant difference in cane yield between treatments for the R2 crop, in all plot replicate the lime treatments achieved higher cane yield that the un-limed counterparts (117 t/ha) and 94 t/ha respectively). Average CCS values were similar (16 and 15.5 respectively) while the sugar yield of the limed plots were statistically higher than the un-limed treatments (18.7 t/ha and 14.6 t/ha respectively).

In the zero N treatments, yields were higher in the lime treated plots compared to the un-limed plots with average cane yields of 106 t/ha for the limes plots and 71 t/ha for the un-ameliorated plots (Figure 13).

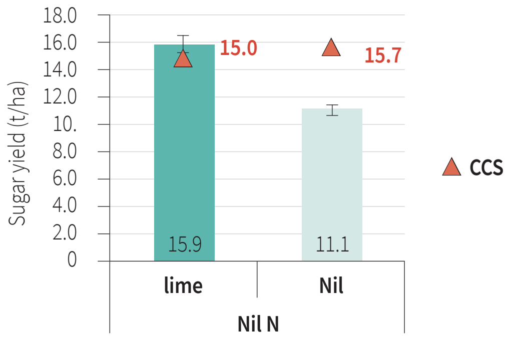
Figure 13: The limed, zero nitrogen treatments compared to the un-ameliorated counterparts across 4 replicates.



The relatively high yields achieved in the limed zero N treatments are notable given the reduced N rates (115 kg n/ha) applied to the R1 crop. The yield results from the zero N treatments on un-ameliorated plots provide an insight into the injurious effects of low pH and low calcium levels on soil biota and the detrimental impact on the mineralisation process. Soil tests results from the trial showed OC levels ranging from 0.49% to 0.61% which constitutes a low N mineralisation index based on 6ES criteria: It is interesting to note the significant capacity of soils with low OC levels to provide sufficient N to produce cane yields in excess of 100 t/ha with relatively low N inputs of (115 kg/ha and nil N/ha respectively)over a two season timeframe where ameliorated soil conditions and moisture regimes support the mineralisation and nutrient cycling processes.

CCS levels of the limed zero N treatments were lower than the zero N un-limed treatments across all replicates (average of 15 and 15.7 respectively), however sugar yields were significantly higher in the limed, zero N treatments (Figure 14)

Figure 14: The zero N limed treatments achieved a 43% increase in sugar yield (t/ha) compared to the zero N un-limed treatments.



It is also noteworthy that the average limed zero N treatments produced a higher cane yield than the un-ameliorated plots that received 115 kg N/ha (106 t/ha and 94 t/ha respectively).

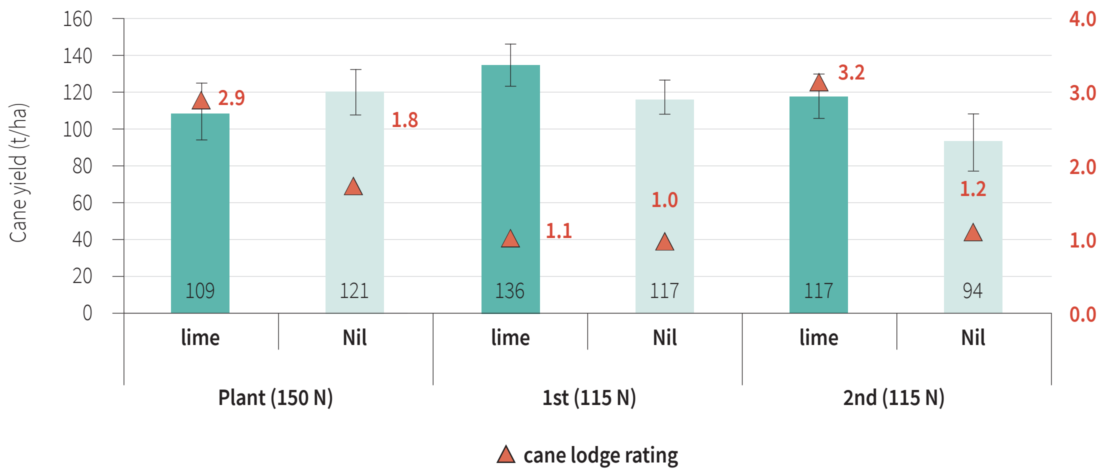
Implications for growers

The results of this three year trial provide a clear insight into the detrimental effects of low pH and low calcium levels on the mineralisation process and the overall functionality of the sugarcane root system. It is also evident that when these constraints are mitigated through amelioration with lime the release of additional mineralised N can result in crop lodging (impacting on yield) and reduced CCS levels. The results of this trial indicates the potential to manipulate N inputs to better manage crop lodging where the mineralisation process is enhanced through the amelioration of acidic low calcium soils with relatively high aluminium saturation.

In the plant cane crop (although not statistically significant) the un-limed plots achieved 11% higher average yield than the limed counter parts with N inputs based on 6ES guidelines. The poorer yielding limed treatment was attributed to early lodging which was observed in mid-May and confirmed at harvest when lodging assessments were undertaken.

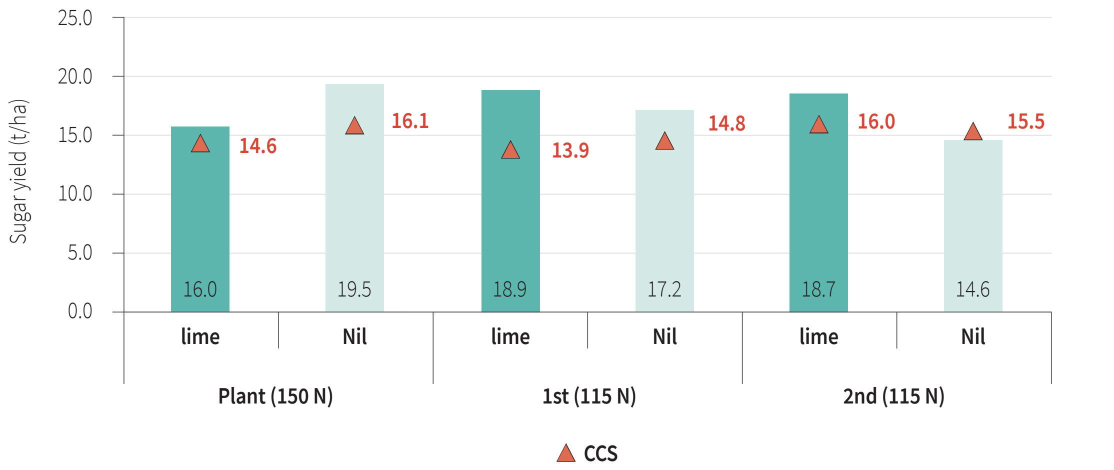
By reducing N inputs to 115 kg N/ha in the R1 crop, lodging was effectively controlled with the limed plots significantly out-yielding the un-limed counterparts by 16%. Nitrogen inputs were maintained at the reduced rate of 115 kg N/ha in the R2 crop with the average limed plots yielding 24.5% higher than the average yield of the un-limed plots. In-season field observations and lodging assessments conducted at harvest showed increased lodging of the limed plots however this occurred late in the crop growth stage following a winter rainfall event and did not impact on the yield potential of the limed plots (Figure 15).

Figure 15: 3 year yield data effect of amelioration on cane yield where lodging is managed through N input to offset additional N through enhanced mineralisation. (NB: timing of lodging has an effect on yield results)



Trial data showed that additional N in the limed plots from enhanced mineralisation significantly depressed CCS particularly in the plant cane crop where N rates were based on traditional industry guidelines. The depressed CCS levels in ameliorated plots was also evident in R1 crop, however by the R2 crop there was no significant difference in CCS between limed and un-limed treatments which possibly indicates the depletion of N reserves through the mineralisation process in the ameliorated plots over the 1st and 2nd ratoon timeframe (Figure 16). The ability of ameliorated low OC soils (average 0.56% OC) to provide significant amounts of N over two production seasons is noteworthy. This is somewhat reinforced by the results of the zero N treatments in the 2nd ratoon crop where a 1.5 fold increase in cane yield was achieved in the ameliorated plots compared to the un-limed counterparts (106 t/ha and 71 t/ha respectively) and this was despite the relatively low N inputs of the previous ratoon crop.

Figure 16: Average CCS values were significantly lower in ameliorated plots in plant cane and R1 which is attributed to the availability of additional N from enhanced mineralisation activity. R2 CCS values were similar indicating a possible run-down of soil N reserves in the ameliorated plots.



Does it pay?

Three years of trial results show the detrimental effects of early crop lodging on final yield and CCS and the influence of N inputs and N uptake on crop lodging. Results from N mulch analysis in the plant and R1 crops indicate that the amelioration of acidic, low calcium soils can result in additional N being available for plant uptake and may be attributed to a number of factors:

- Enhanced nutrient cycling (particularly N) through the mineralisation process due to an improved environment for soil microbial activity
- Improved functionality of sugarcane root systems facilitating enhanced uptake of nutrients and available soil moisture

It is recognised that effective management of crop lodging in sugarcane is difficult given the variability of seasonal conditions, however this trial shows the potential for manipulating N rates to better manage crop lodging particularly where amelioration can influence the availability and uptake of additional N. In the un-limed ratoon cane the reduced N rates (115 kg N/ha) was insufficient to optimise yield although it could be argued that achieved CCS levels were acceptable. In contrast, the reduced N inputs in the ameliorated ratoon plots may have been close to optimal (with additional N being supplied from the organic pool). In the case of the ameliorated ratoon plots, recognition of enhanced mineralisation capacity (and additional N supply) allows for N rate manipulation to optimise yield and CCS.

In the R2 crop it appears that the reduced N rate(115 kg N/ha) may have been close to the optimum application rate as crop remained erect until the end of the active growing season and CCS levels were on par with the un-limed plots.

With the widespread usage of urea as a N source, the acidification of sugarcane lands will continue. Further research is required to better calibrate the effects of low pH and low calcium on soil mineralisation capacity in association with variations in OC levels. Results from this trial indicate that manipulation of N rates to control crop lodging (particularly when soil pH and calcium levels are considered) has the potential to significantly influence yield and CCS values in the Central cane growing region. In addition, crop damage from machine harvesting of lodged crops can also significantly compromise the yield of the subsequent ratoon crop. From a nitrogen use efficiency (NUE) perspective, an understanding of the factors that influence the mineralisation process (and N contributions) is pivotal in optimising N rates and refining the 6ES guidelines for N inputs.

An additional trial – the 'Staggered N rate trial', has been established to determine the effects of N rates on lodging, yield and CCS in highly productive alluvial soils in the Central Queensland region. This long term trial will provide an indication of how long nitrogen from the organic pool can be utilised before depletion occurs. The results of 'Staggered N rate' trial will be assessed in conjunction with results reported in this trial.

Acknowledgements

These trials were funded through the Queensland Government Reef Water Quality Program.

Trial Details

Location:	Septimus
Region:	Central
Crop:	Sugarcane
Variety:	Q240
Soil Type:	Gargett, Yellow-gleyed podzolic soil

Fallow management trial - Bundaberg

Neil Halpin, Bill Rehbein, Ken Bird and Angela Marshall
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

What is the best rotation option?

Key Findings

1. All legumes significantly reduced Lesion nematodes
2. Peanuts provided the highest gross margin; and contained 90kgN/ha in the crop residue

Background

During a growers meeting in Bundaberg in 2017, growers questioned the potential of using peanuts instead of legumes, to maximise their sugarcane productivity. Some growers had observed better sugarcane growth (an increase of 10 tonnes cane/ha) following Kairi peanuts than Holt; others believed that sugarcane productivity was superior following peanuts than soybeans.

Treatments

In an attempt to address this issue, a replicated field trial (randomised complete block design) was established to answer the broad research question ‘what is the best legume to grow in my sugarcane farming system?’ However, ‘best’ could be the most financially rewarding, the crop that provides the most nitrogen to the subsequent crop, or even the crop that minimises plant parasitic nematode populations.

The trial investigated the following 10 treatments:

- Kairi – peanuts
- Holt – peanuts
- 2B35-808 – soybean
- A6785 – soybean
- Jade – mungbean
- Onyx – mungbean
- Sunrise – pigeon pea
- Red Caloona – cowpea
- Bare Fallow
- Continuous cane

Plots were five cane rows (1.83 m) wide by 30 m long and treatments were randomly allocated to plots within three replicate blocks. Prior to establishing the legume crops the site was sampled and gypsum was applied at 2t/ha to improve the soil calcium/magnesium ratio.

The cane stool was destroyed by two rotary hoe operations, with solubor (2kg/ha) and sodium molybdite (500g/ha) sprayed on the soil surface in between rotary hoe operations. The final bed geometry was achieved by ripping the bed area only with a three tyne ripper and waisted crumble roller and the wheel tracks left un-cultivated.

The legume crops were planted with four rows/bed configuration and fertilised with LegumeMax at 370kg/ha. The site was irrigated with a high pressure travelling irrigator; a summary of crop inputs is listed in Table 1. The peanut, soybean, mungbean and pigeon pea crops were grown through to grain and harvested. Red Caloona cowpea was grown as a green manure crop and therefore it didn’t generate an income.

Table 1: list of inputs for the different crops

Inputs/ # of	Peanuts	Soybean	Mung beans	Pigeon pea	Caloona Pea
Land prep	4	4	4	4	4
Basal Fertiliser	1	1	1	1	1
Trace element	2	2	2	2	2
Plant	1	1	1	1	1
Fungicides	6	0	0	0	0
Insecticides	2	6	5	4	1
Herbicides	3	3	3	3	2

Total dry matter production at physiological maturity was determined by destructively sampling a 1.83 m2 quadrat from each plot with samples placed in a dehydrator at 60 deg C until constant dry weight was achieved. After obtaining the dry-weight of the sample, a sub-sample of approximately 12 plants taken and weighed, the plant hand-threshed into grain and material other than grain components (residue), grain weight recorded and expressed as a percentage of total dry matter thereby providing a harvest index. The grain and residue components were then ground to <2mm and sent for analysis to determine N concentration (TKN).

Crop productivity was determined via KEW small plot threshers to provide 'commercial yields'. The grain from the soybean, mungbean and pigeon pea plots were sent to 'Bean Growers Australia' to provide a grade / crop price to allow gross crop value and gross margin determination. The peanut samples were taken to the DAF Kingaroy research facility, cleaned of dirt and extraneous matter, weighed and a 1,000g sub-sample hulled and graded to determine payment pricing based on the 2017 PCA contract; enabling yield, gross crop value and gross margin calculations

Results

Statistical analysis demonstrated that peanuts had the highest gross margin irrespective of variety ($3,176/ha); soybean and pigeon pea were the next most profitable ($664/ha). Mungbean variety Onyx ($119/ha) was significantly more profitable than Jade ($-597/ha). Since both Red Caloona cowpea and the bare fallow didn't generate an income, they had a negative gross margin. The extremely low cane productivity (~40 t/ha) combined with the low sugar price resulted in a negative gross margin for the cane treatment (Table 2).

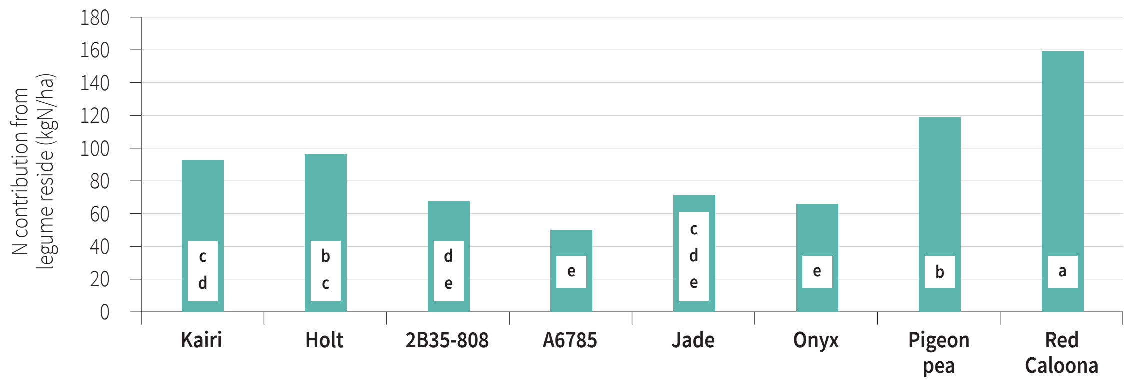
Table 2: Treatment effect on gross margin, yield, amount of crop residue and nitrogen contribution of the legume residue.

Treatment	Gross margin ($/ha)	Crop yield (t/ha)	Crop residue (t/ha)	Nitrogen contribution of residue (kgN/ha)
Kairi – peanut	3,156 ^{a}	6.73 ^{a}	5.99 ^{cd}	92.0 ^{cd}
Holt – peanut	3,196 ^{a}	6.66 ^{a}	6.95 ^{bc}	96.0 ^{bc}
2B35-808 – soybean	569 ^{b}	3.71 ^{c}	6.55 ^{bcd}	66.7 ^{de}
A6785 – soybean	689 ^{b}	4.29 ^{b}	5.60 ^{de}	49.7 ^{e}
Jade – mungbean	-567 ^{d}	1.17 ^{f}	5.42 ^{de}	71.7 ^{cde}
Onyx – mungbean	119 ^{c}	1.64 ^{e}	4.60 ^{e}	65.7 ^{e}
Sunrise – pigeon pea	733 ^{b}	2.18 ^{d}	9.30 ^{a}	118.7 ^{b}
Red Caloona cowpea	-503 ^{d}	-	7.54 ^{b}	158.3 ^{a}
Bare fallow	-553 ^{d}	-	-	-
Continuous cane	-795 ^{e}	-	-	-
P Value	<0.001	<0.001	<0.001	<0.001
LSD (P=0.05)	228	0.42	1.27	25.9

Values in columns followed by the same letter are NOT statistically different (P=0.05)

Sunrise pigeon pea generated the greatest crop residue levels (9.3 t/ha) and mungbean, irrespective of variety, the least (5.0 t/ha) (Table 2). Red caloona cowpea provided the greatest amount of nitrogen in crop residue (158 kg N / ha) due to the grain not being harvested, while soybean hand mungbean provided the least N (58.2 and 68.7 kg N / ha, respectively). The peanut crops returned 94 kg N / ha to the farming system in the crop residue (Figure 1). Please note that these values are only the nitrogen contribution in the above-ground biomass. The Six-Easy-Steps process also factors in another 30% nitrogen to account for the N in the root system and nodules.

Figure 1: Nitrogen contribution from the residue of the different legumes



Treatments with the same letter are not statistically different (p=0.05)

The two most important plant parasitic nematodes in sugarcane farming systems are root knot and lesion nematodes. All the legume options reduced the pressure of lesion nematodes relative to continuous cane (Table 3). There was a large variation in the population of root knot nematodes with the various legume options; peanuts were the only legumes, along with bare fallow, to have statistically fewer root knot nematodes than continuous cane (Table 3).

Table 3: Treatment effect on plant parasitic nematode populations/200 mL soil. Values are log (x+1) transformed counts with back-transformed means in parentheses.

Treatment	Lesion		Root-knot	
	Log Transformed	Back-Transformed mean	Log Transformed	Back-Transformed mean
Kairi – peanut	1.27 d	(2.6)	1.25 de	(3)
Holt – peanut	1.29 d	(2.6)	0.73 e	(1)
2B35-808 – soybean	2.66 bcd	(13.3)	3.69 bcd	(39)
A6785 – soybean	3.58 bc	(34.7)	3.48 bcd	(32)
Jade – mungbean	1.48 cd	(3.4)	6.09 ab	(439)
Onyx – mungbean	2.28 bcd	(8.7)	7.22 a	(1,361)
Sunrise – pigeon pea	2.58 bcd	(12.1)	2.72 cde	(14)
Red Caloona cowpea	1.20 d	(2.3)	3.91 bc	(49)
Bare fallow	4.03 ab	(55.4)	1.13 de	(2)
Continuous cane	5.95 a	(382)	5.22 abc	(184)
P Value	0.005		<0.001	
LSD (P=0.05)	2.22		2.62	

Values in columns followed by the same letter are NOT statistically different (P=0.05).

Stunt, Stubby, Ring and Dagger are considered moderately pathogenic. Stunt and Dagger (data not shown) nematodes were of low numbers and there were no statistically significant treatment effects to report. Whilst not statistically significant there was a clear trend for peanuts to increase the densities of Ring nematode relative to continuous cane and there was a trend for Kairi to host more Ring nematodes than Holt (Table 4). Cowpea, pigeon pea, mungbeans and soybean variety A6785 hosted significantly less Ring nematodes than the cane and peanut plots.

Whilst there was a trend for all legumes to reduce Stubby nematode populations, Onyx mungbean and both of the soybean varieties were not statistically different to the continuous cane treatment. Variety Holt peanut hosted the lowest levels of Stunt nematodes.

Table 4: Treatment effect on plant parasitic nematode populations/200 mL soil. Values are log (x+1) transformed counts with back-transformed means in parentheses.

Treatment	Stubby		Ring	
	Log Transformed	Back-Transformed mean	Log Transformed	Back-Transformed mean
Kairi – peanut	1.27 d	(3)	7.35 a	(1,559)
Holt – peanut	0.46 d	(1)	6.33 ab	(559)
2B35-808 – soybean	3.79 ab	(43)	2.84 cde	(16)
A6785 – soybean	3.84 ab	(46)	0.98 e	(2)
Jade – mungbean	3.04 bc	(20)	2.59 de	(12)
Onyx – mungbean	4.62 ab	(101)	1.50 de	(4)
Sunrise – pigeon pea	3.12 bc	(22)	1.18 de	(2)
Red Caloona cowpea	2.00 cd	(6)	0.0 e	(0)
Bare fallow	1.94 cd	(6)	4.12 bcd	(60)
Continuous cane	5.08 a	(159)	5.72 abc	(302)
P Value	<0.001		<0.001	
LSD (P=0.05)	1.61		2.96	

Values in columns followed by the same letter are NOT statistically different (P=0.05).

Does it pay?

All legumes significantly reduced Lesion nematodes compared to continuous cane; remember nematode surveys in the 1990's demonstrated nearly every cane paddock in Queensland had Lesion nematodes.

Peanuts provided the highest gross margin; contained 90kgN/ha in the crop residue (and another 30% in the roots and nodules); hosted the lowest numbers of Root Knot and Stubby nematodes of all the legumes tested but Peanut Variety Kairi hosted the highest number of Ring nematodes.

Soybean A6785 out yielded 2B35-808 at this site and provided 60kgN/ha in the crop residue (remember that another 18kgN/ha will be in the below-ground material). Cow pea provided the largest N contribution to the farming system, because the grain wasn't removed. Mungbean, particularly Onyx, exacerbated Root Knot Nematode populations.

At the end of the day the choice of legume break crop will depend on a growers risk profile. However, this trial has provided growers with data that will assist them in making a more informed decision.

Acknowledgements

This trial was conducted as part of the GRDC Growers solution project for coastal/hinterland Queensland and NSW North Coast project DAQ00204.

Nitrogen rates for variable rate programs on sodic soils

John Hughes
Department of Agriculture and Fisheries – Coastal Farming Systems, in conjunction with Burdekin Productivity Services.

Research Question

1. *Determine appropriate nitrogen rates for variable rate programs for sodic soils with low yield potential.*

Key Findings

1. The results from this trial show that a reduction in N rates in low yielding zones with elevated ESP levels had no negative yield implications and is a management option in a VRA program.
2. The results of this trial show that where ground-truthing of EC mapping patterns and related yield ratio maps show a reduced yield potential attributed to elevated sodic levels an opportunity exists to manipulate N rates.

Background

Nitrogen constitutes a significant input cost in sugarcane production and has been identified as a major pollutant contributing to the quality of water entering the Great Barrier Reef lagoon (Thorburn et al., 2013).

Variable rate programs in a precision agriculture (PA) system offers the potential to refine nitrogen (N) rates based on variations in yield zones within paddocks (Bramley, 2009).

In a precision agricultural context the process of applying nutrients using variable rate application technology (VRA) is well advanced. However, the uptake of VRA at an intra-paddock scale in the Central Region has been limited particularly for N inputs. From an agronomic perspective, growers may be unsure whether to increase N rates to improve yield in low performing zones of the paddock or to reduce rates based on the low yield potential of defined zones.

Access to key GIS spatial data (fine scale soil mapping layers, yield maps and digital elevation models/surface drainage mapping layers) enables an astute PA advisor to precisely ground-truth the causes of yield variability and to determine what actions and management practices can be economically implemented to manage the variability and affect change in the yield potential of a defined zone (Coventry et al, 2011).

Where economical and practical management practices are not available a PA approach provides the opportunity to potentially reduce inputs without compromising yield and improve the profitability of a defined zone and potentially improve water quality outcomes.

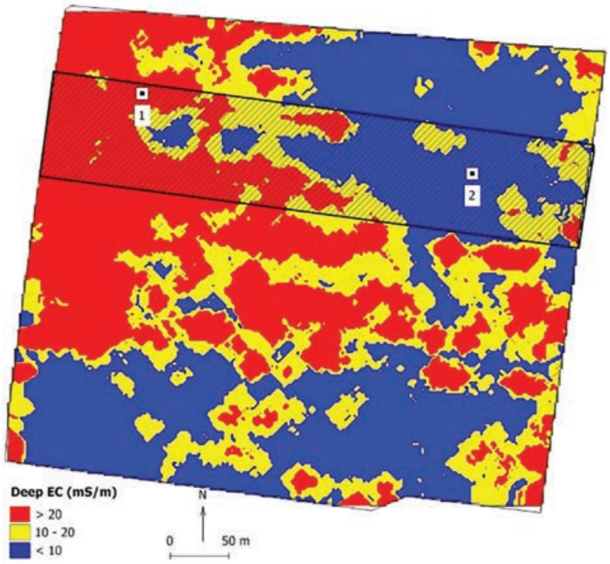
This trial investigates the potential to reduce N rates on soils with elevated levels of exchangeable sodium.

Treatments

A site in the Eton irrigation area was selected on the basis of location and suitability for determining yield response to various nitrogen rates on low yielding sodic soils.

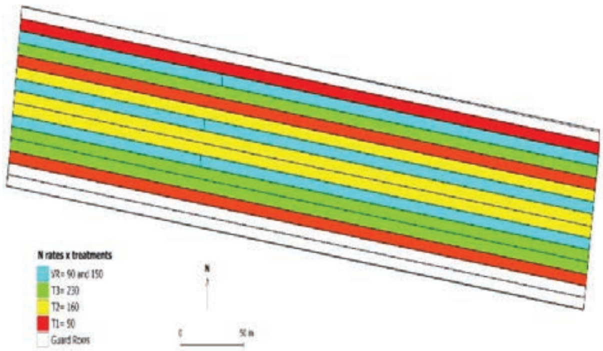
A 3.8ha bed (within the 18.3ha study)was established with variety Q208 for the trial. The deep EC surface mapping layer was used to select borehole sites to characterise the trial site (Figure 1).

Figure 1: Deep EC map and zone characterisation borehole locations showing trial site



The trial design incorporated four nitrogen treatments; 90 kg N/ha, a VRA rate of 90 kg N/ha applied to the low yielding (ESP of 6.9%) western side of the trial and 150 kg N/ha in the higher yielding eastern side of the paddock, plus a 160 kg N/ha and 230 kg N/ha with three replications per treatment. Block length plots were randomised with 3 x 1.9 m rows/plot (Figure 2).

Figure 2: Trial design showing nitrogen treatments and replicates.



The site specific soil test results were utilised to determine macro-nutrient requirements for the 1st ratoon basal application of phosphorus, potassium and sulphur using the Six Easy Steps (6ES) nutrient guidelines.

Application rates were sufficient to ensure there were no deficiencies in phosphorus, potassium and sulphur across the two management zones The balance of the nitrogen for the four treatments (90, 160 and 230 kg N/ha and VRA rates) was applied as urea using a three row electronic controlled stool splitter. The trial was irrigated five times (totalling 1.5 ML/ha) between application of N treatments and the start of the wet season period.

Measuring yield responses to the four N treatments in the two defined management zones of the trial necessitated the establishment of site specific measurement rows to facilitate the commercial harvesting of the N treatments into a mill bin mounted on a tractor drawn weigh trailer. Satellite yield ratio and EC mapping layers were used to select representative yield measurement sites for two management zones (Figure 3).

A hand-held Garmin GPS was utilised to locate the weigh bin harvest sites for each management zone. Two adjacent 20 m rows were marked out in the 1st replicate of each N treatment for the two management zones. Six stalks were randomly selected from N treatment measurement rows for small mill CCS determination

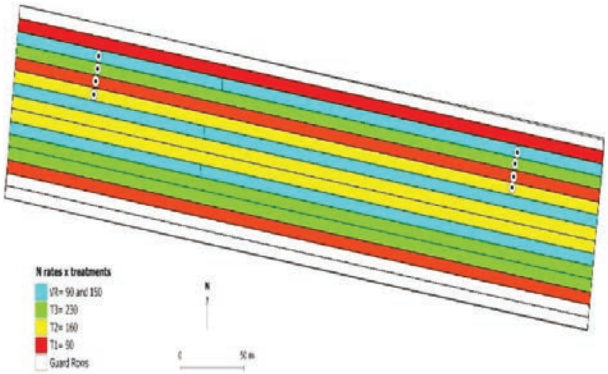


Figure 3a: Location of site specific weigh sites in relation to N treatments across management zones

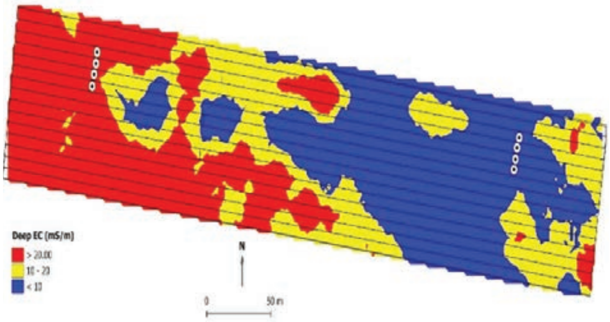


Figure 3b: Location of zonal weigh sites in relation to a five zone EC mapping layer

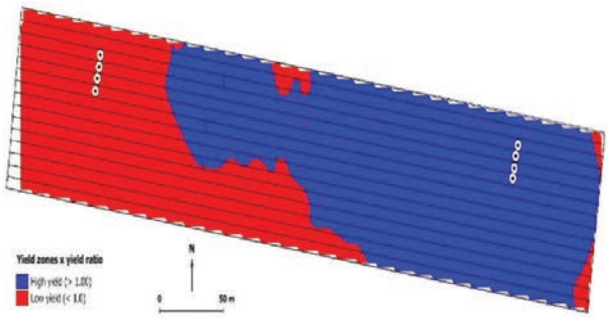


Figure 3c: Location of zone specific weigh sites in relation to yield ratio patterns with the low yielding zone (red) with elevated sodic levels on the western side of the trial site

Results

In the low yielding zone with elevated ESP levels there was no cane yield response to increasing rates of nitrogen with only1 t/ha difference in average cane yield across the N treatments. In the higher yielding section of the trial there was a 10 t/ha (13 %) cane yield increase between the variable rate treatment (150kg N/ha) and the 90 N treatment (Figure 4).

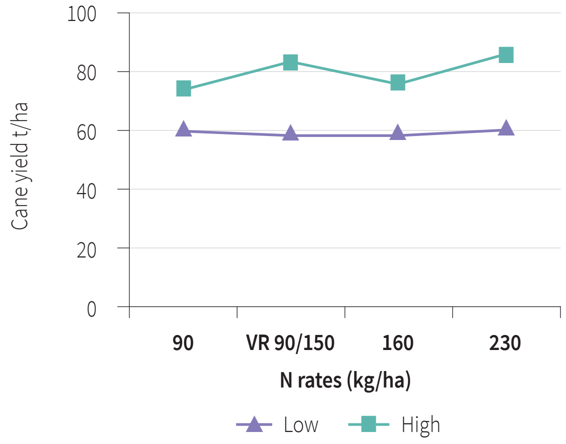


Figure 4: No yield response to increasing N rates in the sodic low yielding zone in contrast to an average 13% yield improvement between the low N rate and the variable rate of 150 kgN/ha in the higher yielding zone.

The difference in yield achieved between the variable N rate in the higher yielding zone (150 kg N/ha) and the 160 N rate is not easily explained. It is possible that the location of the site specific measurement rows for the targeted weighing of the 160 N treatments (higher yielding zone) may have had slightly elevated sodic levels.

There was little variation in CCS values across N treatments in the low yielding zone and similarly, CCS values in the higher yielding zone were similar across N treatments. However, there was a 16% increase in average CCS between the low and high yielding zones (14.2% and 16.6% respectively) which indicates that elevated salt levels in the soil contribute to a depressed sucrose content in the crop (Figure 5).

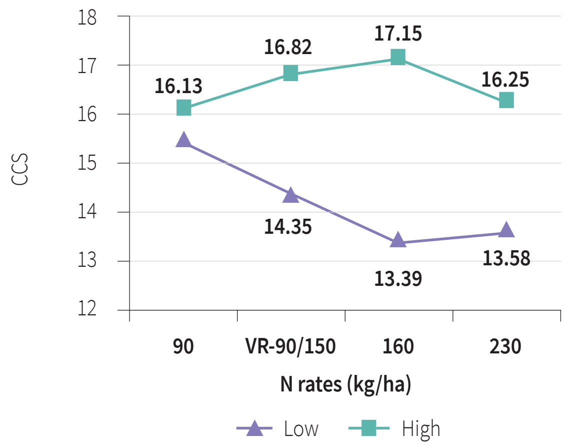


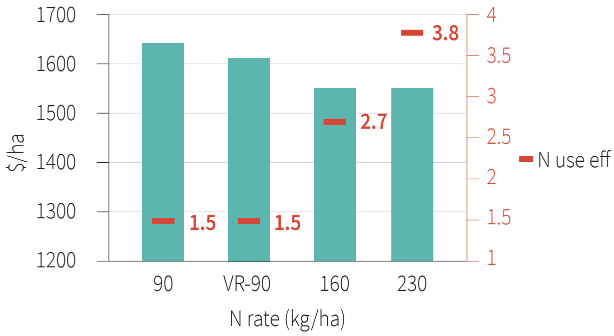
Figure 5: Variability in average CCS values across nitrogen treatments in the low and high yielding zones indicating a suppression in sucrose content attributed to elevated salt levels.

The results from this trial show that a reduction in N rates in low yielding zones with elevated ESP levels had no negative yield implications and is a management option in a VRA program. A nitrogen use efficiency improvement of 44% between the 90 N treatment and the traditional grower input rate of 160 kg N/ha was achieved in this trial.

The reduced cost of N inputs without loss of yield provides a positive financial return to the VRA grower. (Figure 6 – only N inputs costs and marginal changes in harvesting costs were used in the dollar return/ha calculations).

There would be environmental benefits with improved nitrogen use efficiency (calculated by dividing the nitrogen fertiliser by the tonnes cane) whereby the VR90 and 90kgN have a NUE of 1.5, see Figure 6. NUE values in excess of 1.8 will have an environmental loss pathway.

Figure 6: Reducing nitrogen rates in the low yielding sodic zone provided positive returns with the reduced nitrogen inputs and a significant improvement in nitrogen use efficiency.



Does it pay?

The results of this trial show that where ground-truthing of EC mapping patterns and related yield ratio maps show a reduced yield potential attributed to elevated sodic levels an opportunity exists to manipulate N rates. In the low yielding sodic section of defined two-management zone trial area there was no response to increasing N rates despite a comprehensive irrigation program over the traditional dry period.

As suggested for defined low yielding anaerobic zones, the 1.4 kg of N/tonne of cane multiplier may be a mechanism for allocating base N rates for low yield potential sodic zones within a VRA program. A base cane yield platform of 75 t/ha for a low yielding sodic zones provides a minimum N rate of 105 to 110 kg N/ha. This application rate provides some flexibility for a grower considering VRA programs and is unlikely to result in a deterioration of the yield in these defined zones.

The results from these trials and study site observations will be utilised for the refinement of N inputs in VRA programs where N rates are linked to the yield potential of soil groups with known characteristics thereby, providing an opportunity to:

- Manipulate N inputs without compromising yield
- Optimise a growers return on investment in nitrogen inputs
- Improve the quality of water leaving farms by not exceeding a crops capacity to utilise N inputs in defined zones.

Trial Details

Location:	Eton
	Central Qld
Crop:	Sugarcane
Variety:	Q208
Soil Type:	Sodic

Soil borne diseases and poor soil health microwave pot trial (Farleigh)

John Hughes
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Can microwave sterilisation of sugarcane monoculture soils and rainforest soils determine the effects of soil borne diseases and poor soil health on sugarcane productivity?

Key Findings

1. Trial results indicate that soil borne diseases associated with the current farming system have a significant impact on the functionality of the sugarcane root system and the crops ability to effectively take up nutrients and utilise soil moisture (particularly in more fragile soils).

Background

There is an increasing requirement for more astute land resource management through efficiencies in agricultural inputs in a sugar cane production system. This is necessary due to the escalating costs of nutrient inputs and the environmental imperative to improve the quality of water entering the Great Barrier Reef lagoon.

Soil was collected from old sugarcane monoculture soils (80 years in production) in the cane growing area of Farleigh in the Central Queensland region and a soil sample was also collected from an undisturbed rainforest environment. The distance between the two collection sites was 6.25 kilometres.

The cane monoculture soil was identified as a Farleigh soil and classified as Rudosol to Dermosol. No specific classification was available for the virgin rainforest soil collected from the nearby Habana area, but it can be described as shallow loamy topsoil (250mm) over yellow light clay.

The soils collected from the cane paddock had previously received mill mud at an application rate of 200 wet t/ha during the fallow period with annual applications of Dunder Liquid One Shot at 4 m^3/ha over the ratoon cycle (183 kgN/ha, 103 kgK/ha, 17.6 kgS/ha).

Treatments

The two soil group samples were split into sub samples with both sub sample groups being microwaved for seven minutes and retained in the microwave oven for a further five minutes prior to removal.

Sub samples of microwaved and untreated samples from both soil groups were placed in 20 litre containers providing 2 replicates for each treatment, namely;

T1 – Microwaved (sterilised) monoculture sugarcane soil

T2 – Untreated (non-microwaved) monoculture sugarcane soil

T3 – Microwaved (sterilised) rainforest soil

T4 – Untreated (non-microwaved) rainforest soil

Two-eyed billets of Q185 were dipped in fungicide (Shirtan) prior to planting into 20 litre containers.

Above ground biomass samples were collected from the treatments 90 days after planting and oven dried. Root systems for treatments across replicates were isolated, washed and oven dried. Dry weight measurements were calculated across treatments for above ground biomass and root systems.

Results

Trial observations at 90 days after planting (DAP) in the sugarcane monoculture soils showed significantly increased biomass in the microwave sterilised treatments compared to the untreated soil replicates (figure 1).

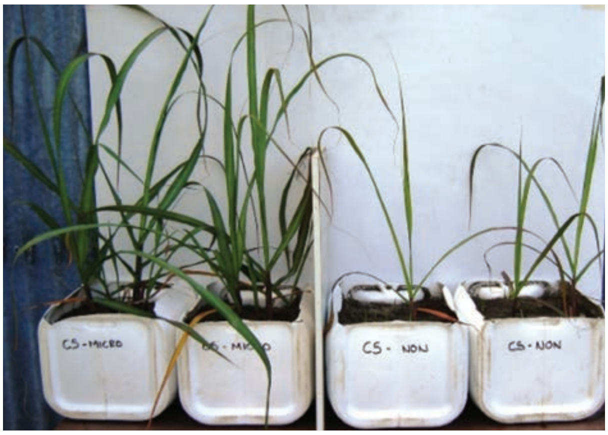


Figure 1: Growth response to microwave sterilisation of monoculture sugarcane soils (left) compared to untreated soil (right), 90 days post planting

There was nearly a five – fold increase in above ground biomass on dry matter weight basis between the sterilised soil treatment and untreated can monoculture soil (40.6g and 8.5g respectively). Similarly, there was greater than a seven-fold increase in root mass between the sterilised and untreated cane soil (21.9g and 2.9g respectively) as seen in figure 2.

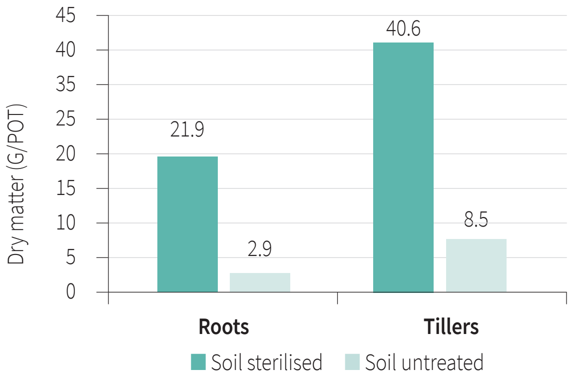


Figure 2: Positive root and tiller growth response through control of soil borne pathogens by microwave soil sterilisation

Visual observations 90 DAP of washed root systems and above ground vegetative biomass confirmed the strong growth responses to the control of soil borne pathogens in the microwaved sterilised soil replicates (Figure 3).

Figure 3: Root growth response in sterilised soil treatment (left) compared to untreated soil (right).

There was a positive two-fold response in above ground biomass to soil sterilisation in the rainforest soils (33.6g and 16.4g respectively) however the response was significantly lower than the cane monoculture soils where there was a five-fold increase in tiller yield from soil sterilisation.

There was a two-fold response in root biomass from sterilisation in the forest soils (23.9g and 10.2g respectively) compared to the seven-fold increase in root yield from sterilisation of the sugarcane monoculture soils. Above ground biomass and root yields for the sterilised sugarcane soils and sterilised rainforest soils were similar which is noteworthy given that the rainforest soils have no history of fertiliser applications. The above ground biomass yields of the untreated forest soils were nearly twice that of the untreated sugarcane soils (16.4g and 8.5g respectively). Root mass of the untreated rainforest soil was three and a half times greater than the untreated cane monoculture soils (Figure 4).

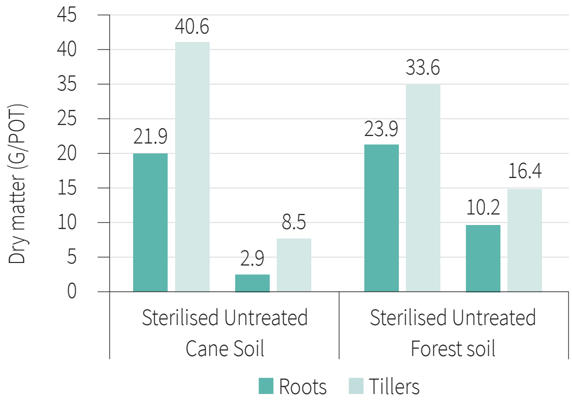


Figure 4: Comparative tiller and root biomass yields for sterilised and untreated treatments for cane monoculture soils and rainforest soils.

Visual root assessment (90 DAP) showed functional and healthy root systems in both the sterilised and untreated rainforest soil treatments indicating relatively low levels of soil borne pathogens (Figure 5). However dry matter root measurements of the treatments showed improved root mass in the sterilised rainforest soil treatments. It is noteworthy that untreated rainforest soils had a two-fold increase in their tiller yield compared to the untreated cane soil counterpart, given no history of applied fertiliser.

Figure 5: Highly functional root systems in both sterilised (right) and untreated (left) rainforest soil treatment. Root mass was greater in the sterilised treatments.

Implications for growers

The results of this pot trial emphasize the implications of poor soil health associated with a monoculture system on sugarcane productivity and the potential for negative water quality outcomes.

Trial results indicate that soil borne diseases associated with the current farming system have a significant impact on the functionality of the sugarcane root system and the crops ability to effectively take up nutrients and utilise soil moisture (particularly in the more fragile soils).

Extrapolating this experiment to consider what an impaired sugarcane root functionality means has widespread productivity, environmental and economic implications:

- Increased N and irrigation water applications to offset dysfunctional root systems ability to utilise inputs leading to a potential for increased N loss (run-off and denitrification)
- Increased pressure from adapted weed species (e.g., nutgrass, vines) resulting in increased herbicide usage with associated water quality issues
- Greater propensity for crop lodging and stool tipping
  - Increased rodent infestations and rodenticide applications
  - CCS and yield loss implications
  - Increased stool damage from harvesters
- Impaired ability to withstand insect pressure (cane grubs and soldier fly)
- Sugarcane variety breeding program is focussed on breeding variety resistance to a plethora of sugarcane specific diseases.

Trial Details

Location:	Farleigh
Crop:	Sugarcane
Variety:	Q185

Pesticides Research

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Pesticides Research and Development
Introduction

By Allan Blair

The use of herbicides containing hexazinone, diuron, ametryn, atrazine and tebuthiruron was regulated in 2010. These regulations resulted in new efforts by the Department of Agriculture and Fisheries to examine application technology of sugar cane herbicides containing diuron and to a lesser extent atrazine and hexazinone.

The results of this application research was the development of the Dual Herbicide Sprayer (DHS) and consequential field trials to test its efficacy. Most of the field work is now complete to trial and test the DHS, however some continuing improvements are still being considered. These include:

1. - Developing a tap mechanism that can turn the DHS spray bar in to an all knockdown applicator if required.
2. - Developing a process where the centre air induction nozzle can be turned off remotely when weeds are not present. This could be incorporated using weed mapping data.

Workshops demonstrating the DHS have taken place throughout the reef catchment and over 350 growers have attended to see the DHS in operation to date. Sales of DHS spray bars and new DHS sprayers have continued at a steady rate. Currently about 14,000 hectares of cane is sprayed with DHS type machines.

Where to next

Bananas and other crops are now included as an ERA (Environmentally Relevant Activity) or its equivalent under the Reef Water Quality Improvement Plan. While the Banana industry has set high standards and has its own BMP, there appears to be an issue with some protectant fungicides including chlorothalonil being found in aquatic areas. This may be due to application rates and timings as these products are applied every two weeks at times of high disease pressure and are subject to run off in rainfall. Most spray applications are applied by air. In recognition of this DAF is starting to look at possible improvements in application systems; alternatives to CP nozzles; drift and release height interactions and more. A study on the effectiveness of stickers and other adjuvants will also be useful.

The joint work with SRA on water quality is continuing and this cooperative approach between DAF, SRA and JCU is bringing about good results.

DAF continues to lead the way in pesticide best management practice through training for resellers and the development of a BMP training manual for agribusiness which is currently undergoing peer review.

Dual herbicide sprayer trial

Allan Blair
Department of Agriculture and Fisheries – Coastal Farming Systems

Research Question

Can the dual herbicide sprayer provide effective results using combinations of residual and knockdown herbicides?

Key Findings

1. The use of knockdown herbicides in the inter row in combination with residual herbicides in the row effectively controlled weeds present.

Background

Pollutants found in water flowing from creeks and waterways in the Great Barrier Reef catchment can be attributed to a number of sources. Ones of these is herbicides which can be found in concentrations that pose a significant risk to wetlands and to the quality of water entering into the Great Barrier Reef.

In an effort to reduce herbicide loads, alternatives to PSII's (and their effectiveness) are being investigated using the dual herbicide sprayer (DHS).

Banded spraying with the dual herbicide sprayer reduces the amount of pre-emergent PSII chemicals by 40-60%. In a furrow irrigated system this has attributed to up to 90% reduction in PSII herbicides detected in the tail water. The reason behind this is that these chemicals are applied only to the top of the hill through the wing nozzles which reduces the ease in which those chemicals can be moved off farm either by their solubility in water or moving with the sediment to which they are bound. These modes of loss are more likely to occur when applied in a broadcast over the hill and furrow - where the water is most likely to travel in either irrigation or flood events.

Treatments

A range of treatments using different formulations were identified to assess effectiveness. The large plot treatments were 500m in length and were 4 rows wide on 1.65m row spacing and were replicated 3 times.

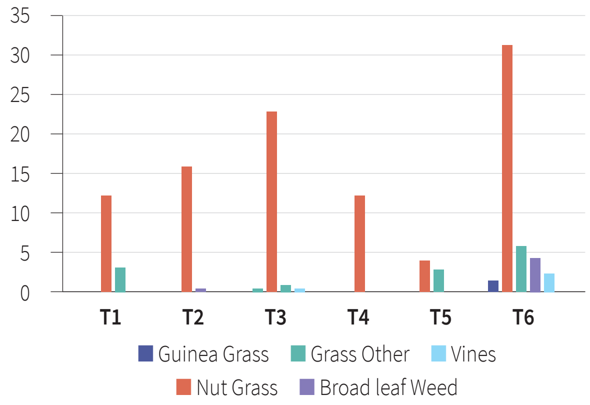
The treatments used on a 1.0 ha sprayed area (band spray area rates are label rate divided by 2) are as follows:

1. Blanket spray Bobcat Imax® @ 3.4 L/ha plus Paraquat @ 1.3L/ha in 400L water
2. DHS Glyphosate @ 1.1 L in 30 L water in centre plus Balance® @ 62.5 gm and Paraquat @ 650 ml in 125 L water in the wing.
3. DHS Basta® @ 1.0L in 100 L water in the centre plus Balance® @ 62.5 gm and Paraquat @ 650 ml in 125 L water in the wing.
4. DHS Glyphosate @ 1.1L in 30 L water in the centre plus Bobcat Imax® @ 1.7L and Paraquat @ 650 ml in 200 L water in the wing.
5. DHS Basta® @ 1.0L in 100 L water in the centre plus Bobcat Imax® @ 1.7L and Paraquat @ 650 ml in 200 L water in the wing.
6. Control – Untreated.

Results

The treatments were applied to small plots 3m long x 1.65m wide covering both the row and inter row marked out in the middle of the 4 row swath. The plots were 20m in from the start of the row at both the eastern and western end of each treatment. Weed counts were recorded for Guinea grass (GG), Nut grass (NG), Grass – other (GO), Broad leaf weeds (BL) and Vines (V) as a total averaged across the replicates for each treatment as seen in Figure 1.

Figure 1: Weed counts for the different treatments.



As there were so many zero weed counts through the treatments, total weed counts for each treatment were analysed using a generalised linear model (GLM) and found the total weed count per sampling unit (individual row plus inter row) was significantly higher in treatment 6 (Control) compared to all other treatments and treatment 4 was significantly lower compared to all other treatments (p=0.002), see Table 1.

Table 1: Statistical analysis of the average total weed count for each treatment (p=0.002)

Treatment	Weed count
T1	9.5 c
T2	9.3 c
T3	16.0 b
T4	1.3 e
T5	4.8 d
T6	43.2 a

Treatments with the same letter are not statistically different (p=0.05)

Within the GLM analysis contrasts were performed between treatments containing Glyphosate (T2 and T4) and treatments containing Basta® (T3 and T5). The resulting contrast suggested there was no significant difference between the mean for the Glyphosate treatments and the mean for the Basta® treatments (p=0.279). A second contrast was performed to compare T2 and T3 (both containing Balance® and Paraquat in the wing), with T4 and T5 (both containing Bobcat Imax® and Paraquat in the wing). The contrast was marginally significant (p=0.046), where the mean for treatments T4 and T5 combined was significantly lower than for T2 and T3 combined.

To determine if there was any effect from the use of a knockdown herbicide in the inter row on the growth of the cane, measurements were taken in March to determine the distance to the top visible dewlap. Stalk measurements were also taken between the 5th and 6th node in May.

The distance to the top visible dewlap was measurement on 5 stalks in each plot and the length between the 5th and 6th node was also recorded on 10 stalks. From these values the mean dewlap and stalk measurements were calculated for each plot. Analysis of variance (ANOVA) was used to compare the mean dewlap measurement and mean stalk measurement. The results are summarised in Table 2 below and suggest that there is no significant effect of treatment on the mean dewlap and stalk measurements.

Table 2: Analysis of mean dewlap and stalk measurements.

Treatment	Dewlap (mm)	Stalk (mm)
T1	1120	20.3
T2	*1189*	*21.1*
T3	*1109*	*19.9*
T4	*1087*	*19.9*
T5	*1081*	*20.7*
T6	1109	20.6
p-value	*0.601*	*0.795*

The results suggest the treatments have had no effect on the dewlap and stalk measurements.

Implications for growers

The results from this trial indicate growers can use the dual herbicide sprayer to safely apply knockdown herbicides in the inter row to control weeds effectively without impacting the growth of the sugarcane. This will allow growers to reduce the amount of the residual herbicides being used and in turn reduce the amount of pesticides entering waterways leading into the Great Barrier Reef.

Acknowledgements

The development and production of DHS and these trials were funded through the Queensland Government Reef Water Quality Program.

Trial Details

Location:	Mourilyan
	Wet Tropics
Crop:	Sugarcane
Variety:	Q228
Soil Type:	Sand

Appendix

Six-Easy-Steps (6ES) nutrient management guidelines have been developed for the various cane growing regions in Queensland. The basis of the guidelines is that the amount of fertiliser to be applied will vary between areas and is dependent on soils type, position in the landscape, appearance etc.

Knowledge of soil types is essential as the amount of fertiliser required will vary based on the soils and nutrients already present in the soil.

Essentially the steps are:

1. Understanding and testing the soils on your farm/in your paddock
2. Understanding the properties of each soil type and associated nutrient processes and loss pathways
3. Regular soil testing
4. Developing a nutrient management plan based on the soil test and soil type for each paddock
5. Leaf testing to ascertain if the nutrient management plan is matching crop requirements
6. Documenting the processes so that the nutrient management plan becomes a living document

Acronmyns

CS	Cane sugar
CCS	Commercial cane sugar
CR	Controlled release
(DAF)	Dept of Agriculture and Fisheries
DIN	Dissolved inorganic nitrogen
EC	Electrical conductivity
ESP	Exchangeable sodium percentage
GLM	Generalised linear model
K	Potassium
MOP	Muriate of Potash
N	Nitrogen
NIR	Near Infra Red
OC	Organic carbon
P	Phosphorus
PA	Precision agriculture
(SYDJV)	Sugar Yield Decline Joint Venture
TSPH	Tonnes of sugar per hectare
VRA	Variable rate application
6ES	Six easy steps method

For more information on any of these trails please contact the Department of Agriculture and Fisheries (DAF) at business.qld.gov.au/industries/farms-fishing-forestry/agriculture or telephone 13 25 23.