Incitec Pivot Fertilisers

Green Urea NV® Trial Report 2024

Reducing Nitrogen Loss: Results From Volatilisation Trials Across Southern Australia

Introduction

Urea is the most used nitrogen (N) fertiliser. When applied to soil, urea is hydrolysed in the presence of moisture to ammonium, facilitated by the action of urease enzyme present in the soil. The hydrolysis process is completed within a few days (1-4 days). Under alkaline or high pH conditions, the ammonium (NH_4^+) can be converted to ammonia gas (NH_3) which can be lost through volatilisation from the soil especially when urea is surface applied. Other loss pathways for applied urea include leaching of nitrate (NO_3^-) and denitrification of NO_3^- to nitrous oxide (N_2O) and dinitrogen (N_2) under very high soil moisture content.

The scope of this trial focused on the measurement of NH_3 volatilisation from surface-applied urea and the performance of Green Urea NV®[1] in mitigating the volatilisation losses.

Incitec Pivot Fertilisers (IPF) Green Urea NV, an enhanced efficiency fertiliser (EEF), contains urease inhibitor which slows the conversion of urea to ammonium which is subject to loss as NH_3. The Green Urea NV minimises N losses leading to more retention in the system for a crop and pasture production. Extensive research trials by IPF with the help of co-operators (see appendix) in 2024 measured NH_3 volatilisation from Green Urea NV compared to urea at 11 winter cropping sites across south eastern Australia with varying soil types over multiple topdress applications.

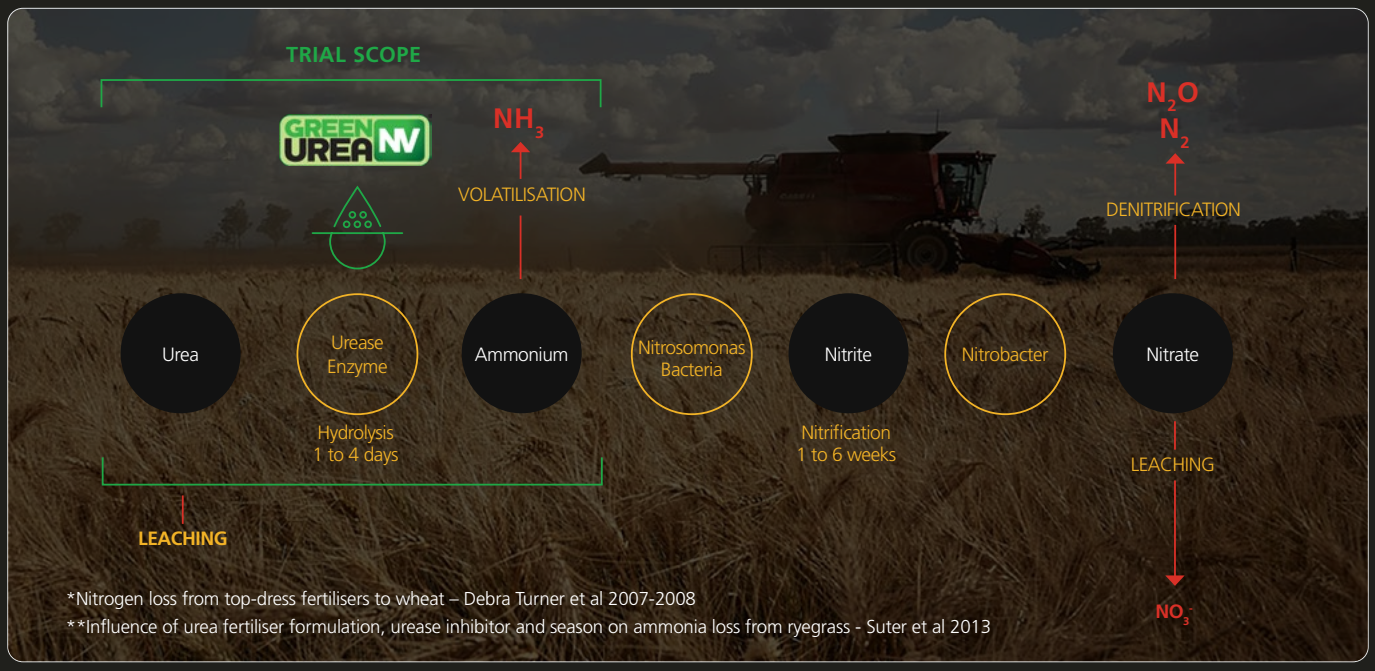


Figure 1. *Nitrogen transformation and loss pathways for applied urea. The urease inhibitor in Green Urea NV slows the urease enzyme responsible for the rapid hydrolysis of urea to ammonium which can be lost as NH_3 under certain soil and climatic conditions.*

Summary of findings

Up to 26% (12 kg N/ha out of the 46 kg N/ha) of N applied as urea was lost through NH_3 volatilisation over two weeks. The Green Urea NV consistently reduced N loss across all sites by an average of 77%, 82% and 76% for the topdress applications in June, July and August respectively. Results show a higher percentage of losses occurred in the seven days post-treatment applications compared to the second week.

1 Green Urea NV is a registered trademark of Incitec Fertilisers Operations Pty Ltd

Figure 2. *Setup for ammonia measurement in the field.*

Method

The setup for NH_3 measurement consists of 150 x 300 mm PVC chamber with a cap and an acid treated foam. The chamber, which was driven into the soil over the topdressed area, provides an enclosure and holds the foam above the soil surface whilst the cap excludes moisture over the course of measurement. The foam was replaced at weekly intervals for two weeks for continuous trapping of NH_3 from either the urea or Green Urea NV. The NH_3 in the foam was subsequently extracted for analysis at the Nutrient Advantage Laboratory. While the effectiveness of Green Urea NV was the primary focus of the trials, other common N products such as Gran Am and Easy N were also trialled. Winter crops including wheat, barley and canola received separate topdresses in mid-June, mid-July and mid-August with N applied at a rate of 46 kg N/ha.

Table 1. *Trial sites showing a range of soil properties and crop types.*

Site	Texture	pH (1:5 water)	CEC (cmol (+)/kg)	Organic Carbon (%)	Crop
Naracoorte, SA	Clay	8.3	52.9	3.7	Wheat
Murchison East,VIC	Silty Clay	6.3	11.0	1.6	Canola
Howlong, SA	Loam	6.5	5.9	1.0	Wheat
Bendigo (Derby), VIC	Sandy Loam	5.9	4.0	1.3	Barley
Hopetoun, VIC	Sandy Clay Loam	7.3	12.0	0.8	Wheat
Longerenong, VIC	Clay Loam	6.3	10.8	1.3	Wheat
Lake Bolac, VIC	Clay	5.6	5.4	1.4	Wheat
Ungarra, SA	Clay	8.2	42.9	2.2	Wheat
Kanagulk, VIC	Loam	6.1	7.3	1.8	Wheat
Arthurton, SA	Clay Loam	8.5	35.0	2.3	Wheat

Figure 3. *IPF's volatilisation trial sites across a range of soil types and geographical areas.*

Results

Results are being presented as how many kilograms of N has been lost as NH_3 for each topdress at each trial site. At each site, the percentage reduction in NH_3 loss from Green Urea NV application relative to urea is shown in the graph. Results from the Longerenong site have been presented as an example. Results for the remainder of the trial sites are summarised in the appendix. The average NH_3 volatilisation data across the three topdress applications, factors driving NH_3 loss and the economics of N loss are discussed.

At the Longerenong site, between 6 and 7 kg N/ha out of the 46 kg N/ha (13-15%) applied was lost through NH_3 volatilisation over the three topdress applications. Green Urea NV reduced NH_3 loss by 83%, 78% and 73% for June, July and August applications respectively. An average of 72% of the total N lost occurred in the first week of urea application.

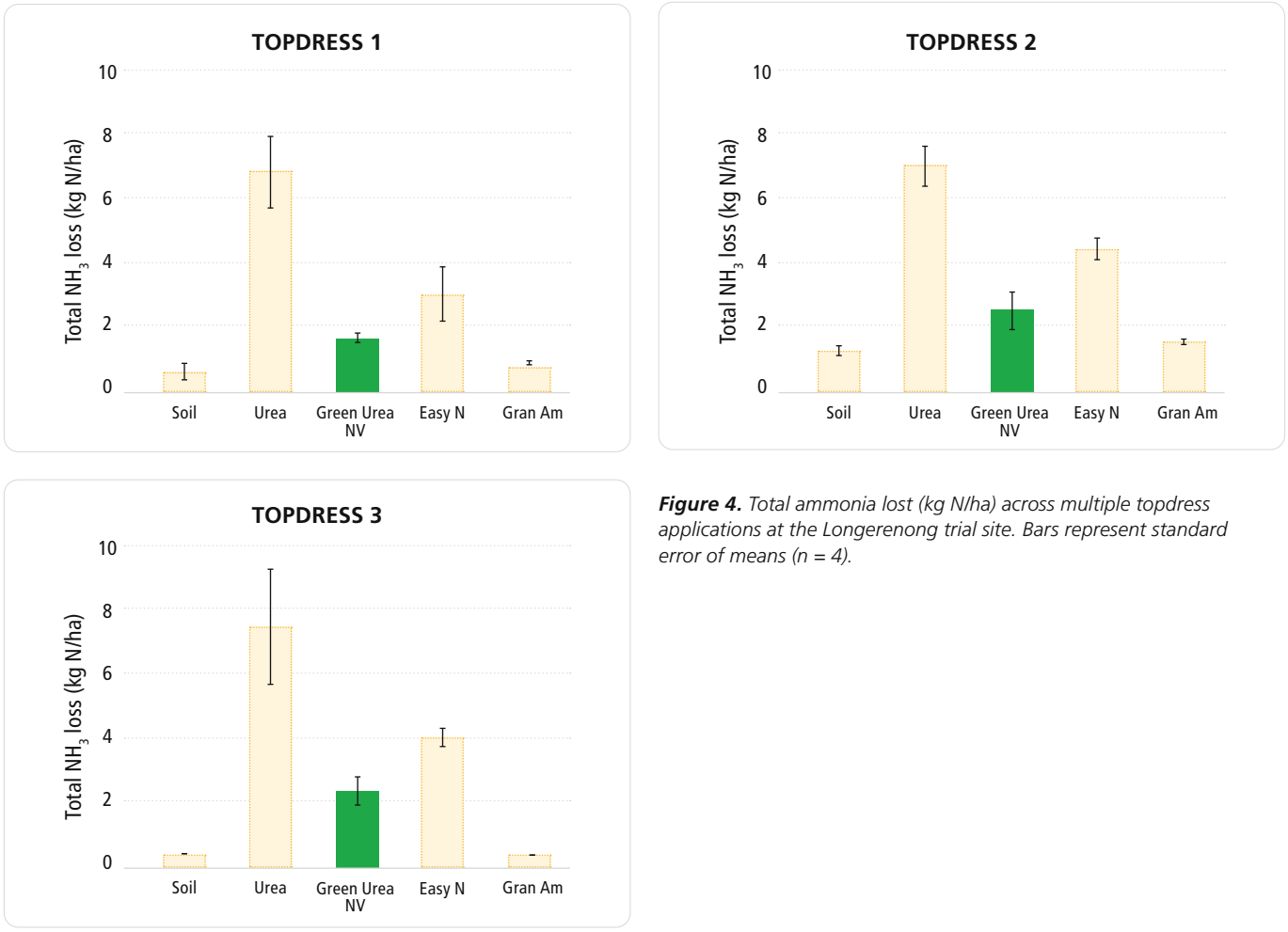


Figure 4. *Total ammonia lost (kg N/ha) across multiple topdress applications at the Longerenong trial site. Bars represent standard error of means (n = 4).*

Table 2. *Amount of nitrogen lost (% of applied) for urea, Green Urea NV and other fertilisers across multiple topdresses in June-August at the Longerenong trial site.*

	June application				July application				August application			
	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am
Nitrogen lost (% of application)	13.4	2.3	5.3	0.4	12.5	2.7	6.8	0.6	15.3	4.2	7.9	NA[2]

[2] NH_3 lost was lower than from soil only plot where no N was applied.

Green Urea NV reduced volatilisation losses

June topdress

Green Urea NV reduced the total NH_3 loss across all cropping sites with an average reduction of 76% (33 – 93%). Between 8 and 19% (4 and 9 kg N/ha) of the applied N was lost over the two-week trial period. The lowest reduction (33%) was observed at the Howlong site, and the highest reduction was observed at Lake Bolac (93%).

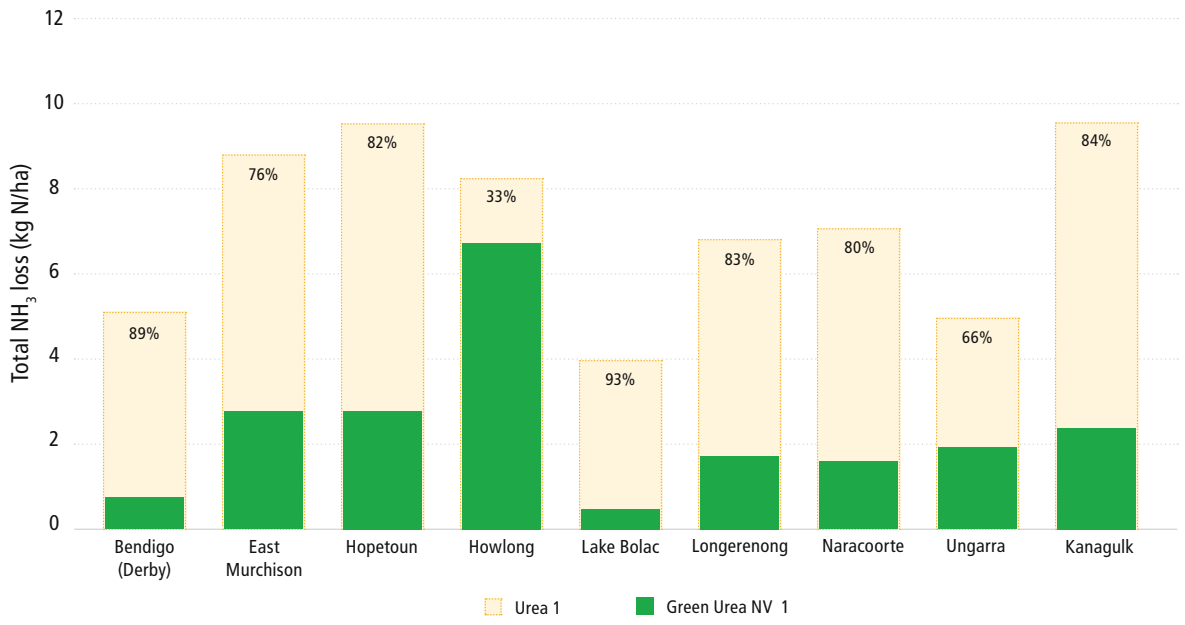


Figure 5. *Total NH_3 loss (kg N/ha) from urea and Green Urea NV treated plots in June topdress across multiple trial sites. Values in bars are the percentage reduction, relative to urea, in volatilisation losses when Green Urea NV was applied.*

July topdress

Green Urea NV reduced the total NH_3 loss across all cropping sites with an average reduction of 77% (55 – 97%). Between 10 and 26% (5 and 12 kg N/ha) of the applied N was lost over the two-week trial period. The lowest reduction (55%) was observed at the Howlong site, and the highest reduction was observed at Lake Bolac (97%).

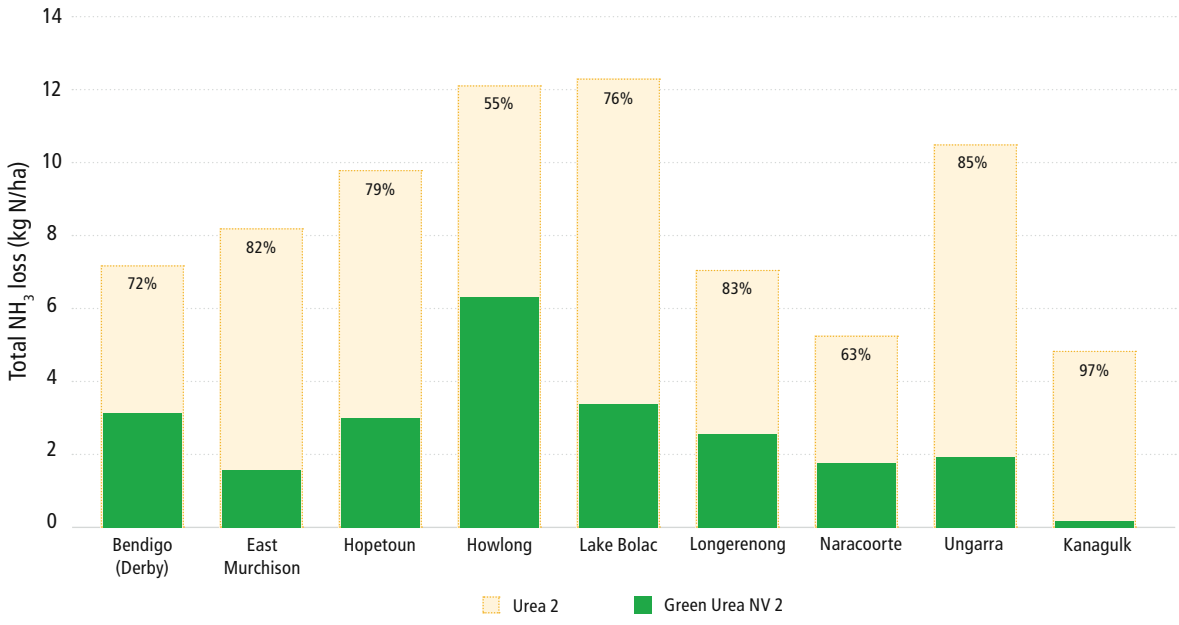


Figure 6. *Total NH_3 loss (kg N/ha) from urea and Green Urea NV treated plots in July topdress across multiple trial sites. Values in bars are the percentage reduction, relative to urea, in volatilisation losses when Green Urea NV was applied.*

August topdress

Green Urea NV reduced the total NH_3 loss across all cropping sites with an average reduction of 82% (72 – 86%). Between 15 and 23% (7 and 11 kg N/ha) of the applied N was lost over the two-week trial period. The lowest reduction (72%) was observed at the Longerenong site, and the highest reduction was observed at Lake Bolac (86%).

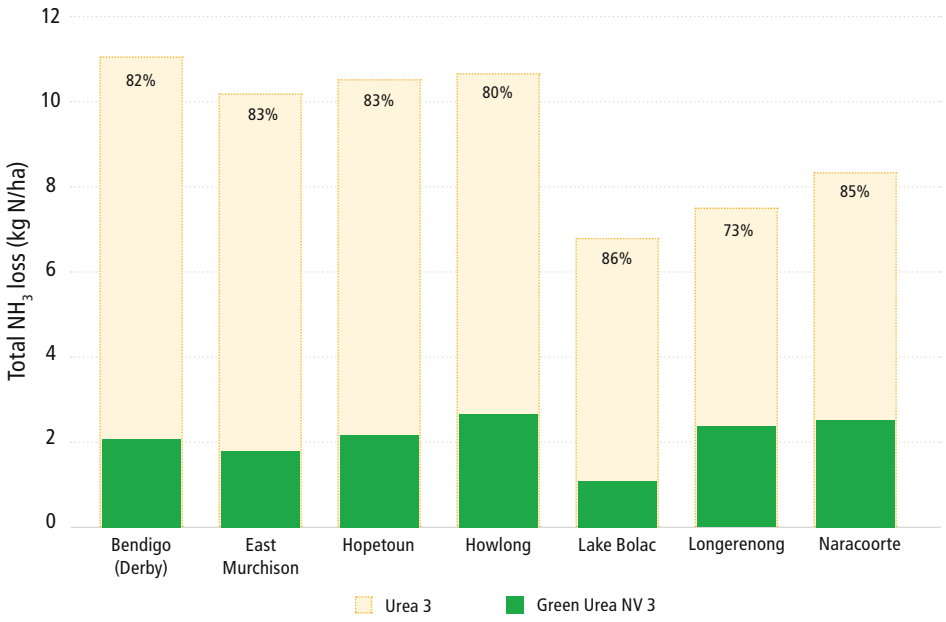


Figure 7. *Total NH_3 loss (kg N/ha) from urea and Green Urea NV treated plots in August topdress across multiple trial sites. Values in bars are the percentage reduction, relative to urea, in volatilisation losses when Green Urea NV was applied.*

Average across topdress applications per site

Overall, Green Urea NV reduced NH_3 volatilisation, compared to urea, by between 60 and 89% (average of 2-3 topdress applications per trial site). The Green Urea NV consistently mitigated NH_3 volatilisation across a range of soil types and geographical areas across multiple topdress applications.

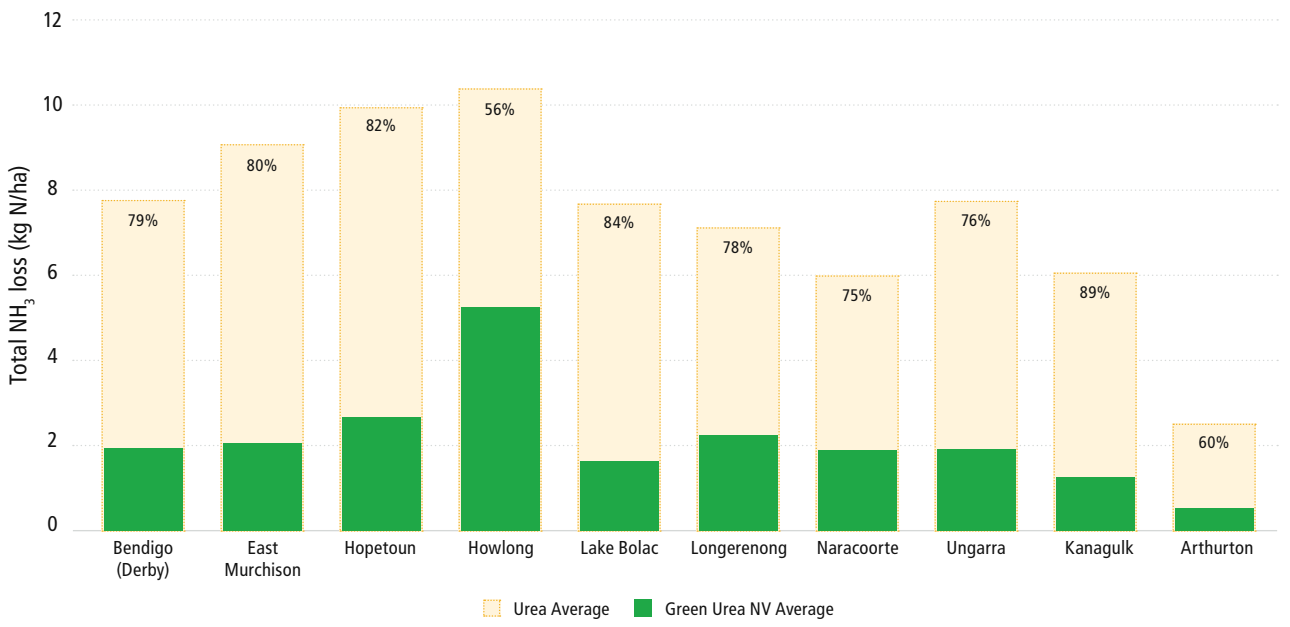


Figure 8. *Total NH_3 loss (kg N/ha) from urea and Green Urea NV treated plots (average across 2-3 topdress per trial site). Values in bars are the percentage reduction, relative to urea, in volatilisation losses when Green Urea NV was applied.*

Losses in week 1 vs week 2 – average across all topdress

Most of the NH_3 volatilisation occurred in the first week (up to 84% of the total NH_3 loss) following topdress applications compared to the second week. The onset of urea hydrolysis (within the first four days of urea application) is characterised by high soil pH around the urea granules creating a favourable environment for NH_3 volatilisation.

The Green Urea NV slows the hydrolysis of urea – activity of a specific biological process involved in the conversion of urea to ammonium.

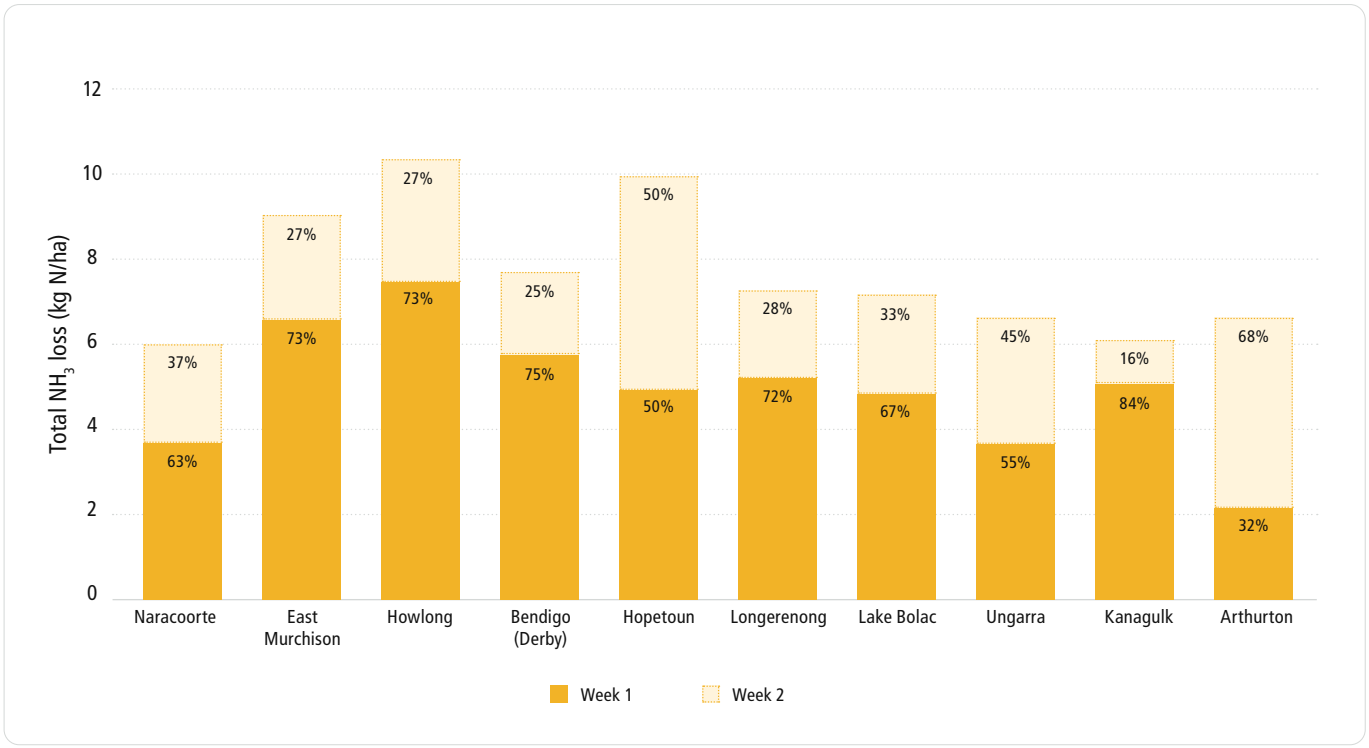


Figure 9. *Average percent loss (values in bars) of NH_3 loss in week 1 vs week 2 applied as urea across all topdress.*

Factors impacting ammonia volatilisation

Soil pH: High soil pH drives NH_3 volatilisation. At high pH, the ammonia-ammonium equilibrium is shifted towards ammonia leading to high volatilisation losses. Regardless of soil type, the soil pH under the urea granule will increase, converting ammonia to ammonia gas and leading to N loss. Green Urea NV slows this pH rise, reducing volatilisation losses.

Cation exchange capacity (CEC) of soil: Soils with high CEC can retain NH_4^+ on its exchange (negatively charged surfaces) leading to a reduction in the NH_4^+ available for conversion to NH_3. This results in lower volatilisation losses in soil with high CEC, such as soils high in clay and organic matter contents. Sandy soils have a low CEC, meaning they don't hold nutrients well. Green Urea NV reduces N loss, keeping more available for crop uptake.

Organic material (pasture thatch, crop residues, stubble, trash): Organic material can trap urea granules above the soil surface, exposing them to volatilisation. Green Urea NV slows urea breakdown, helping retain N until it is incorporated.

Low rainfall or dew conditions: When urea granules dissolve but are not incorporated deep enough, volatilisation risk increases. The amount of rainfall needed to reduce losses varies by soil type: sandy soils require >10mm, loam soils >16mm, and clay soils >25mm.

The economics

When assessing the cost of N volatilisation losses, there is the direct cost of loss from the cropping system plus the opportunity miss of lost grain yield (and/or protein). *Table 3* shows the calculation of lost value for both urea and Green Urea NV from the June topdress application at the Longerenong site. The total economic loss of urea was $59.85/ha compared to $20.21/ha from the Green Urea NV, showing a net positive return from Green Urea NV of $39.64/ha. From the total net positive return, $5.15/ha was attributed to direct ammonia loss and $36.05/ha from potential lost grain production.

Table 3. *Example of the economic analysis on the cost of ammonia loss including the loss associated with yield from the June topdress at the Longerenong site. Analysis based on urea valued at $800/t,Green Urea NV +$53.70/t RRP applied at 100kg/ha. Wheat $350/t. 1kgN produces 20kg grain.*

Factor	Standard Urea	Green Urea NV
Urea Cost	$800/t ($1.74/kg N)	$853.70/t ($1.85/kg N)
Nitrogen Loss	6.84 kg N/ha	1.69 kg N/ha
Cost of Lost Nitrogen	6.84 kg N x $1.74/kg = $11.90/ha	1.69 kg N x $1.74/kg = $2.94/ha
Loss in Production (Grain Yield)	6.84 kg N/ha x 20 kg grain/kg N = 137 kg/ha lost grain production	1.69 kg N/ha x 20 kg grain/kg N = 34 kg/ha lost grain production
Cost of Lost Production	137 kg x $0.35/kg = $47.95/ha	34 kg x $0.35/kg = $11.90/ha
Investment in Green Urea NV	N/A	$5.37/ha
Total Losses	$59.85/ha	$20.21/ha

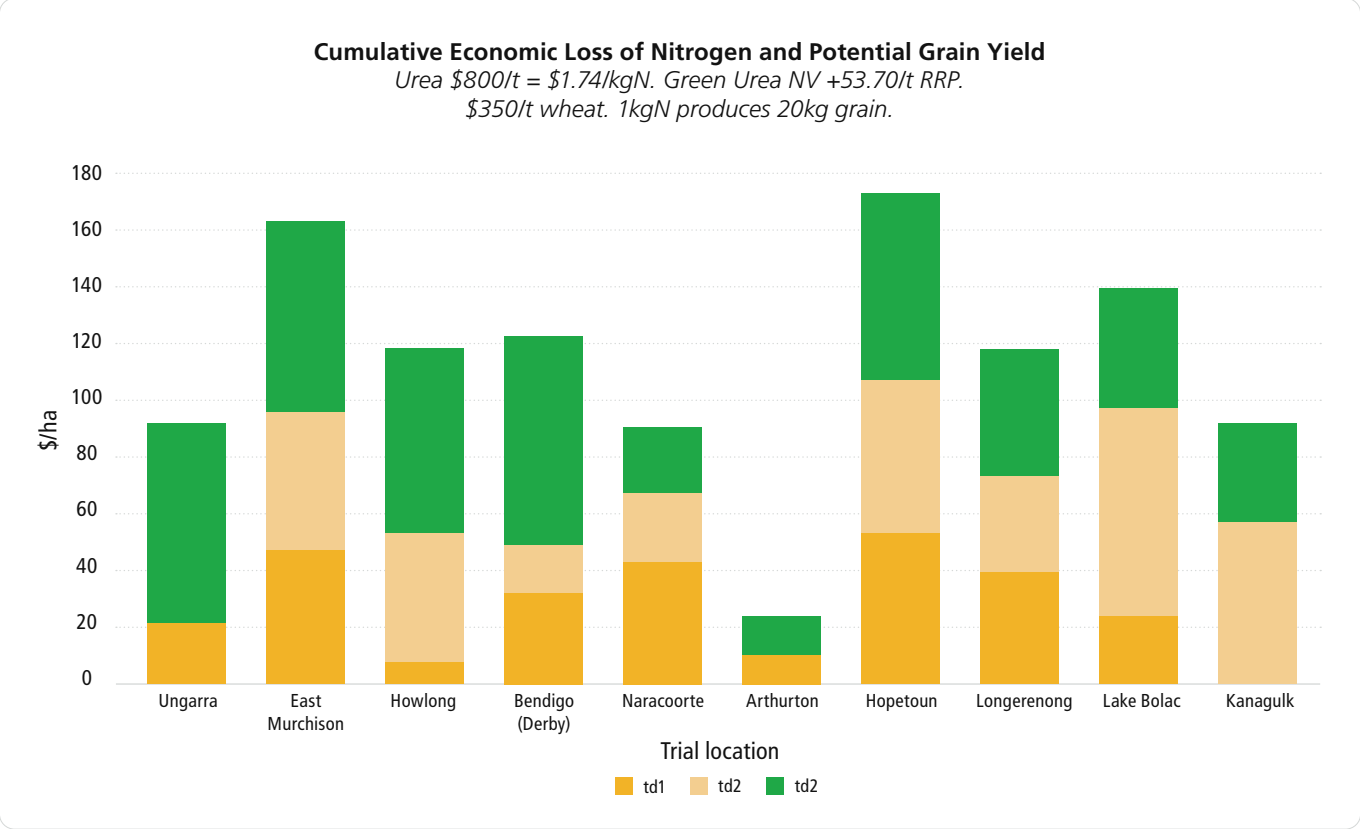


Figure 10. *Economic outcome for each site for each topdress.*

Figure 10 shows the results of applying the economic logic from *Table 3* across all sites for each topdress.

The Green Urea NV Value Calculator

The new Green Urea NV Value Calculator can be used to see how much you could save by using Green Urea NV. It's a useful tool that allows you to:

- Estimate nitrogen losses from standard urea.
- Compare the investment vs. return of upgrading to Green Urea NV.
- Get a customised assessment based on your crop and conditions.

The calculator can be found on the Incitec Pivot Fertilisers website.

General comments

The trials have demonstrated the loss of N from the system and the lost yield opportunity are both real and significant from an economic perspective and something growers need to consider. Up to 26% (12 kg N/ha out of the 46 kg N/ha) of N applied as urea was lost through NH_3 volatilisation over two weeks. You can grow up to 20 kg of cereal grain for every kilogram of N available, so every kilogram of N loss is lost yield potential.

Topdressing with IPF's Green Urea NV consistently reduced the volatilisation of NH_3 by up to 89% across a range of soil types and geographical areas in different southern cropping regions. Compared to urea, the Green Urea NV reduced NH_3 losses across all trial sites by an average of 77%, 82% and 76% for the June, July and August topdress applications respectively. The urease inhibitor in Green Urea NV slows the conversion of urea to ammonium which can be lost as NH_3.

Appendix

Site: Howlong

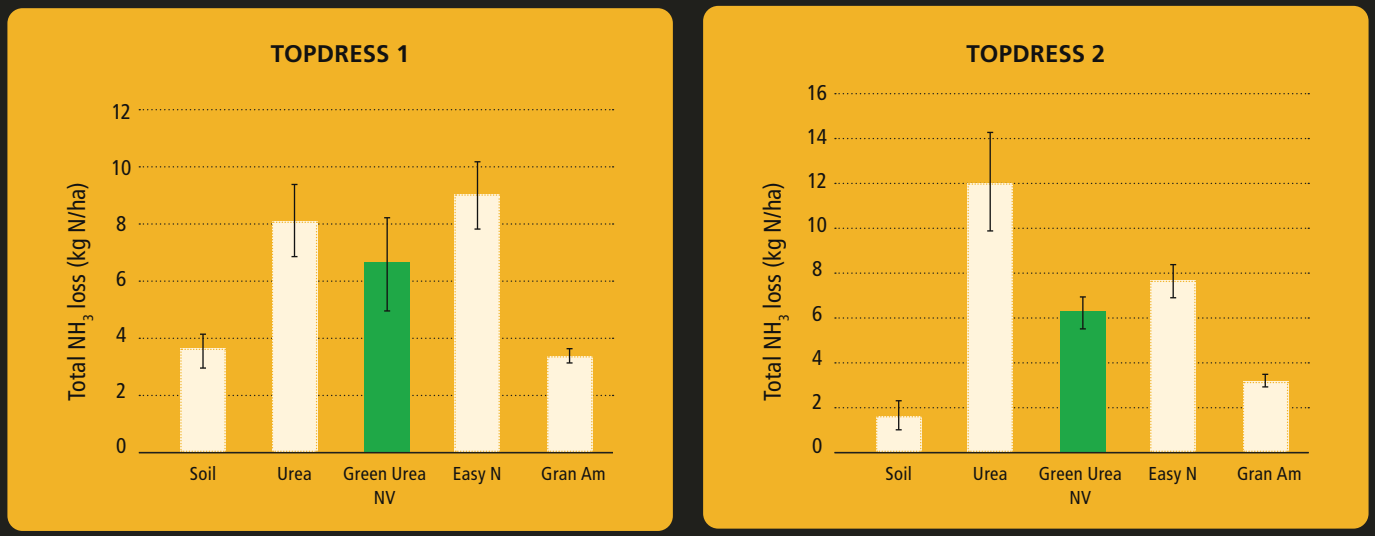


Figure 11. *Total ammonia lost (kg N/ha) across multiple topdress applications at the Howlong trial site. Bars represent standard error of means (n = 4).*

Table 4*. Amount of nitrogen lost (% of applied) for urea, Green Urea NV and other fertilisers across multiple topdresses in June-August at the Howlong trial site.*

	Topdress one				Topdress two				Topdress three			
	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am
Nitrogen lost (% of application)	9.8	6.6	11.8	NA	22.9	10.3	13.2	3.3	22.2	4.6	15.3	2.3

Site: Derby

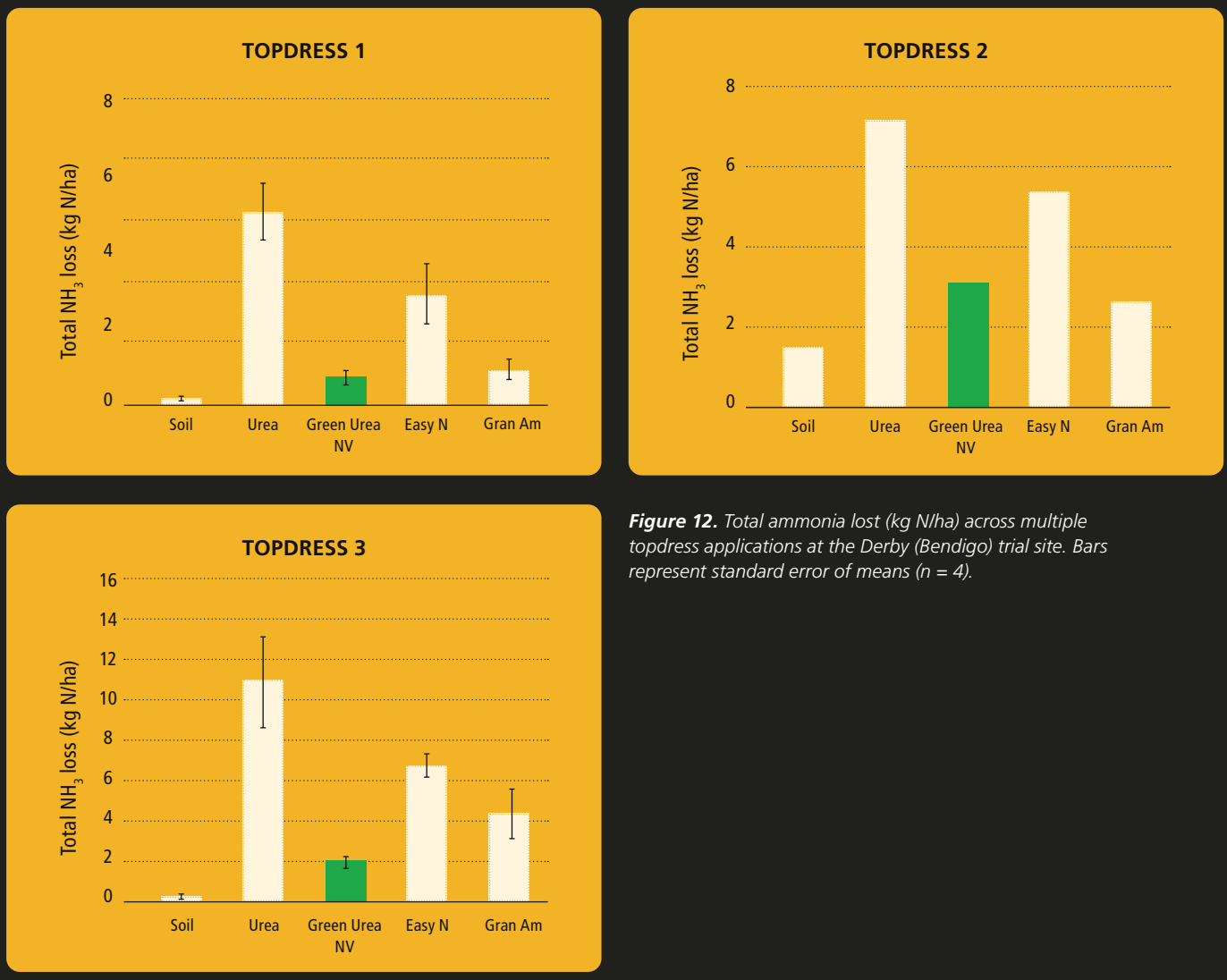


Figure 12. *Total ammonia lost (kg N/ha) across multiple topdress applications at the Derby (Bendigo) trial site. Bars represent standard error of means (n = 4).*

Table 5. *Amount of nitrogen lost (% of applied) for urea, Green Urea NV and other fertilisers across multiple topdresses in June-August at the Derby trial site.*

	Topdress one				Topdress two				Topdress three			
	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am
Nitrogen lost (% of application)	10.6	1.2	5.9	1.7	12.3	3.4	8.5	2.5	23.4	3.8	14.1	8.9

Site: Hopetoun

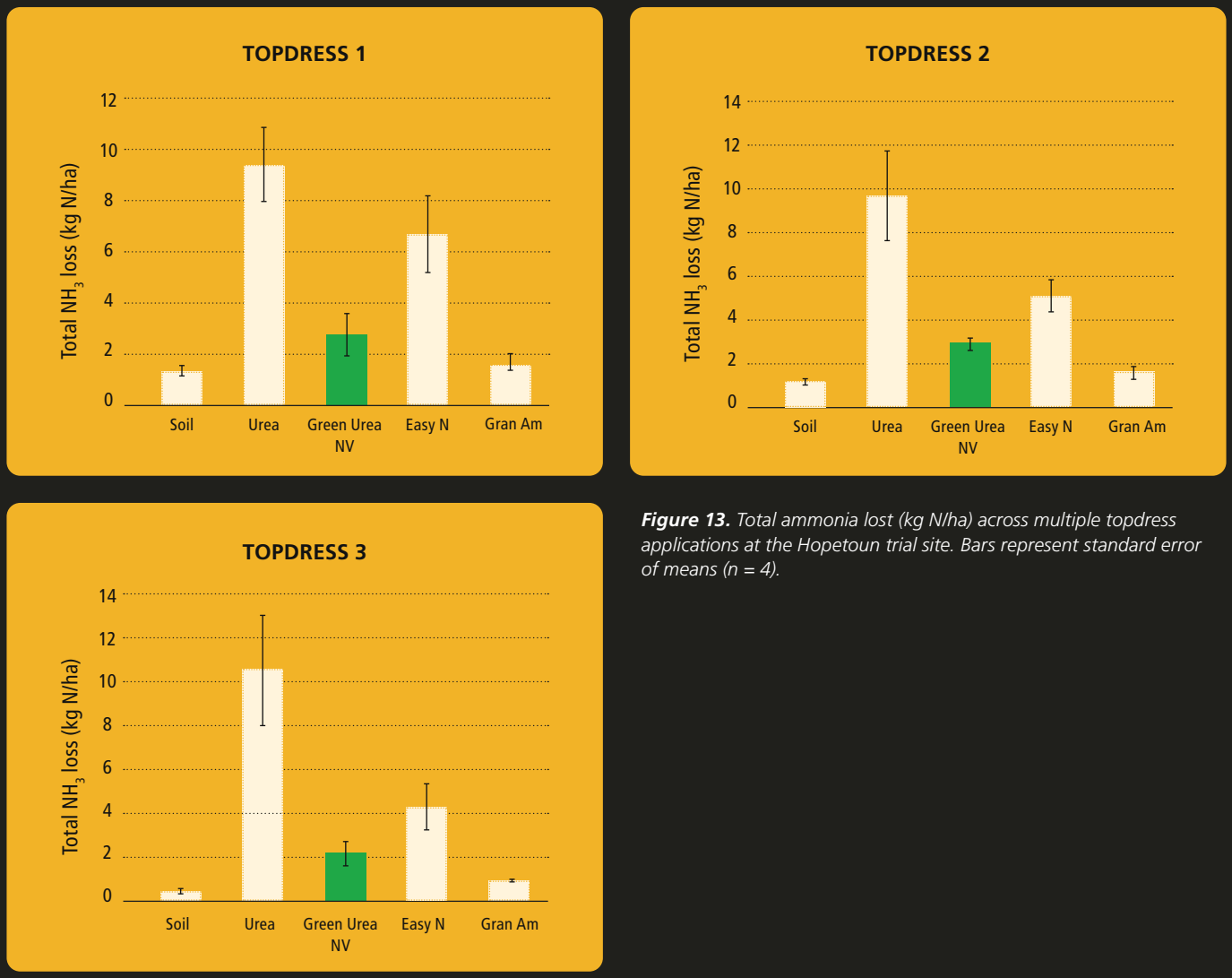


Figure 13. *Total ammonia lost (kg N/ha) across multiple topdress applications at the Hopetoun trial site. Bars represent standard error of means (n = 4).*

Table 6*. Amount of nitrogen lost (% of applied) for urea, Green Urea NV and other fertilisers across multiple topdresses in June-August at the Hopetoun trial site.*

	Topdress one				Topdress two				Topdress three			
	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am
Nitrogen lost (% of application)	17.7	3.1	11.7	0.7	18.7	4.0	8.7	1.0	21.9	3.7	8.3	1.0

Site: Longerenong

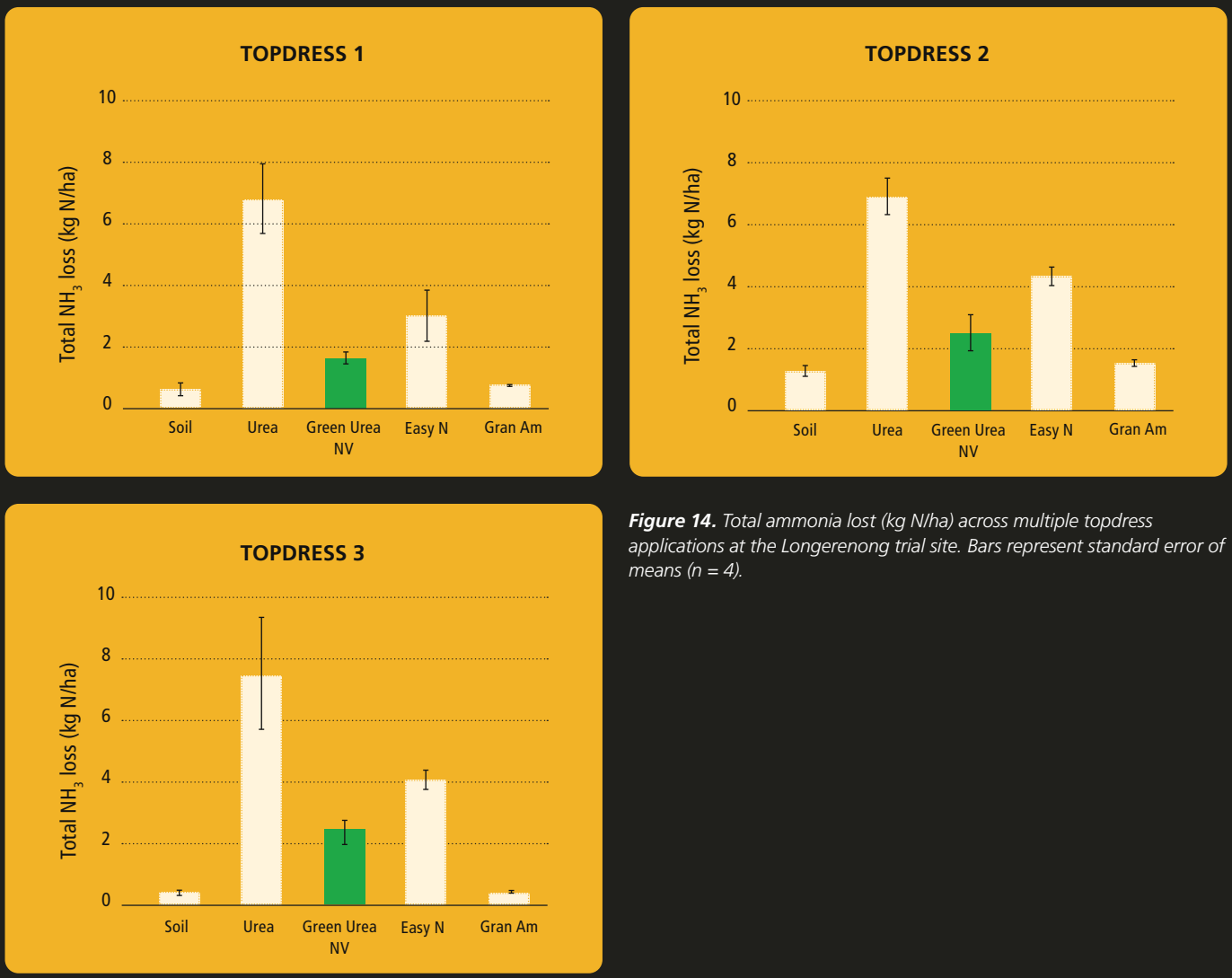


Figure 14. *Total ammonia lost (kg N/ha) across multiple topdress applications at the Longerenong trial site. Bars represent standard error of means (n = 4).*

Table 7*. Amount of nitrogen lost (% of applied) for urea, Green Urea NV and other fertilisers across multiple topdresses in June-August at the Longerenong trial site.*

	Topdress one				Topdress two				Topdress three			
	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am
Nitrogen lost (% of application)	13.4	2.3	5.3	0.4	12.5	2.7	6.8	0.6	15.3	4.2	7.9	NA

Site: Lake Bolac

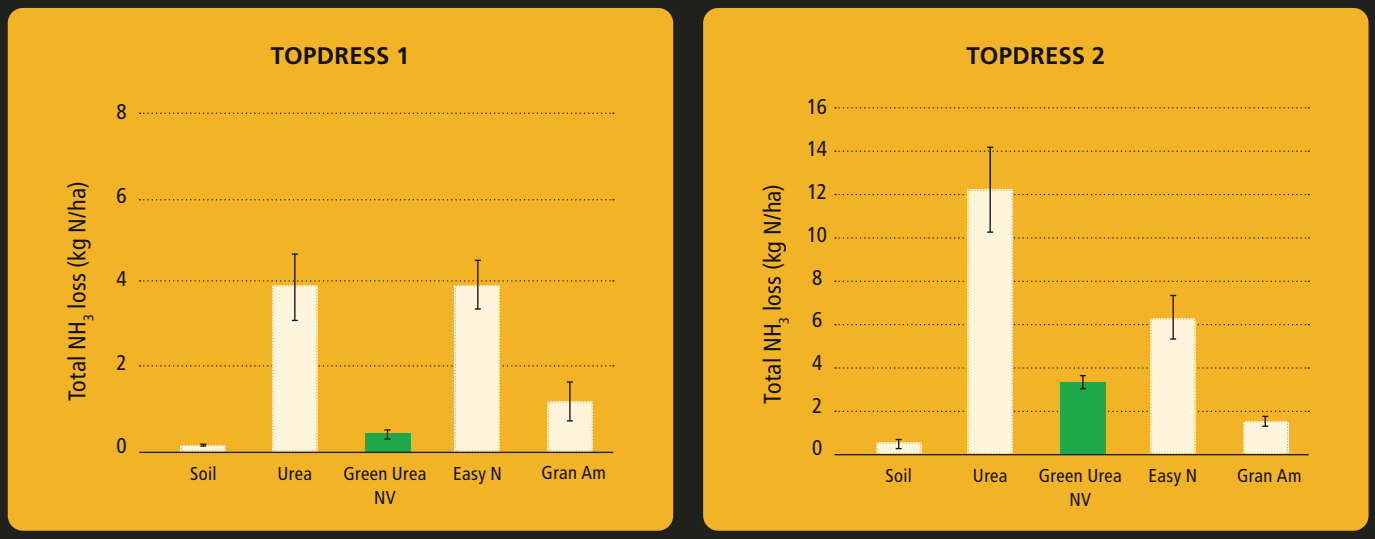


Figure 15. Total ammonia lost (kg N/ha) across multiple topdress applications at the Lake Bolac trial site. Bars represent standard error of means (n = 4).

***Table 8**. Amount of nitrogen lost (% of applied) for urea, Green Urea NV and other fertilisers across multiple topdresses in June-August at the Lake Bolac trial site.*

	Topdress one				Topdress two				Topdress three			
	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am
Nitrogen lost (% of application)	8.2	0.6	8.4	2.3	25.8	6.2	12.8	2.3	14.6	2.1	8.5	0.6

Site: Ungarra

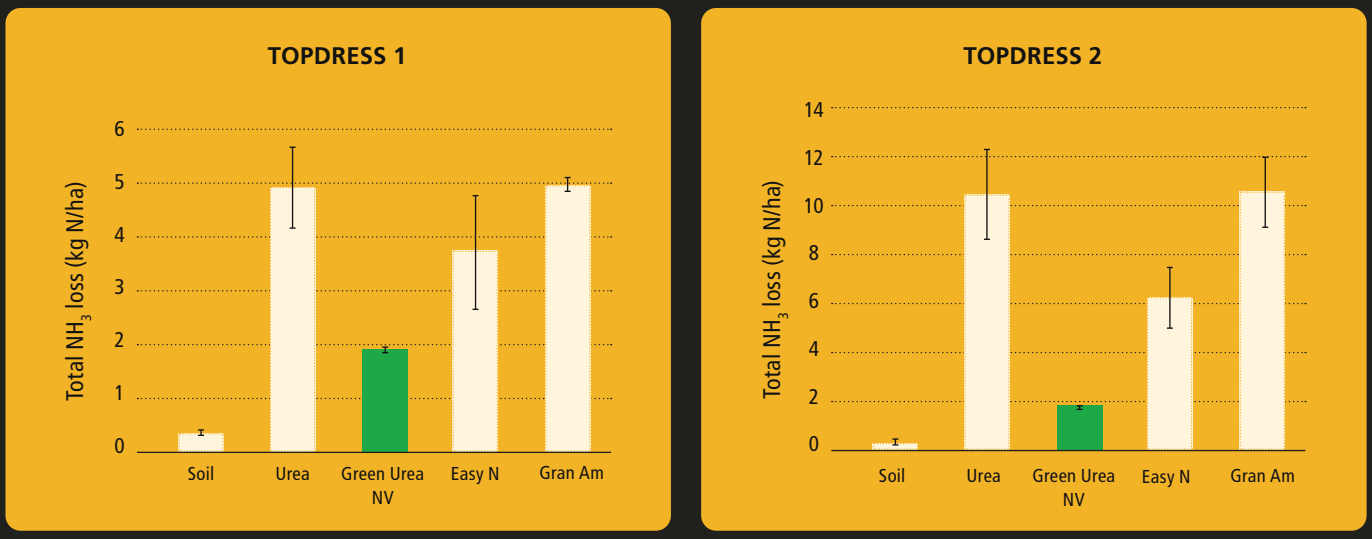


Figure 16. *Total ammonia lost (kg N/ha) across multiple topdress applications at the Ungarra trial site. Bars represent standard error of means (n = 4).*

Table 9*. Amount of nitrogen lost (% of applied) for urea, Green Urea NV and other fertilisers across multiple topdresses in June and August at the Ungarra trial site.*

	Topdress one				Topdress two			
	Urea	Green Urea NV	Easy N	Gran Am	Urea	Green Urea NV	Easy N	Gran Am
Nitrogen lost (% of application)	10.0	3.4	7.4	10.2	22	3.3	12.9	22.3

Site: Murchison East

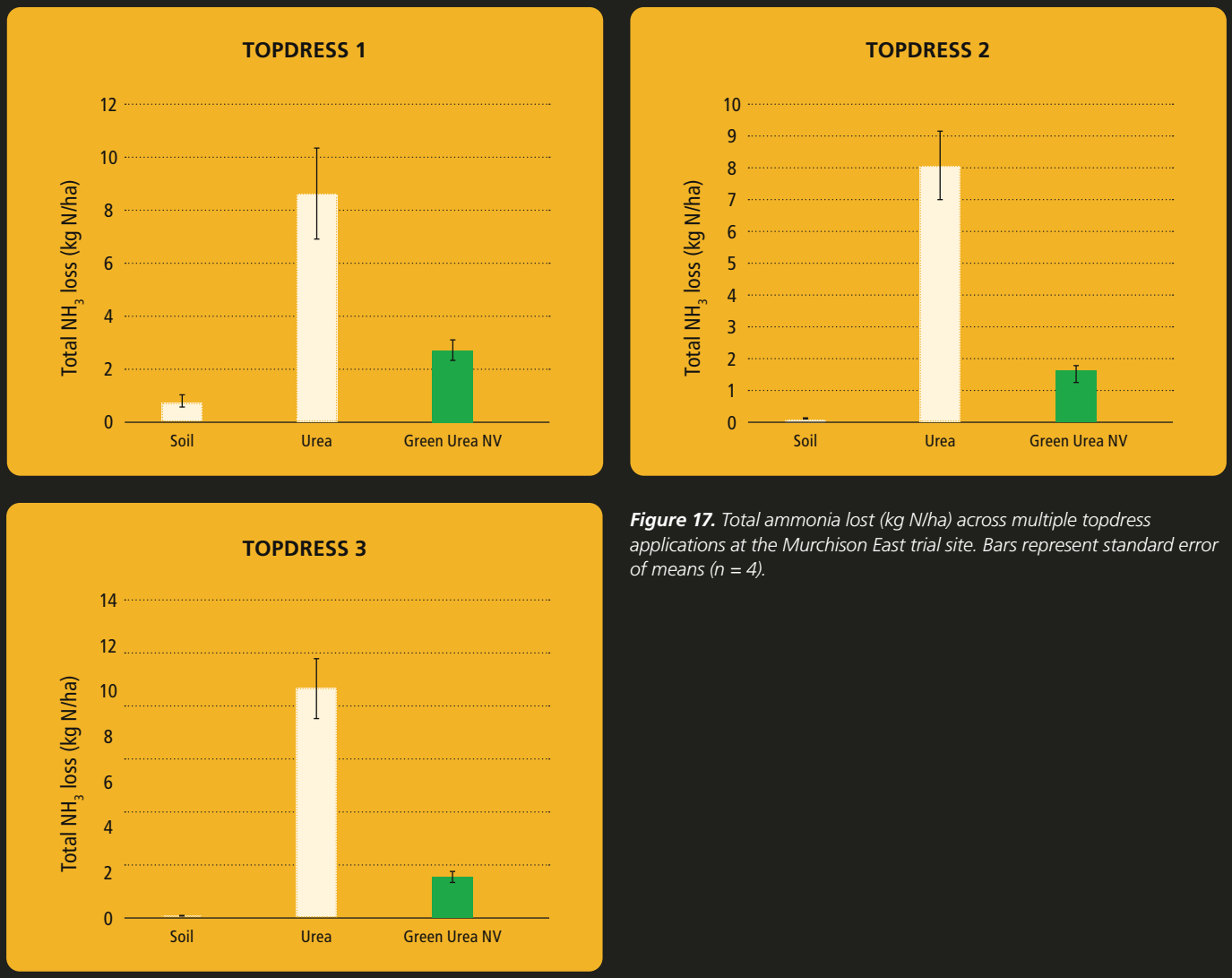


Figure 17. *Total ammonia lost (kg N/ha) across multiple topdress applications at the Murchison East trial site. Bars represent standard error of means (n = 4).*

Table 10*. Amount of nitrogen lost (% of applied) for urea and Green Urea NV across multiple topdresses in June-August at the Murchison East trial site.*

	Topdress one		Topdress two		Topdress three	
	Urea	Green Urea NV	Urea	Green Urea NV	Urea	Green Urea
Nitrogen lost (% of application)	17.3	4.1	17.5	3.2	21.9	3.7

Site: Kanagulk

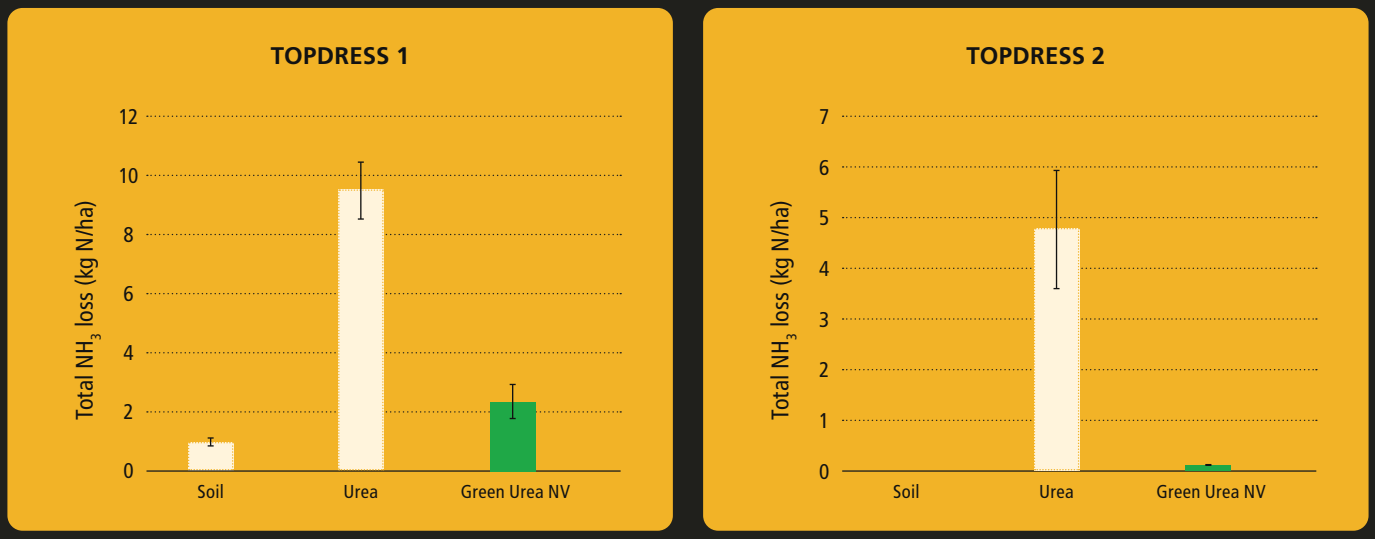
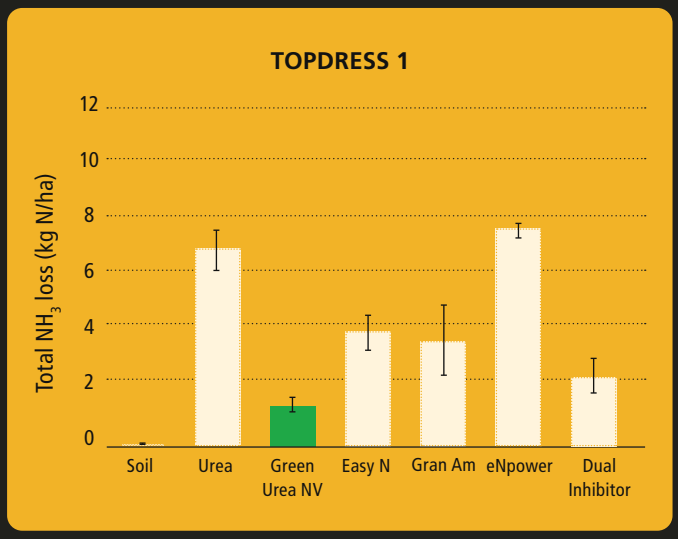


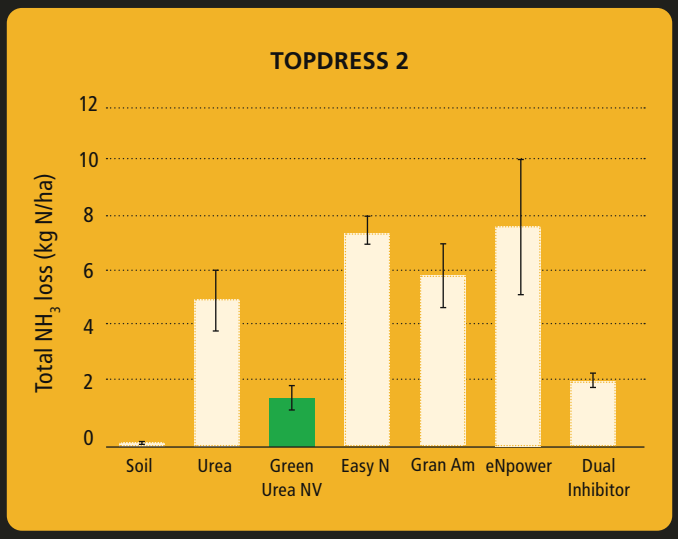
Figure 18. *Total ammonia lost (kg N/ha) across multiple topdress applications at the Kanagulk trial site. Bars represent standard error of means (n = 4).*

Table 11*. Amount of nitrogen lost (% of applied) for urea and Green Urea NV across multiple topdresses in June-August at the Kanagulk trial site.*

	Topdress one		Topdress two	
	Urea	Green Urea NV	Urea	Green Urea
Nitrogen lost (% of application)	18.5	3.0	10.4	0.3

Site: Naracoorte





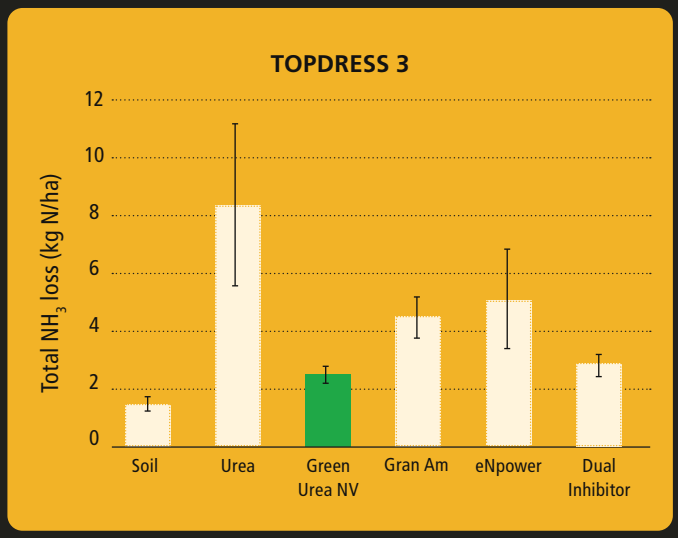


Figure 19. *Total ammonia lost (kg N/ha) across multiple topdress applications at the Naracoorte trial site. Bars represent standard error of means (n = 4).*

Table 12*. Amount of nitrogen lost (% of applied) for urea and Green Urea NV across multiple topdresses in June-August at the Naracoorte trial site.*

	Topdress one						Topdress two					
	Urea	Green Urea NV	Easy N	Gran Am	eNpower	Dual Inhibitor	Urea	Green Urea NV	Easy N	Gran Am	eNpower	Dual Inhibitor
Nitrogen lost (% of application)	15.1	3.0	8.8	8.1	16.6	5.3	11.1	3.5	16.4	13.0	16.8	4.8

	Topdress three				
	Urea	Green Urea NV	Gran Am	eNpower	Dual Inhibitor
Nitrogen lost (% of application)	15.0	2.3	6.6	7.8	3.0

Table 13. *List of co-operators involved in the ammonia volatilisation research trials.*

Trial site	Co-operators
Naracoorte	Elders Naracoorte – Adam Hancock
Arthurton	Nutrien Central Ag – Paul Ackland
Murchison East	Riverine Plains – Peter Chen
Howlong	Lawson Grains – Nick Innis
Derby	Elders Bendigo – Craig Farlow
Hopetoun	Dodgshun Medlin – Hamish McDonald
Longerenong	CropOpti – Meaghan Polhner
Lake Bolac	Gorst Rural – Alex Prince
Ungarra	Bawdens Rural Supplies – Max Baldissera
Kanagulk	Western Ag – Adrik Wright

Incitec Pivot Fertilisers