Project Catalyst Report

Groundwater Nitrate Monitoring and Reduced N rate Trial

Grower Information	
Grower Name:	Bryan Langdon
Entity Name:	Langfarm Pty Ltd
Trial Farm No/Name:	BKN-09449A
Mill Area:	Kalamia
Total Farm Area ha:	168ha
No. Years Farming:	
Trial Subdistrict:	Maidavale
Area under Cane ha:	

Trial Status
• Continuing

Background Information

Aim: To develop a site-specific nitrogen reduction rate that the grower can implement on their blocks that are irrigated with underground water high in nitrates.

Background: (Rationale for why this might work)

There are a number of growers in the Burdekin that are irrigating their sugarcane with water that is high in nitrates. This nitrogen is plant available and can be used as part of the farm's fertiliser program. There a number of issues with reducing fertiliser rates according to the amount applied via irrigation water. Firstly, the level of nitrates may vary throughout the season so there is no set amount of nitrogen that is applied to paddock per irrigation. Secondly, the number of irrigation events may be increased or decreased, depending on the annual rainfall volume and pattern. Due to this variability, developing an area wide "nitrogen-reduction-rate" for farms in areas with ground water nitrates is a difficult and inexact process. To compensate for this, monitoring the level of nitrates in irrigation water on a specific block will be conducted for 6-12 months. This data will be used to calculate the total amount of nitrogen applied to the paddock through irrigation over a season. After this, a "safe" reduction rate (or rates) will be developed and implemented in a trial, comparing it to the recommended 6 Easy Steps rate of fertiliser. There will also be a 20m strip of "Zero-N" where no fertiliser will be applied. This will be used to assess how available the irrigation-nitrates are to the crop. The trial will be reimplemented and harvested for a second year.

Potential Water Quality Benefit:

Reducing nitrogen fertiliser rates to compensate for nitrogen applied with the irrigation water, could see (in high nitrate areas) large reductions of fertiliser applied. With less fertiliser applied, there is less risk of the applied nitrogen being lost to run off/deep drainage.

Expected Outcome of Trial:

That a "safe" nitrogen deduction value will be produced for the grower, that he will be able to implement on his farm, without risks to water quality and his productivity.

Service provider contact: Billie White (0409 477 359, billiew@farmacist.com.au)

Where did this idea come from: There have been a number of ground water nitrate projects conducted in the Burdekin, though the focus has been placed on an area-wide solution. This idea was developed to provide a number of growers will safe nitrogen reduction values that are specific to their farms.

Plan - Project Activities	**Date : (mth/year to be undertaken)**	**Activities :(breakdown of each activity for each stage)**
Stage 1	**September 2016-August 2017**	- A specific block has been selected for monitoring - Regular monitoring of irrigation water samples for nitrates - The grower is keeping a record of irrigation timings and lengths in this period, for that block - A bucket a stopwatch assessment will be conducted to assess flow rate - This data will be used to assess the total amount of nitrogen being applied to the crop over the season - This data will be then used to develop a “safe nitrogen reduction”
Stage 2	**August 2017-October 2018**	- A trial will be implemented on the monitored block - This trial will compare the 6 Easy Steps rate to the reduced rate of fertiliser. There will also be a zero N treatment. - Biomass samples will be taken to assess nitrogen uptake - This trial will be harvested and the data will be analysed for differences in yield between the treatments
Stage 3	**October 2018-October 2019**	- A trial will be re-implemented on the monitored block - This trial will compare the 6 Easy Steps rate to the reduced rate of fertiliser. There will also be a zero N treatment. - Biomass samples will be taken to assess nitrogen uptake - This trial will be harvested and the data will be analysed for differences in yield between the treatments
Stage 4		
Stage 5		
Stage 6		

Project Trial site details	
Trial Crop:	Sugarcane
Variety: **Rat/Plt:**	KQ 228
Trial Block No/Name:	3-1
Trial Block Size Ha:	28.73ha
Trial Block Position (GPS):	19˚ 39’ 01.00’’ 147˚ 22’ 00.20’’
Soil Type:	Medium Clay (Sandy?)

Block History, Trial Design:

A trial has not been implemented on the block this year. 12 months of monitoring is being conducted of the irrigation water being applied to the block. A water sample of as many irrigations as possible is being taken and sent to the Hortus Technical Services Laboratory for analysis (current results below). The block is currently a first ratoon crop of KQ228.

A trial will be established on the block once the current cane has been harvested – it will compare the normal Six Easy Steps nitrogen rate to a fertiliser rate with a "safe" nitrogen reduction. There will also be a section of zero-N – this will help us assess the crop's ability to uptake the irrigation nitrates. The trial will be implemented on a second ratoon, KQ228 crop.

As of September 2017, a randomised, replicated strip trial (3 treatments, 4 replications) has been implemented on Bryan's farm. This trial is comparing 3 different N rates (125N v. 155N v. 185N). 185N is the grower's current N rate, compared to two reduced rates. The bore is still being monitored through regular water samples. A sensor has been placed at the top of the block to assist the grower in recording his irrigations.

Bryan Langdon
Ground Water Nitrates

Block	3-1
Variety	KQ 228
Ratoon	2
Date Applied	19/09/2017

Top

25m Zero N (3 rows)	T1	T2	T3	T2	T3	T1	T2	T3	T1	T3	T2	T1	
	R1			R2			R3			R4			Guard
	6	6	6	6	6	6	6	6	6	6	6	6	6
	0.5944	0.5944	0.5944	0.5944	0.5944	0.5944	0.5944	0.5944	0.5944	0.5944	0.5944	0.5944	

Bottom

Treatment	Description	Product	Rate (kg/ha)	N Rate (kgN/ha)	K Rate (kgK/ha)
1	Grower Rate (6ES-20)	CK 135 S	640	185	89
2	6ES rate - 50kgN/ha	CK 135 S	540	155	75
3	6ES rate - 80kgN/ha	Nitra King S	460	125	75
Zero N		Sulphate of Potash	200	0	83

Treatments:

No Treatments for the current season.

Results:

2016-2017 Results:

Soil Sample Analysis Summary Report

FARMACIST

Lab Sample Id	70021548
Test Code	FA2
Sample Name	1411Langdon
GPS Name	1411Langdon
Paddock Name	3-1
Sample Depth (cm)	0 - 20
Sampling Date	30/11/2014

Analyte / Assay	Units	
Soil Colour		Grey
Soil Texture		Medium Clay
pH (1:5 Water)		7.8
pH CaCl		6.5
ECSE	dS/m	0.4
EC (1:5)		0.06
Chloride	mg/kg	
Organic Carbon (OC)	%	0.63
Nitrate Nitrogen (NO3)	mg/kg	
Phosphorus (Colwell)	mg/kg	18
Phosphorus (BSES)	mg/kg	110
PBI-Col		33
Potassium (Amm-acet.)	Meq/100g	0.16
Potassium	%	1.1
Potassium (Nitric K)	Meq/100g	3.2
Available Potassium	mg/kg	
Sulphate Sulphur (MCP)	mg/kg	15
Cation Exchange Capacity	Meq/100g	14.3
Calcium (Amm-acet.)	Meq/100g	9.5
Calcium %CEC	%	
Magnesium (Amm-acet.)	Meq/100g	4
Magnesium %CEC	%	
Sodium (Amm-acet.)	Meq/100g	0.61
Sodium % of Cations (ESP)	%	4.3
Aluminium Saturation	%	0.7
Aluminium (KCl)	mg/kg	
Zinc (HCl)	mg/kg	2
Zinc (DTPA)	mg/kg	2
Copper (DTPA)	mg/kg	0.99
Iron (DTPA)	mg/kg	32
Manganese (DTPA)	mg/kg	16
Silicon (BSES)	mg/kg	1200
Silicon (CaCl2)	mh/kg	28

Min	Max

Analyses conducted by Nutrient Advantage Laboratory Services, NATA Accreditation No: 11958

02/11/2016 02:31 PM

Complete Water Test

W2 - COMPLETE WATER TEST

HORTUS TECHNICAL SERVICES

FARMACIST

Client Information

Organisation	FARMACIST PTY LTD	Analysis Request No.	W14599-W2-C-Analytical
Name	Evan Shannon/Peter McDonnell/ Billie white	Date Results Confirmed	02/11/2016 3:51PM
Agent Phone	0429837497	Purchase Order Number	
Email	evans@farmacist.com.au; billiew@farmacist.‹	The Bill for this account will be sent to:	146 Young St (Evan - 41 Cole Street, AYR) Ayr QLD 4807
Grower	Farmacist Pty Ltd	Region	World
Block Reference	Bryan Langdon	Payment Status	To be billed
Report No.	HTS1878899-02112016	Date of Report	2/11/2016

Field Information

Crop		Soil Texture		Irrigation Type	
Variety		Soil Structure		Treatment Area	0
Crop Stage		Soil Colour		Yield Goal	0.00

Method	Element	LOD	Result	Units	Optimal Range	Comment
	pH		7.0		5 - 8.5	Optimal
	EC		0.51	mS/cm	0.28 - 0.9	Suits most crops
G3a	Nitrate-N (water)		9.60	mg/L	0.5 - 10	Optimal
	Phosphate-P		0.05	mg/L	0.5 - 2	Low
L3b	Potassium (water)		2.0	mg/L	0.5 - 15	Optimal
L1b	Calcium (water)		38.0	mg/L	10 - 60	Optimal
L2b	Magnesium (water)		16.0	mg/L	10 - 100	Optimal
L4b	Sodium (water)		48.0	mg/L	20 - 150	Optimal
J1a	Sulfate-S (water)		7.7	mg/L	5 - 50	Optimal
K1a	Zinc (water)		0.00	mg/L	0.5 - 2	Low
K1a	Copper (water)		0.00	mg/L	0.02 - 0.2	Low
K1a	Manganese (water)		0.00	mg/L	0.2 - 0.5	Low
K3b	Iron (water)		0.00	mg/L	0.01 - 0.3	Low
K5	Boron (water)		0.05	mg/L	0.3 - 0.5	Low
E1a	Chloride (water)		38.0	mg/L	20 - 350	Optimal
HTSCALC	Total Dissolved Solids		326.4	mg/L	175 - 500	Irrigation Class 2

The methods of chemical test(s) included in this document are derived from:

GE Rayment and FR Higginson: Australian Laboratory Handbook of soil and water chemical methods, Inkarta Press Melbourne, 1992
GE Rayment and DJ Lyons: Soil Chemical Methods - Australasia, CSIRO Publishing Collingwood, 2011
B Cartwright, KG Tiller, BA Zarcinas and LR Spouncer: The chemical assessment of the boron status in soils. Aust. J. Soil Res. 21,321-32, 1983
MB C Haysom and GK Kingston: Soil analysis for predicting sugar cane response to silicon. Proc of the Australian Society of Sugar Cane Technologists, Poster Papers 21, 498, 1999
DW Nelson and LE Sommers: Total Carbon, Organic Carbon and Organic Matter in Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties, 2nd ed. 539-577, 1982.

Note: OC result may be affected by soils with high chloride content.

Soil Analysis: an interpretation manual edited by K.I. Peverill, L.A. Sparrow and D.J. Reuter Published by CSIRO Publishing, 1999
AOCS Ca 5a-40. Free Fatty Acids. Revised 2012
AOCS Cd 8b-90. Peroxide Value Acetic Acid-Isooctant Method. Revised 2011

Optimal Range: Chemical Thresholds pertaining to Region, Soil type, Crop, Crop Stage, Sample Type and Analyte

Optimal Range and Comment are not included in the NATA Scope and not provided by the Analyst

Measurement Uncertainties for accredited analytes are available on request.

ASPAC

"This laboratory has been awarded a Certificate of Proficiency for specific soil and plant tissue analyses by the Australasian Soil and Plant Analysis Council (ASPAC). Tests for which proficiency has been demonstrated are highlighted in each report." * indicates elemental analysis certified by ASPAC

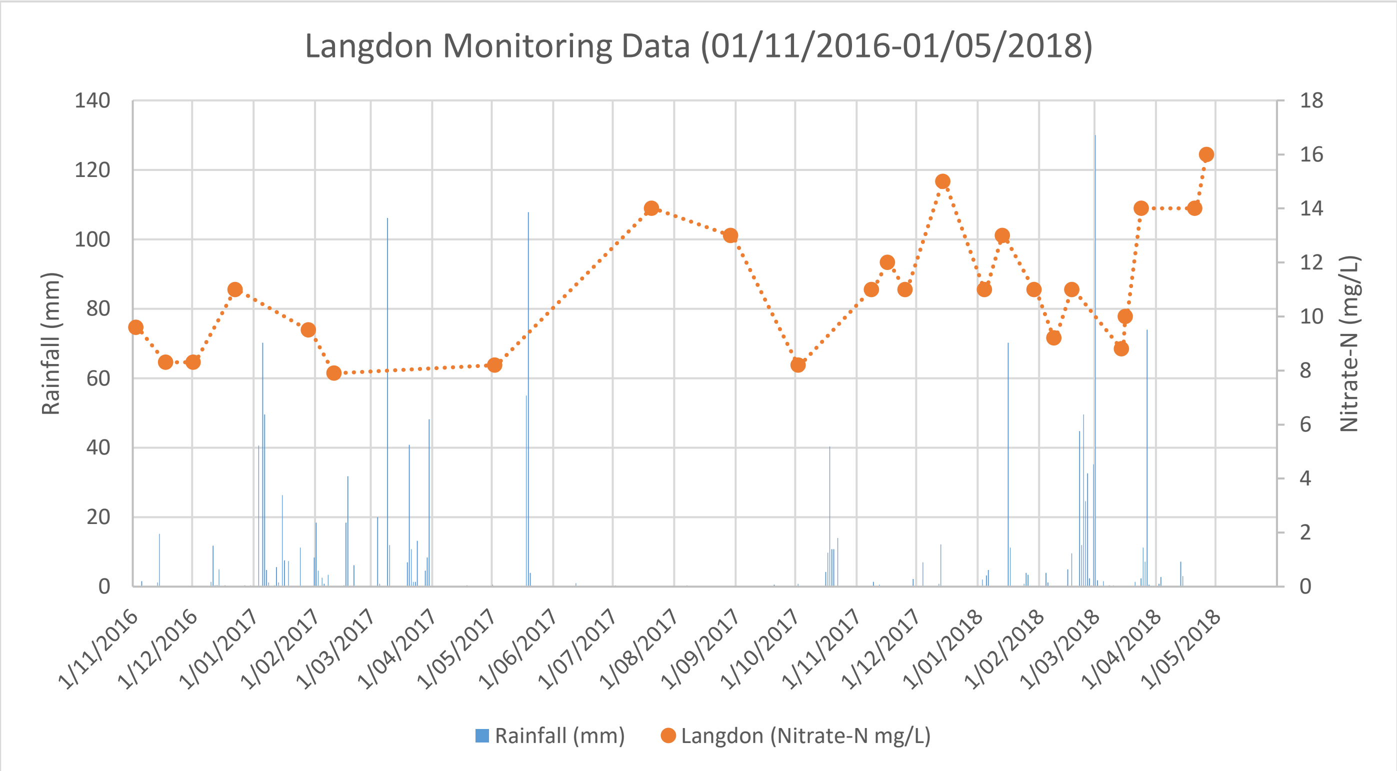
Signatory

Angela Hanke - Analyst

Monitoring Data:

Date	Nitrate-N Level (mg NO3-N/L)	kgN/ha applied per irrigation (using a ML/ha value of 0.8ML/ha)
2/10/2017	8.2	6.56
8/11/2017	11	8.8
16/11/2017	12	9.6
25/11/2017	11	8.8
13/12/2017	15	12
18/12/2017	11	8.8
26/12/2017	11	8.8
4/01/2018	11	8.8
13/01/2018	13	10.4
29/01/2018	11	8.8
8/02/2018	9.2	7.36
17/02/2018	11	8.8
14/03/2018	8.8	7.04
16/03/2018	10	8
24/03/2018	14	11.2
20/04/2018	14	11.2
26/04/2018	16	12.8
14/05/2018	9.8	7.84
Approximate kgN/ha applied through irrigation water		165kgN/ha

Approximate volume of water applied per irrigation:
0.86ML/ha



Cane Yield

There was a 11.21tC/ha difference between the highest yielding treatment (T2 155N, 178.52) and the lowest yielding treatment (T3 125N, 167.31). At P=0.05, there was no significant difference between the cane yield results of year treatment. When the probability value is increase to 0.15, there was a significant difference between the results. T2 (178.52) yielded significantly higher than T3 (167.31). There was no significant difference between T1 (174.81) and either of the other treatments.

The significant difference at P=0.15 and not at P=0.05, indicates that we can be 85% sure that the cane yield results are due to the treatments, but we cannot be 95% sure (P=0.05).

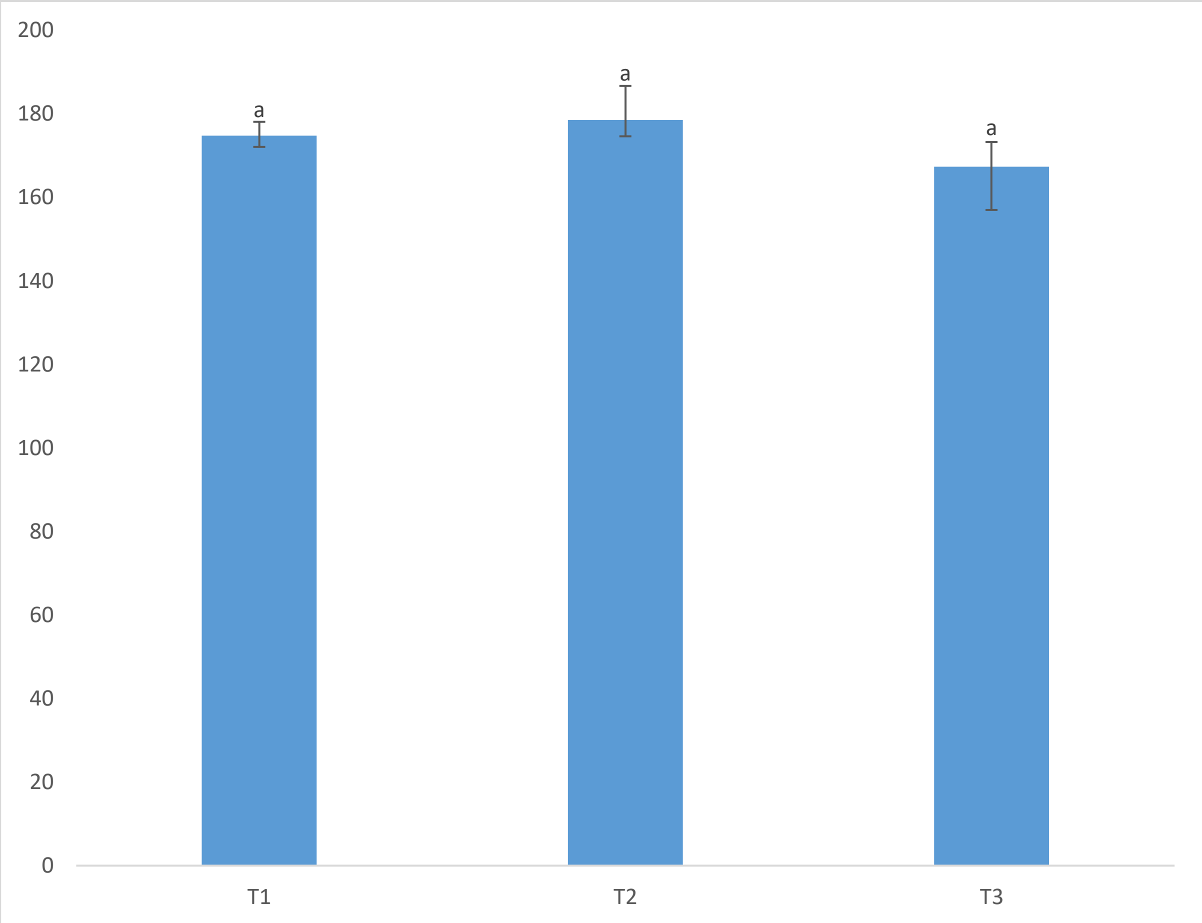


Figure 1 Treatment Cane Yield Results (tC/ha) (P=0.05)

Table 1 Treatment Cane Yield Results (tC/ha)

Treatment	tC/ha	P=0.05	P=0.15
T1 (185N)	174.81	a	ab
T2 (155N)	178.52	a	a
T3 (125N)	167.31	a	b
Prob (F)		0.1227	0.1227

CCS

There was a 0.25-unit difference between the highest CCS treatment (T2 155N, 13.89) and the lowest CCS treatment (T1 185N, 13.64). At P=0.05, there was no significant difference between the cane yield results of year treatment. When the probability value is increase to 0.15, there was a significant difference between the results. There was no significant difference between T2 and T3 (13.89 and 13.86 respectively); however, both treatments were significantly higher than T1 (13.64).

The significant difference at P=0.15 and not at P=0.05, indicates that we can be 85% sure that the CCS results are due to the treatments, but we cannot be 95% sure (P=0.05).

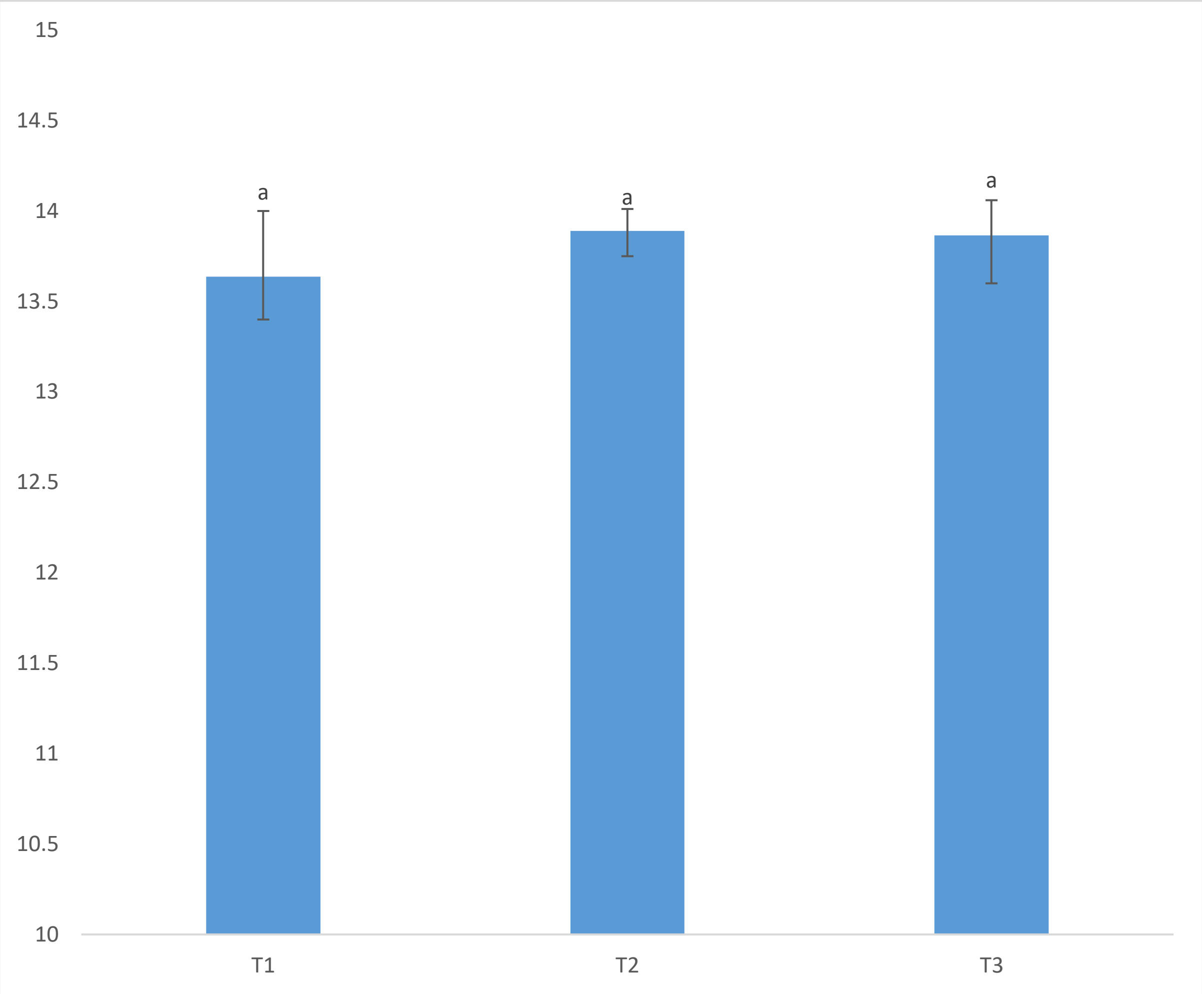


Figure 2 Treatment CCS results (P=0.05)

Table 2 Treatment CCS Results

Treatment	CCS	P=0.05	P=0.15
T1 (185N)	13.64	a	b
T2 (155N)	13.89	a	a
T3 (125N)	13.86	a	a
Prob (F)		0.1191	0.1191

Sugar Yield

There was a 1.59tS/ha difference between the highest yielding treatment (T2 155N, 24.79) and the lowest yielding treatment (T3 125N, 23.20). At P=0.05, there was no significant difference between the cane yield results of year treatment. When the probability value is increase to 0.15, there was a significant difference between the results. T2 (24.79) yielded significantly higher than T3 (23.20). There was no significant difference between T1 (23.84) and either of the other treatments.

The significant difference at P=0.15 and not at P=0.05, indicates that we can be 85% sure that the sugar yield results are due to the treatments, but we cannot be 95% sure (P=0.05)

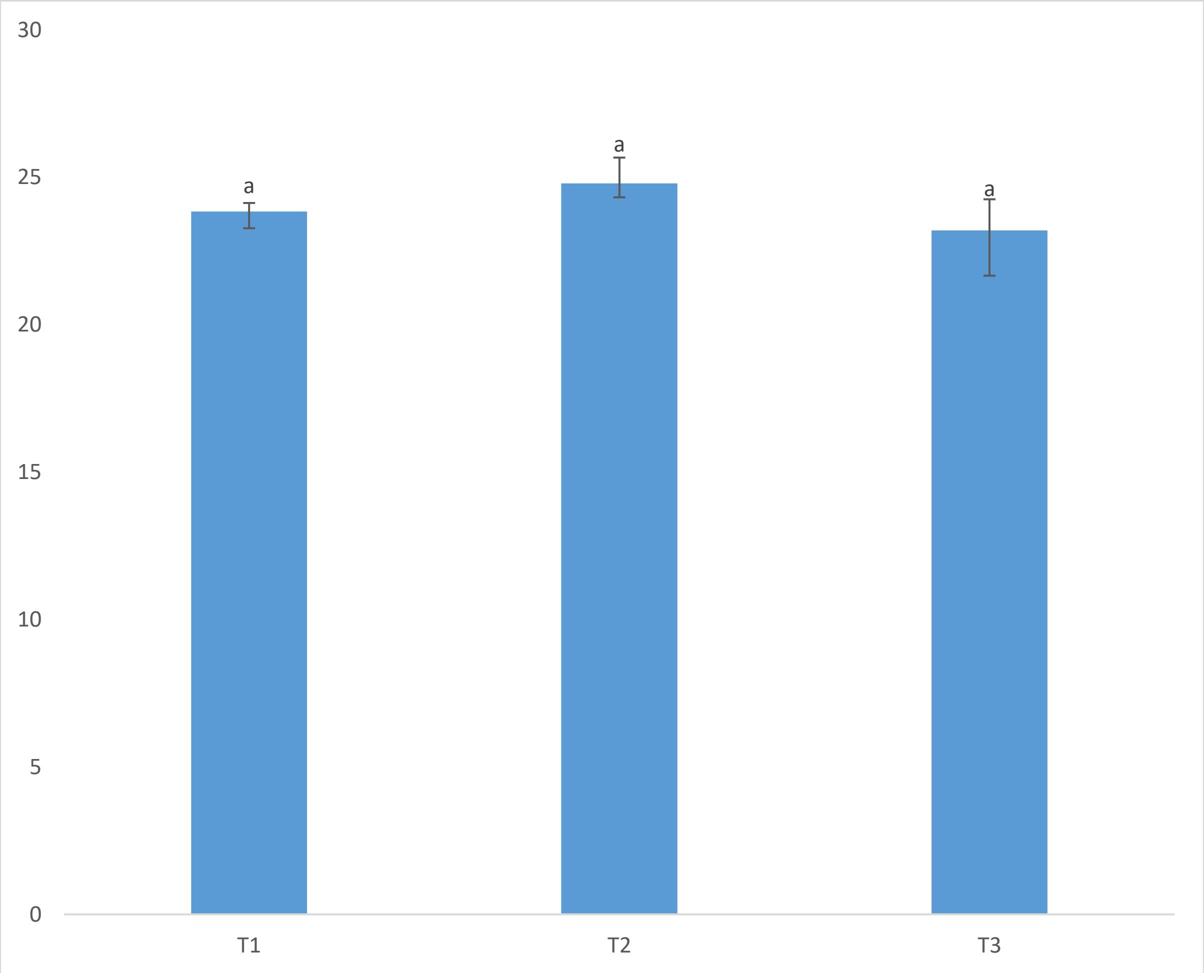


Figure 3 Treatment Sugar Yield results (tS/ha) (P=0.05)

Table 3 Treatment Sugar Yield Results (tS/ha)

Treatment	Sugar Yield (tS/ha)	P=0.05	P=0.15
T1 (185N)	23.84	a	ab
T2 (155N)	24.79	a	a
T3 (125N)	23.20	a	b
Prob (F)		0.1012	0.1012

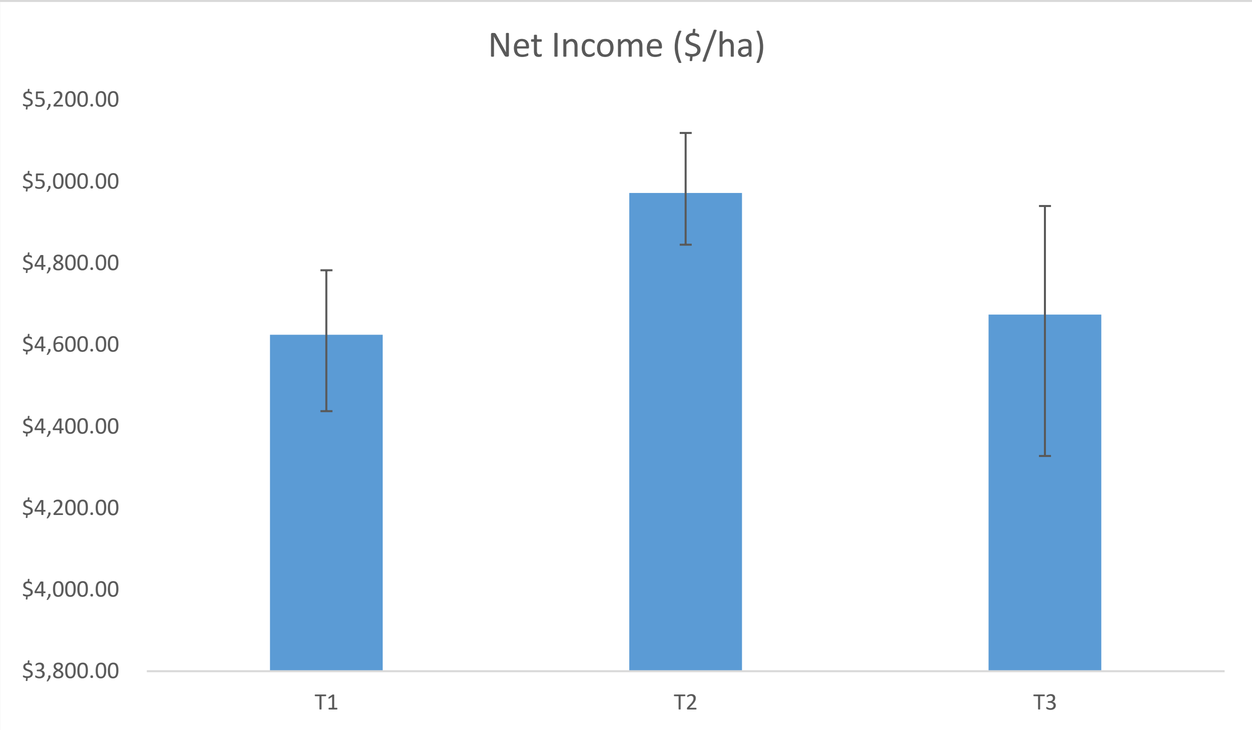
Economic Data:

Using the following figures:

Sugar Price	$420/tonne of sugar
Levies and Harvesting	$8.11
Fertiliser Prices	(Landmark, as of 10/9/2018)
CK 134 (S)	$690.00 (incl. GST)
Nitra K (S)	$693.92 (incl. GST)

Net Income:

(Gross income – (fertiliser costs + harvesting costs and levies) = Net Income)



Treatment	Average Net Income ($/ha)
T1	4623.63
T2	4970.13
T3	4673.25

- **Approximately $300/ha difference between 155N and the other two N rate (185N and 125N)**

The trial has been reimplemented for a 2019 harvest. Yield data to be assessed will be tonnes of cane per hectare, CCS and tonnes of sugar per hectare. The trial will be biomass sampled at 9months (post fertiliser application) to assess each treatment for nitrogen uptake.

Conclusions and comments

The trial has been reimplemented to assess the effect off the treatments over another harvest year.

Regarding the nitrate levels in the underground:

- The nitrate levels remain fairly stready throughout the year; however, they do spike following significant rainfall events (>80mm) that occur during fertilising periods (planting/ratooning). If large rainfall events occur when fertiliser is not being applied, the nitrate levels tend to remain steady.
- Multiple samples should be taken over the year (minimum, 1 during the "wet season/slack," before and after a large rainfall event, during a significant dry period) to assess the acutal nitrate level in the underground stream that the grower is accessing as a one off sample is not enough data to assess the nitrate level accurately.

Regarding using Ground Water Nitrates as part of a fertiliser budget:

- From the first harvest of the trial, it appears **that ground water nitrates can be used as part of a fertiliser budget.** There was no significant difference between the treatment yields (tC/ha, CCS & tS/ha) at 95% confidence. This **suggests that a significant amount of the nitrate applied through the irrigation water is avaliable to the plant.**
- The **amount the nitrate rates can be reduced is still unknown** (plant uptake still needs to be more thoroughly investigated.
- **The amount of nitrogen that rates can be reduced needs to take climatic conditions into consideration**. The amount of nitrate applied through irrigation water will vary significantly depending on rainfall – if there is a large amount of rain, the grower does not need to irrigate; therefore, the nitrate will not be applied in large amounts.
- It is essential to calculate the annual volume of water being applied in order to more accurately assess the amount of nitrogen being applied through irrigation.

Advantages of this Practice Change:

- Reduced amount of synthetic nitrogen fertiliser being applied.
- Economic savings can be made when using irrigation nitrates (applying less synthetic fertiliser = spending less money)
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Disadvantages of this Practice Change:

- Reducing nitrogen rates to account for nitrate in the irrigation water can be risky depending on rainfall. If the grower reduces his nitrogen rates significantly, then rain falls over a long period of time and as a result the grower does not irrigate, he may suffer significant productivity losses due to not applying enough fertiliser in the first place.
- Calculating the amount of nitrogen to reduce fertiliser rates by is difficult at this stage. Not enough research has been conducted into plant uptake of irrigation nitrates to make a "safe" recommendation. Additionally, many Burdekin growers do not know their annual water use (ML/ha/year). This is another important element in calculating nitrogen rate reductions.
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Will you be using this practice in the future:

- The grower already reduces his nitrogen rates to account for irrigation nitrates (from 210N to 180N). He is open to further reducing his nitrogen rates; however, more trials need to be conducted before he has confidence in the practice.

% of farm you would be confident to use this practice :
The grower already reduces his N rate over the area of the farm effected by nitrates (approximately 80%); however, he requires a bit more confidence to reduce his nitrogen rate further.