



NGN COMPARISON OF NITROGEN-BASED DEMAND AND BANKING STRATEGIES TO AID N DECISION MAKING IN SE NSW

Griffith N Systems Trial

Testing N management decisions to inform risk-reward



**ZONE 3 – CENTRAL WEST & NORTHERN RIVERINA
(CWFS AND AG GROW AGRONOMY)**



INDEPENDENT AGRONOMY ADVICE + CUTTING EDGE RESEARCH

Griffith N Systems Trial 2023

KEY POINTS

The 2023 season was generally dry, although there was a full profile of moisture coming into the season. Dry and frosty conditions were endured late winter and early spring, with the season finishing with hot dry conditions, causing canola to quickly ripen.

Grain yield was related to the total amount of nitrogen applied, with grain yield increasing as total N applied increased. The highest grain yield was achieved with the Manure treatment (3.2 t/ha), which had the highest amount of applied N (239 kg N/ha) through the manure and urea. This treatment yielded 1 t/ha higher than the Nil control (2.2 t/ha).

N application had direct correlations to the grain quality attributes of canola. Grain oil decreased as the total amount of N applied increased, with both grain protein and test weight increasing as the amount of applied N increased.

A partial gross margin, focussing on nitrogen treatment costs, showed replacement+30% (which had 133 kg N/ha applied), had the highest profit over the Nil treatment in 2023.

BACKGROUND

This project is part of 'RiskWi\$e' (the National Risk Management Initiative) which includes a \$30 million investment by GRDC over 5 years, as well as investment from researchers, growers, advisors and extension groups across Australia. The national program lead is CSIRO.

Six Action Research Groups (ARG) have been formed nationally and in NSW the team is led by Charles Sturt University and FarmLink. NSW research partners include Riverine Plains, Central West Farming Systems, Ag Grow Agronomy, AMPS, IREC, Southern Growers, Holbrook Landcare Network, Grain Orana Alliance, and Irrigated Farmers Network.

Ag Grow Agronomy and Research is working closely with Central West Farming Systems as part of Zone 3, covering the Central West and Northern Riverina.

The project has five priority areas including nitrogen (N) decisions, sowing decisions, enterprise agronomic decisions, enterprise financial decisions

and managing natural resource capital. It aims to give growers and advisers the tools to evaluate potential risks and rewards, as identified by growers, in their production management decisions, therefore improving the quality of on-farm decision making.

As part of the NSW ARG, and as part of the Nitrogen Theme, Ag Grow Agronomy set up a nitrogen (N) systems trial in 2023 to test the performance of different nitrogen management strategies over a four-year period. Grower engagement by Ag Grow Agronomy identified N as their number 1 issue and their biggest expense. Which gave direction to theme 1 for the first year of the project.

This trial will test N management decisions to inform risk-reward as well as compare N banking to existing N demand strategies.

This report provides a summary of the 2023 N systems trial results for Griffith.

TRIAL DETAILS

The Griffith trial is located on the Ag Grow Agronomy research farm “Ridgetop” Beelbanger, approximately 16km NE of Griffith.

The aim of the trial is to compare the yield, grain quality, and profitability (gross margin, risk) of different nitrogen (N) management approaches over the long term. It will also provide information on whether fertiliser N not used by crops in the year of application carries over to subsequent seasons, what the consequences of excessive N fertiliser are for crop productivity, and the effect of different N fertiliser strategies on legume productivity and N fixation.

The trial was statistically designed in a randomised complete block, consisting of 4 replications. Each treatment ‘plot’ comprised of three small plots to minimise edge effects, with measurements taken on the central plot. The trial was sown with a Morris Contour Drill plot seeder, with 25cm row spacings. Plot sizes were 12m by 1.75m (21m²).

The trial consisted of 12 treatments, table 1, with the first 5 treatments compulsory as part of the project.

The remaining treatments were determined based on grower feedback and consultation. A description of each of the treatments is also provided in table 1.

It is important to note that the Grower Practice treatment (treatment 2) was based on a combination of soil test data, attitude to risk, historical results and seasonal forecast. It was also made with the decision that if conditions changed and looked better than seasonally forecasted that more fertiliser would be applied as topdressed nitrogen.

Initial soil testing was undertaken pre-sowing, at depths of 0-10cm, 10-40cm, 40-70cm and 70-100cm. 2023 soil test results showed the site had a pH (CaCl₂) 6.5, total mineral N (0-100cm) 55 kg N/ha and Colwell P (0-10cm) 40.5ppm. Nitrogen rates planned for each treatment were calculated from these soil test results, table 2.

The trial was sown into moisture on 14th April 2023 with Trident canola at 2.5 kg/ha and with 70 kg/ha superphosphate. Appropriate pest, disease and weed control were undertaken on the trial post-emergent, with the trial sprayed early August with 450 ml/ha Prosaro. The trial was harvested 24th October 2023.

Table 1: Griffith site treatment list and description.

No.	Treatment	Description
1	Nil N Control	No N fertiliser applied; P applied with superphosphate
2	Grower Practice	Rate determined by current grower decision making
3	Low Risk	Low Risk Seasonally Responsive - Sufficient N applied to meet water limited potential yield assuming a decile 2-3 season finish (equivalent to Yield Prophet 75%)
4	Med Risk	Moderate Risk Seasonally Responsive - Sufficient N applied to meet water limited potential yield assuming a decile 5 season finish (equivalent to Yield Prophet 50%)
5	High Risk	High Risk Seasonally Responsive - Sufficient N applied to meet water limited potential yield assuming a decile 7-8 season finish (equivalent to Yield Prophet 25%)
6	Climate Forecast	Seasonal Forecast Responsive - Sufficient N applied to meet water limited potential yield assuming whichever of treatments 4-5 is most likely based on BOM 3-month forecast
7	8% Gross Income	Financially Responsive - apply as much N fertiliser as can be purchased with 8% of gross income from the previous season at current market value of urea (source – FM500 benchmarking)
8	Replacement	Apply N fertiliser equal to grain N offtake from previous season
9	Replacement+30%	Apply N fertiliser equal to grain N offtake from previous season plus 30%
10	Replacement-30%	Apply N fertiliser equal to grain N offtake from previous season minus 30%
11	Manure	Proportion of N supplied through addition of manure of known N content
12	Enhanced Fertiliser	N fertiliser is supplied with coatings to reduce losses - Green Urea used which has a urease inhibitor to protect against volatilisation losses

With the exception of the manure treatment, which was applied before sowing and IBS, nitrogen treatments were applied 25th May 2023 when the canola was at 6-8 leaf, figure 1.

Further N was also applied to some plots prior to flowering early July. Table 3 shows the actual total amount of nitrogen applied to each treatment and timing based on soil test results, target yields and seasonal conditions.

Table 2: Nitrogen fertiliser planned for each treatment based on 2023 soil test results.

Trt No	Treatment	Soil N (kg/ha)	Target water limited potential yield (t/ha)	Economic yield (t/ha)	N demand (kg N/ha)	N fertiliser required (kg N/ha)	Comment
1	Nil Control	55	NA	NA	NA	0	Control treatment
2	Grower Rate	55	NA	1.0	86	28	*Adjusted Grower Practice (lower target yield than paddock)
3	Low Risk Seasonally Responsive (Decile 2-3)	55	1.9	1.5	122	67	From Yield Prophet Lite assuming Harries canola PYw=(WU-80)*15
4	Medium Risk Seasonally Responsive (Decile 5)	55	2.9	2.3	186	131	From Yield Prophet Lite assuming Harries canola PYw=(WU-80)*15
5	High Risk Seasonally Responsive (Decile 7-8)	55	3.9	3.1	250	195	From Yield Prophet Lite assuming Harries canola PYw=(WU-80)*15
6	Climate Forecast - Seasonal Forecast Responsive	55	1.9	1.5	122	67	60% chance of <decile 1-4 Jul-Sep, 74% Jun-Aug
7	8% Gross Income - Financially Responsive	55	NA	NA	NA	91	Gross income \$1,729.56 (5.275 t/ha Rockstar wheat at \$327.88/t) urea spend = \$138.36 = 198 kg/ha urea = 91 kgN/ha
8	Replacement	55	NA	NA	NA	102	5.275 t/ha wheat at 10.5% protein (1.94% N as per Mariotti factor of 5.4) = 102 kgN/ha
9	Replacement+30%	55	NA	NA	NA	133	As above plus 30%
10	Replacement-30%	55	NA	NA	NA	71	As above minus 30%
11	Manure	55	NA	NA	NA	131	3t/ha manure (3.6% N) applied yr1 plus matched with treatment 4 Med risk (131 kgN/ha) - every year (including year 1)
12	Enhanced Fertilisers	55	NA	NA	86	28	Green Urea used and rate N applied matched with grower practice in 2023

*Note: actual grower practice of paddock surrounding trial had 100kg urea spread before sowing + 100kg SOA topdressed, a total of 66kg N/ha.

Figure 1: Nitrogen treatments applied to canola, 25th May



Table 3: Actual total Nitrogen applied to each treatment and timing for 2023.

Trt No.	Treatment	N before sowing			N Topdress 1			N Topdress 2			2023
		Product	Rate t/ha	kg N/ha	Product	Rate kg/ha	kg N/ha	Product	Rate kg/ha	kg N/ha	TOTAL N kg N/ha
1	Nil Control			0	0	0	0			0	0
2	Grower Rate			0	Urea	60	28	*Gran Am	100	20	48
3	Low Risk			0	Urea	145	67			0	67
4	Medium Risk			0	Urea	284	131			0	131
5	High Risk			0	Urea	423	195			0	195
6	Climate Forecast			0	Urea	145	67			0	67
7	8% Gross Income			0	Urea	198	91			0	91
8	Replacement			0	Urea	222	102			0	102
9	Replacement+30%			0	Urea	288	133			0	133
10	Replacement-30%			0	Urea	155	71			0	71
11	Manure	Manure	3	108	0	0	0	Urea	284	131	239
12	Enhanced Fertilisers			0	Green Urea	60	28	*Gran Am	100	20	48

Note: the use of Gran Am confounds these treatments with sulphur - Gran Am was used as Urea could not be sourced.
Some treatments had more N applied than planned due to seasonal conditions.

Seasonal Conditions 2023

The 2022 season was generally wet, so coming into the 2023 season there was a full profile of moisture. Whilst this trial was sown into moisture, there was little rain the second half of April and most of May drying out the top profile, table 4. These drier conditions led to slower early crop growth.

There were good conditions in June and early July, which allowed crops to get away and tap into subsoil moisture reserves. Dry and frosty conditions persisted in August and early September. The season finished with hot dry conditions, with canola quickly ripening.

Table 4: 2023 Rainfall and Growing Season Rainfall (GSR) for the trial site, compared to long term rainfall taken at Griffith Airport.

MONTH	"Ridgetop" Beelbangera 2023	Griffith Airport 2023	Griffith Airport Long Term (1958 to 2023)
January	31	39	36
February	0	0	28.1
March	61.5	12.2	35.8
April	33	34	29.2
May	9	10.6	35.1
June	41.5	38	35.4
July	18	24.4	32.6
August	10	18	35
September	0	2.4	32.9
October	25	12.4	40.4
November	78	90.6	35.5
December	31	53.2	32.9
TOTAL	338	334.8	409.8
GSR (April - Oct)	136.5	139.8	240.6

RESULTS AND DISCUSSION

NDVI, yield and grain quality were statistically analysed using ANOVA (Analysis of Variance) in Genstat.

An establishment score (plots scored from 0 to 9, 0 indicating poor establishment and 9 indicating very even establishment) and indicative plant counts were also taken 17th May at the 4-5 leaf stage, figure 2. The average establishment score of the trial was 7.4, with the trial establishing well, despite the conditions.

Figure 2: Establishment 17th May 2023.



NDVI

An NDVI reading was taken using a handheld GreenSeeker crop sensor on 27th June 2023 at budding, figure 3.

The average NDVI of the trial was 0.74, table 5. Medium risk (moderate Risk Seasonally Responsive) treatment had the highest NDVI with 0.77 and the Nil N Control had the lowest NDVI at budding with 0.69.

Figure 3: NDVI at budding, June 2023.



Table 5: NDVI data at budding, June 2023.

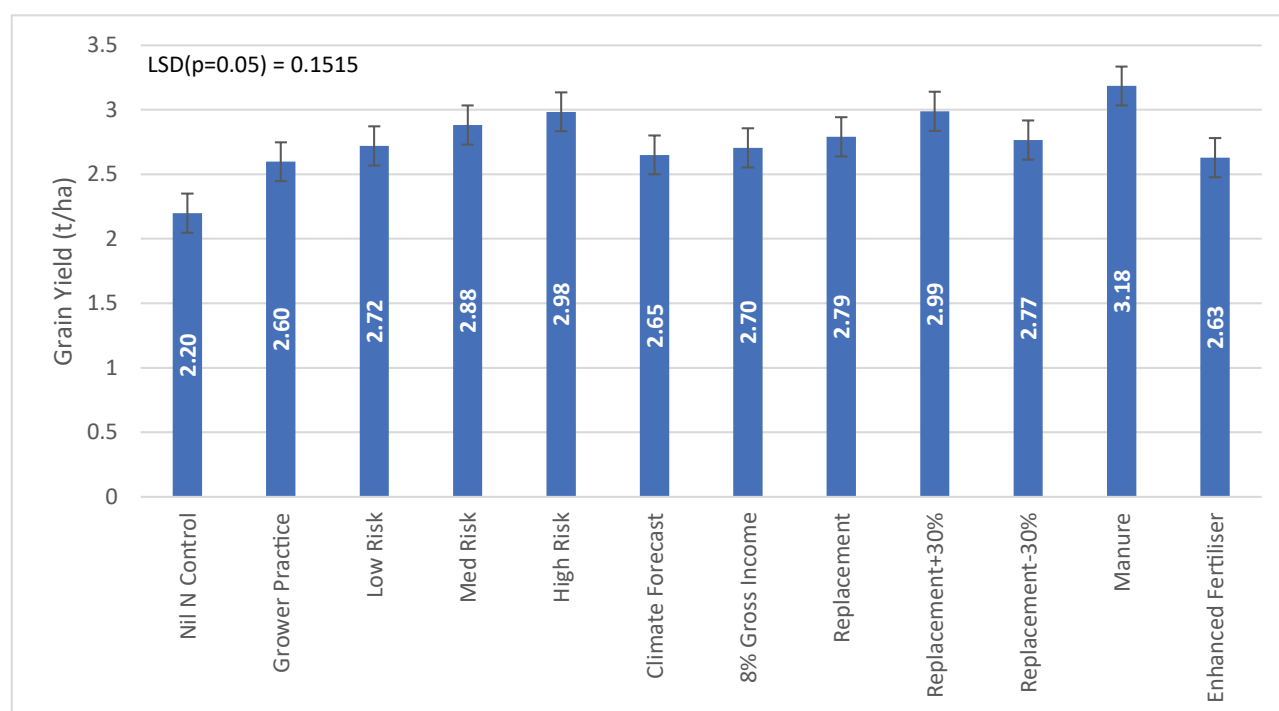
Treatment	NDVI	Sig
Med Risk	0.77	a
High Risk	0.76	ab
Replacement	0.76	ab
8% Gross Income	0.75	abc
Replacement+30%	0.75	abc
Grower Practice	0.74	bcd
Low Risk	0.73	cde
Climate Forecast	0.73	cde
Replacement-30%	0.73	cde
Manure	0.72	de
Enhanced Fertiliser	0.71	ef
Nil N Control	0.69	f
Mean	0.74	

Note: Means followed by same letter do not significantly differ

Grain Yield

The average grain yield of the trial was 2.76 t/ha. The Nil control treatment, which had no N fertiliser applied, was the lowest yielding treatment in the trial yielding 2.2 t/ha, figure 4. This treatment was significantly lower yielding than all other treatments in the trial. The manure treatment was the highest yielding treatment in the trial yielding 3.18 t/ha. This treatment was significantly greater than all other treatments in the trial.

Figure 4: Grain yield of the N Systems Trial - harvested 24th October 2023.

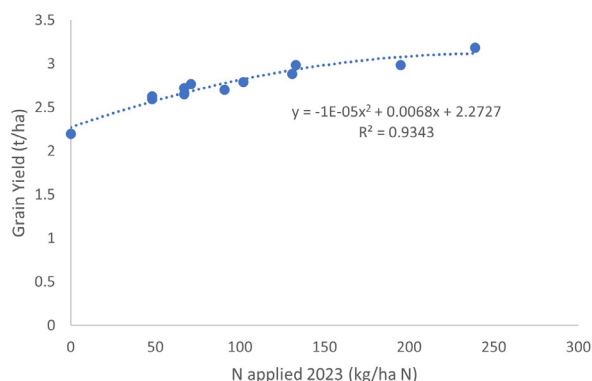


There was a strong correlation in 2023 with the amount of N applied and grain yield, figure 5. Grain yield increased as the amount of N applied for each treatment increased.

The manure treatment, which had the greatest amount of nitrogen applied with 239 kg/ha N, was the highest yielding, 3.18 t/ha. This treatment had a portion of the N applied as urea, 131 kg N/ha, which was the same amount of urea applied to the Medium risk treatment which yielded 2.88 t/ha.

The second highest amount of N was applied to the High Risk (high Risk Seasonally Responsive) treatment with 195 kg N/ha applied, yielding 2.98 t/ha. Besides the Nil N control treatment, treatments 2 (Grower Practice) and 12 (Enhanced Fertiliser) had the next lowest amount of N applied with 48 kg/ha N and were the next lowest yielding treatments, yielding 2.6 t/ha and 2.63 t/ha respectively.

Figure 5: Grain yield v Total amount of N applied.



Grain Quality:

A summary of grain quality (grain oil, grain protein and test weight) data is shown in table 6.

Table 6: Grain quality data for Griffith N Systems trial 2023.

Trt No.	Treatment	Grain Oil (%)	Grain Protein (%)	Test Weight kg/hL
1	Nil N Control	46.7 <i>a</i>	19.4 <i>h</i>	63.3 <i>e</i>
2	Grower Practice	46.0 <i>ab</i>	20.3 <i>g</i>	64.5 <i>d</i>
3	Low Risk	45.5 <i>bc</i>	20.8 <i>fg</i>	64.6 <i>d</i>
4	Med Risk	44.0 <i>e</i>	22.4 <i>b</i>	65.7 <i>ab</i>
5	High Risk	42.7 <i>f</i>	23.0 <i>ab</i>	65.9 <i>ab</i>
6	Climate Forecast	45.2 <i>bcd</i>	20.9 <i>efg</i>	64.7 <i>d</i>
7	8% Gross Income	44.7 <i>de</i>	21.5 <i>cde</i>	64.8 <i>d</i>
8	Replacement	44.3 <i>e</i>	21.9 <i>bcd</i>	65.5 <i>bc</i>
9	Replacement+30%	44.1 <i>e</i>	22.2 <i>bc</i>	65.7 <i>ab</i>
10	Replacement-30%	44.7 <i>cde</i>	21.4 <i>def</i>	64.3 <i>d</i>
11	Manure	42.3 <i>f</i>	23.8 <i>a</i>	66.2 <i>a</i>
12	Enhanced Fertiliser	45.6 <i>b</i>	20.7 <i>fg</i>	64.9 <i>cd</i>
Mean		44.6	21.5	65.0
Lsd (p=0.05)		0.78	0.75	0.67

Note: Means followed by same letter do not significantly differ

Grain Oil:

The average grain oil content of the trial was 44.64%, with the Nil N treatment having the highest oil content in the trial with 46.73%, which was statistically greater than all others except Grower Practice (45.95%).

The Manure treatment had the lowest oil content in the trial with 42.30%, statistically lower than all others in the trial except High Risk (42.68%).

There was a direct correlation in 2023 with the amount of N applied and grain oil, with grain oil decreasing as the amount of N applied increased, figure 6.

Whilst grain oil yield, given the positive relationship with grain yield and N applied in 2023, increased as the amount of N applied increased, figure 7.

Figure 6: Grain oil v Total amount of N applied.

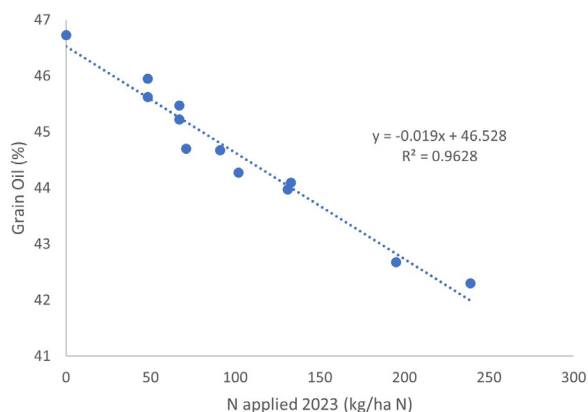
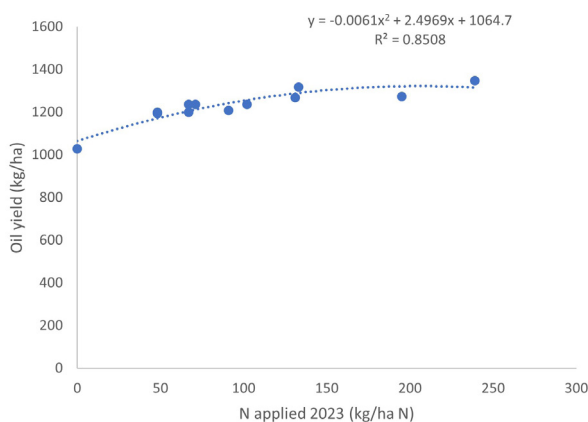


Figure 7: Grain oil yield v Total amount of N applied.



Grain protein:

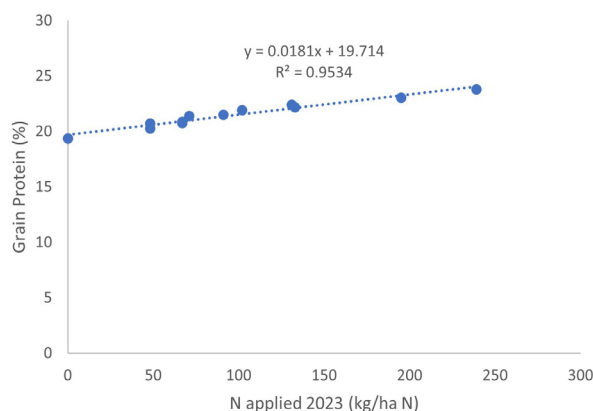
The average grain protein of the trial was 21.51%. There was a direct correlation in 2023 with the amount of N applied and grain protein, figure 8. Grain protein increased as the amount of N applied with each treatment increased.

The manure treatment, which had a total of 239 kg/ha N applied, had the highest grain protein with 23.80%, statistically higher than all other treatments in the trial, except High Risk (23.03%), which had 195 kg/ha N applied.

The Nil N treatment had the lowest protein content in the trial with 19.38%, which was

statistically lower than all other treatments in the trial.

Figure 8: Grain protein v Total amount of N applied.



Test Weight:

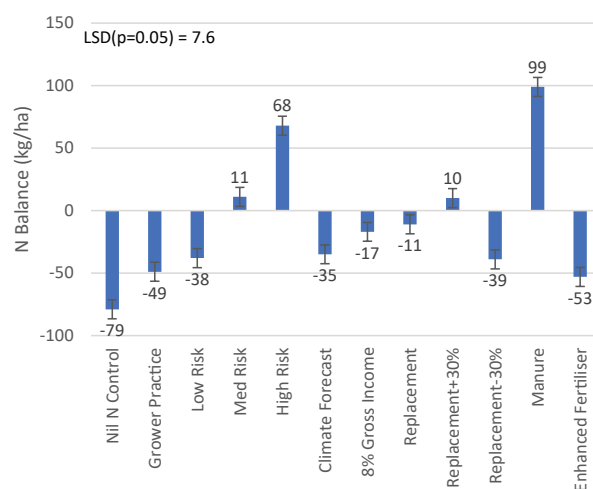
The average test weight of the trial was 65.01 kg/HL. The manure treatment had the highest test weight with 66.22 kg/HL, statistically higher than all other varieties in the trial, except High Risk (65.88 kg/HL), Replacement+30% (65.69 kg/HL) and Med Risk (65.65 kg/HL).

The Nil N treatment had the lowest test weight with 63.64 kg/HL, statistically lower than all other treatments in the trial.

Nitrogen Balance

After harvest the treatments which had a positive N balance were the treatments which had the higher rates of N applied, figure 9. Manure, High risk, medium risk and Replacement+30% all had a positive nitrogen balance.

Figure 9: N balance for each treatment.



Economics

Partial gross margins for each treatment were calculated using the grain yields and nitrogen costs for each treatment and a grain price of \$625/t on farm for canola. An oil bonus, above 42%, was also considered.

After the first year of the project a partial gross margin, focussing on nitrogen treatment costs and the profitability of each treatment over the Nil control treatment, showed the treatment which had the greatest profit, above the Nil control (treatment 1), was the Replacement+30% (treatment 9) with a \$333 profit, followed by Replacement-30% (\$301) and Low Risk (\$298) table 7.

There was not a sliding scale of profit based on N applied as there was for grain yield, due to the effect of N on grain oil and the input cost of the nitrogen.

Treatment 11 Manure, which was the highest yielding treatment and had the most N applied (239 kg/ha N), did not return the greatest profit. Whilst the manure was sourced locally, the treatment cost including application was the greatest with \$351.

Treatment 5 High Risk, which had the second highest amount of N applied with 195 kg/ha N, also had the second highest treatment cost (\$318) and returned a lower profit over the Nil than both the medium and low risk seasonally responsive treatments.

Table 7: Partial Gross Margin for Griffith N Systems trial 2023.

No.	Treatment	2023 Canola Grain Yield (t/ha)	2023 Canola Grain Oil (%)	Oil bonus multiplier *base of 42% oil	2023 Revenue *canola \$625 on farm	2023 Total N applied (kg/ha N)	Treatment Cost ** (\$)	Revenue minus Treatment Costs (\$)	Profit (compared to control)
1	Nil N Control	2.2	46.7	1.0709	\$1,472	0	0	\$1,472	\$0
2	Grower Practice	2.6	46.0	1.0593	\$1,720	48	\$122	\$1,598	\$224
3	Low Risk	2.7	45.5	1.0521	\$1,788	67	\$115	\$1,672	\$298
4	Med Risk	2.9	44.0	1.0296	\$1,855	131	\$216	\$1,638	\$264
5	High Risk	3.0	42.7	1.0101	\$1,884	195	\$318	\$1,566	\$192
6	Climate Forecast	2.7	45.2	1.0484	\$1,737	67	\$115	\$1,621	\$247
7	8% Gross Income	2.7	44.7	1.0401	\$1,758	91	\$154	\$1,604	\$230
8	Replacement	2.8	44.3	1.0341	\$1,803	102	\$171	\$1,632	\$258
9	Replacement+30%	3.0	44.1	1.0315	\$1,926	133	\$219	\$1,707	\$333
10	Replacement-30%	2.8	44.7	1.0405	\$1,798	71	\$123	\$1,676	\$301
11	Manure	3.2	42.3	1.0045	\$1,999	239	\$351	\$1,648	\$274
12	Enhanced Fertiliser	2.6	45.6	1.0544	\$1,732	48	\$124	\$1,608	\$234

**Costs are based on actual 2023 paddock costs; Treatment costs are those above the standard paddock costs and are the costs attributed to the actual N treatment only.

Nitrogen fertiliser input costs based on:

Urea \$727/t	plus \$10/ha application
Green Urea \$767/t	plus \$10/ha application
Gran Am \$580/t	plus \$10/ha application
Manure \$18/t	plus \$9/m ³ to spread and load



DISCUSSION

Canola yields in 2023 were above expectations, given there was only 137mm of April to October rain. Stored soil moisture was the key, with canola tapping into the full soil moisture profile, and with roots observed beyond 2m in depth in a soil pit.

Of the N management strategies used in 2023 the Manure treatment was the standout. This treatment yielded approximately 1 t/ha higher than the Nil control (2.2 t/ha) and 0.3 t/ha higher than the Medium risk treatment (2.88 t/ha), which had the same amount of urea applied. Canola yields in 2023 were responsive to nitrogen, with the greater amount of nitrogen applied the greater the yield.

Economically, when looking at the profitability of the treatments in terms of applied nitrogen and considering the oil bonus paid, the manure treatment which had the highest yields and the greatest amount of N applied, was not the most profitable. The Replacement+30% treatment provided the highest returns in 2023.

Grain quality was also dictated by the amount of N applied. Grain oil decreased and both grain protein and test weight increased as the amount of N applied increased. This impacted on the profitability of the higher yielding high N treatments.

Year 2 will see wheat sown over the Griffith trial as part of the overall cropping rotation. Given the canola yields in 2023 and nitrogen treatments applied, it will be interesting to see if the treatments with high rates of N have any residual benefits for the following crop, given they were the only treatments to have a positive N balance after harvest.

ACKNOWLEDGEMENT:

RiskWi\$e is made possible thanks to the involvement of all partners and was established through an investment of the Grains Research and Development Corporation (GRDC).

RiskWi\$e is conducted in partnership with grower groups, 6 action research group leads, research/extension partners, CSIRO and the Grains Research and Development Corporation (GRDC). Ag Grow Agronomy and Research is leading RiskWi\$e work on nitrogen decision making in the Griffith area, in collaboration with Central West Farming Systems.

Find out more at the GRDC website:

<https://grdc.com.au/research/trials,-programs-and-initiatives/riskwise>

RiskWi\$e

– the National Risk Management Initiative

