Nitrogen management in wheat – 2015

Richard Daniel, Rachel Norton, Anthony Mitchell and Linda Bailey

Northern Grower Alliance

Key words

Nitrogen, wheat, yield and protein

GRDC code

NGA00004: GRDC Grower Solutions for Northern NSW and Southern Qld

Take home messages

1. The rate of nitrogen applied was the main factor impacting yield and grain quality (both positive and negative) in all trials

2. There was no significant benefit from polymer coated urea products compared to urea alone at any site

3. Urea spread immediately post sowing, and with no physical incorporation, provided equivalent crop responses to urea spread and incorporated by sowing

4. Split application of urea at 50 kg N/ha drilled preplant or incorporated by sowing followed by 50 kg N/ha spread in-crop at ~GS30 provided at least equivalent crop responses to urea at 100 kg N/ha spread and incorporated by sowing

5. Although grain protein levels increased with rate of N application at all sites, grain quality was reduced (screenings and test weight) in response to N rate at sites where yield losses occurred

In recent years, NGA have been heavily involved in projects focussed on nitrogen application strategies in wheat, particularly to assist the management of high yielding - and frequently lower protein achieving - wheat varieties such as EGA Gregory. In 2015 the trial activity focussed on two main areas; 1) the impact of application timing on N responses and 2) a second year of evaluation of the fit of 'enhanced' urea products.

Method

Six trials were established in 2015 in paddocks nominated by agronomists and growers as low in nitrogen or expected to be N responsive. Unfortunately the site chosen near Billa Billa was later found to have a high variability in starting N and the trial was discontinued. EGA Gregory was the test variety at all sites.

All trials were established using small plot planters with row spacings of 32cm and plot lengths of 9-12m. Five N application approaches were evaluated;

- Application A - N disc drilled preplant (late March/early April)
- Application B – N spread on soil surface on same date as Timing A

- Application C - N spread immediately before sowing and incorporated by sowing (IBS) with narrow point tynes
- Application D - N spread immediately post sowing (PSPE) and
- Application E – N spread in-crop at GS30

Table 1 – Site details 2015

	Moree	**North Star**	**Bellata**	**Narrabri**	**Macalister**
Previous crop	Chickpea	Chickpea	Chickpea	Wheat	Maize
Available soil nitrogen preplant (kg N/ha)	71 (0-90cm) April 2015	41 (0-90cm) Jan 2015	68 (0-120cm) May 2015	83 (0-60cm) Feb 2015	64 (0-120cm) Feb 2015
Available soil nitrogen sowing (kg N/ha)	25 (0-30cm)	44 (0-30cm)	41 (0-30cm)	68 (0-30cm)	50 (0-30cm)
Applications A & B (preplant)	30/3/15	30/3/15	2/4/15	2/4/15	10/4/15
Timing and quantity of first rain preplant	8mm 1 DAA	74mm ~5 DAA	69mm 2-5 DAA	60mm 2-3 DAA	8mm 10-11 DAA
Applications C & D (sowing)	5/5/15	16/5/15	26/5/15	27/5/15	1/6/15
Timing and quantity of first rain post sowing	7mm 16 DAA	8mm 5-6 DAA	10mm 5 DAA	5mm 4 DAA	9mm 16 DAA
Application E (in-crop)	20/7/15	20/7/15	21/7/15	21/7/15	30/7/15
Timing and quantity of rain post in-crop application	62mm 3-5 DAA	51mm 3-5 DAA	13mm 3-7 DAA	4mm 2 DAA	4mm 26 DAA
Final NDVI assessment	10/9/15	10/9/15	15/9/15	15/9/15	7/9/15
In-crop rainfall (mm)	128	129	300	203	132

Available soil nitrogen = total soil mineral N kg/ha (to soil depth) using a bulk density of 1.3. It does NOT include any mineralisation credit. DAA= Days after application.

Urea was the main nitrogen formulation used with two polymer coated formulations also evaluated for impact on canopy management. Equivalent rates of total N/ha were applied as ESN (in a ratio of 60% ESN and 40% urea) or Agrocote N39 (in a ratio of 30% ESN and 70% urea).

Soil testing for N level was conducted twice. An initial sample for site selection but an additional shallow sample (0-30cm only) at sowing to determine whether the preplant N application had moved in the profile. The levels found at 0-30cm in the untreated at sowing were higher than expected, particularly at North Star, Bellata and Narrabri. This suggested increased levels of N mineralisation may have occurred since the initial testing and that these sites may have been less responsive to applied N.

Table 2 – Treatments evaluated (rates in kg N/ha applied)

Application	Description	Urea	ESN	Agrocote N39
A	Disc drilled preplant	50, 100, 200	100	100
B	Spread at preplant timing	100	-	-
C	Spread and IBS	50, 100, 200	50, 100	50, 100
D	Spread PSPE	50, 100, 200	-	-
E	In-crop	100	-	-

NB the 200 kg N/ha rate was included in an attempt to over-fertilise.

In addition two split applications of a total of 100 kg N/ha were applied as urea to evaluate top dressing following either drilled preplant or IBS application. (50% at Timing A plus 50% at Timing E or 50% at Timing C plus 50% at Timing E).

Results

The large number of treatments were selected to allow a number of key comparisons. The three major comparisons of interest were:

1. **Nitrogen rate**: response to urea when applied at three rates and three key timing/application methods (drilled preplant v IBS v spread PSPE)
2. **Product**: all three products were drilled preplant at 100kg N/ha or applied via IBS at 50 or 100kg N/ha
3. **Timing**: urea was applied at a total of 100kg N/ha using five individual timing/application methods plus two split applications

Rainfall for incorporation of spread urea

Conditions for natural incorporation (rainfall) of urea spread at the preplant timing were considered good at all sites. Rainfall post sowing was much more limited but with 5-10mm within 5-16 DAA at all sites. Good rainfall (5-60mm within 2-7 DAA) was received at all sites except Macalister following in-crop application.

Were the trial sites nitrogen responsive?

The first objective was to determine whether the sites were actually N responsive. NDVI (Normalised Difference Vegetation Index) was used to provide an in-crop objective measurement of nitrogen response between treatments. Larger NDVI results indicate increased biomass and/or greener treatments. Figure 1 shows the NDVI results at each site from the factorial analysis of urea applied at three rates and Timings A, C and D.

1. **Nitrogen rate comparison**

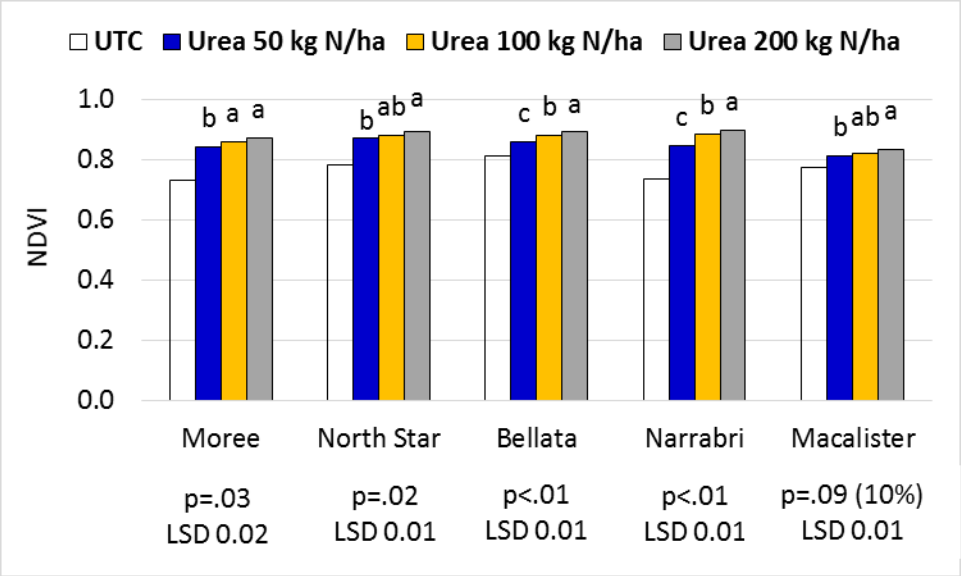

Figure 1 – NDVI responses to nitrogen rate by trial site when assessed in mid-September

UTC= untreated (no additional nitrogen applied). UTC not able to be included in factorial analysis but graphed for reference. Treatments that share the same letter within each site are not significantly different at P=0.05, except Macalister where p=.10.

- **NDVI results (in mid-September) indicated all sites were responsive to added nitrogen.** This was visually apparent in 'greenness' of plots but also in increased biomass and density of crop canopy
- At Bellata it was estimated that the 200kg N/ha rate may have delayed maturity by ~10 days compared to the untreated
- The 100kg N/ha rate significantly increased NDVI compared to 50 kg N/ha at three of the five sites
- The 200kg N/ha rate significantly increased NDVI compared to 50 kg N/ha at all sites

NDVI data not presented

- **All treatments significantly increased NDVI compared to the untreated at all sites except Macalister** (12 of 19 individual treatments were significant at Macalister)
- There was no significant difference in NDVI response between the products at any site
- There was no significant difference in NDVI response between application timing or method for urea when applied at 100kg N/ha at 4 of the 5 sites
- However at Macalister, **urea drilled or spread preplant provided significantly higher NDVI response** than the IBS application
- At Macalister, **split applications of urea provided equivalent NDVI response** to IBS application
- At Macalister, **urea spread in-crop only resulted in significantly lower NDVI response** compared to IBS application

Key points:

1. Significant NDVI/crop responses to nitrogen were recorded at all sites with **nitrogen rate the main factor**
2. Product differences were not apparent at the rates and timings tested
3. Conditions for 'incorporation' of nitrogen spread at either the preplant or IBS timings were sufficient to provide equivalent responses to the IBS application at all sites
4. Split application of nitrogen, with 50% at GS30, provided equivalent responses to IBS application at all sites

Yield

1. Nitrogen rate comparison

NDVI measurements provide an objective measure of crop response during the growing season but obviously yield and grain quality determine the economic outcome. Figure 2 shows the factorial analysis of yield when urea was applied at three rates and Timings A, C and D.

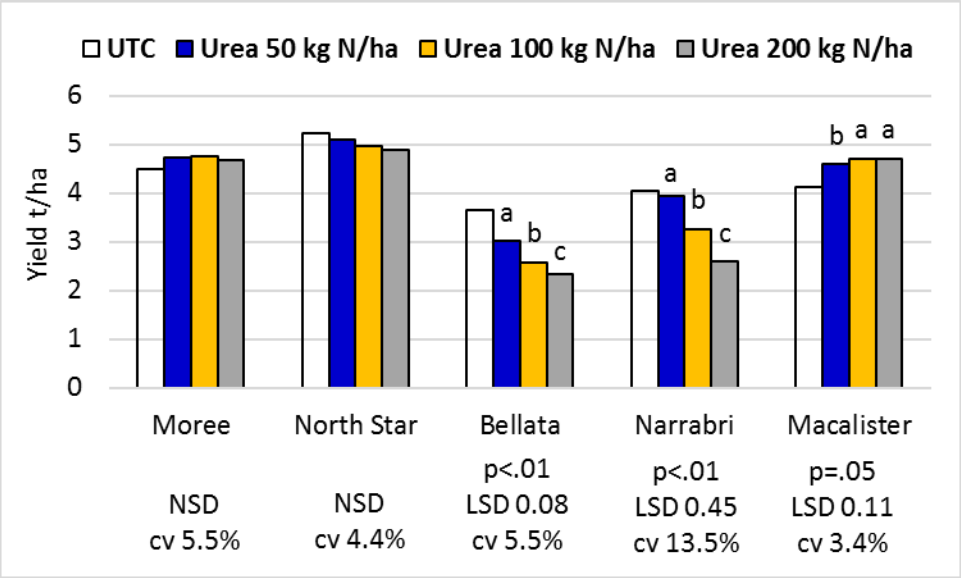

Figure 2 – Grain yield responses to nitrogen rate by trial site

UTC= untreated (no additional nitrogen applied). UTC not able to be included in factorial analysis but graphed for reference. Treatments that share the same letter within each site are not significantly different at P=0.05, except Macalister where p=.10.

Despite all sites appearing N responsive when assessed for crop growth in mid-September, only one site recorded increased yields from N application, one site was unresponsive and three sites recorded reduced yields with N application

- At Moree, there was no significant difference in yield between any treatment and the untreated
- At North Star, 5 of the 19 individual treatments recorded significantly reduced yield compared to the untreated
- At Bellata, all individual treatments recorded significantly reduced yield compared to the untreated. There was a significant rate response with the 100kg N/ha rate significantly lower than 50kg N/ha, and 200kg N/ha significantly lower yielding than 100kg N/ha

- At Narrabri, 9 of the 19 individual treatments recorded significantly reduced yield than the untreated. There was also a significant rate response with the 100 and 200kg N/ha rates significantly lower yielding than 50kg N/ha
- At Macalister, all individual treatments recorded significantly increased yield compared to the untreated with 100 and 200kg N/ha significantly higher yielding than 50kg N/ha

Yield data not presented

- There was no significant difference in yield between urea and the two polymer coated formulations at any site when drilled preplant or spread and IBS
- There was no significant difference in yield from urea applied at 100kg N/ha at any timing or application method

Key points:

1. Although the addition of nitrogen produced significant crop growth benefits at all 5 sites, yield benefits were only recorded at the Macalister site.
2. **Nitrogen rate was the key factor affecting yield**
3. There was no significant difference between the polymer coated urea products and urea alone
4. There was no significant difference in yield between timings and application method at any site
5. Bellata and Narrabri were both sites that recorded good levels of early rainfall in-crop but experienced a dry and hot September/October

The most likely explanation for the negative yield responses at North Star, Bellata and Narrabri is a combination of limited soil moisture during flowering/grain fill and the impact of N application on time of flowering combined with increased temperatures during grain fill in late October.

Grain protein

1. **Nitrogen rate comparison**

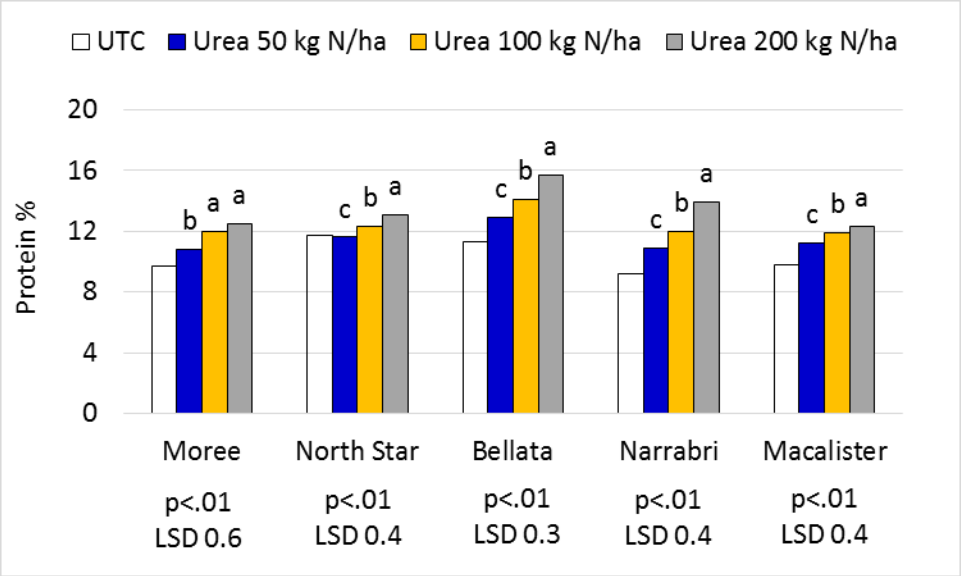

Figure 3 – Grain protein responses to nitrogen rate by trial site

UTC= untreated (no additional nitrogen applied). UTC not able to be included in factorial analysis but graphed for reference. Treatments that share the same letter within each site are not significantly different at P=0.05

- **Analysis of grain protein levels showed all sites were responsive to added nitrogen**
- The 100kg N/ha rate recorded significantly increased protein levels compared to the 50 kg N/ha rate at all sites
- The 200kg N/ha rate recorded significantly increased protein levels compared to 100 kg N/ha at 4 of 5 sites

Grain protein data not presented

- There was no significant difference in grain protein levels between urea, ESN and Agrocote N39 at 3 of the 5 sites (North Star, Narrabri and Macalister)
- At Moree, there was no significant difference in grain protein levels between urea and Agrocote N39, however ESN recorded significantly lower protein (by ~0.5-0.7%) than the other products
- At Bellata, ESN and Agrocote N39 recorded significant lower protein (by ~0.3-0.4%) than urea. There was no significant difference between ESN and Agrocote N39
- There was no significant difference in grain protein levels between application timing or method for urea when applied at 100kg N/ha at 3 of the 5 sites (Moree, North Star and Narrabri)
- At Bellata, urea drilled preplant or spread at GS30 both provided significantly higher protein levels (by ~0.3-0.4%) than the IBS application
- At Macalister, urea either drilled or spread preplant, split applied at preplant and GS30 or applied PSPE all recorded significantly higher protein levels (by ~0.5-1.5%) than the IBS application
- At Macalister, urea drilled preplant recorded significantly higher protein levels than all other applications (by ~0.8-1.6%)

Key points:

1. Grain protein levels in the untreated ranged from 9.2 to 11.7%
2. The addition of nitrogen resulted in increased grain protein levels at all sites with **nitrogen rate the main factor.**
3. Product differences were minor with no apparent benefit from either ESN or Agrocote N39 at the rates and timings tested
4. At sites where application differences were apparent, urea drilled preplant provided the highest protein levels
5. Urea spread PSPE provided at least equivalent grain protein levels to the IBS application at all sites
6. Split application of nitrogen, with 50% at GS30, provided at least equivalent protein levels to IBS application at all sites

Screenings

1. **Nitrogen rate comparison**

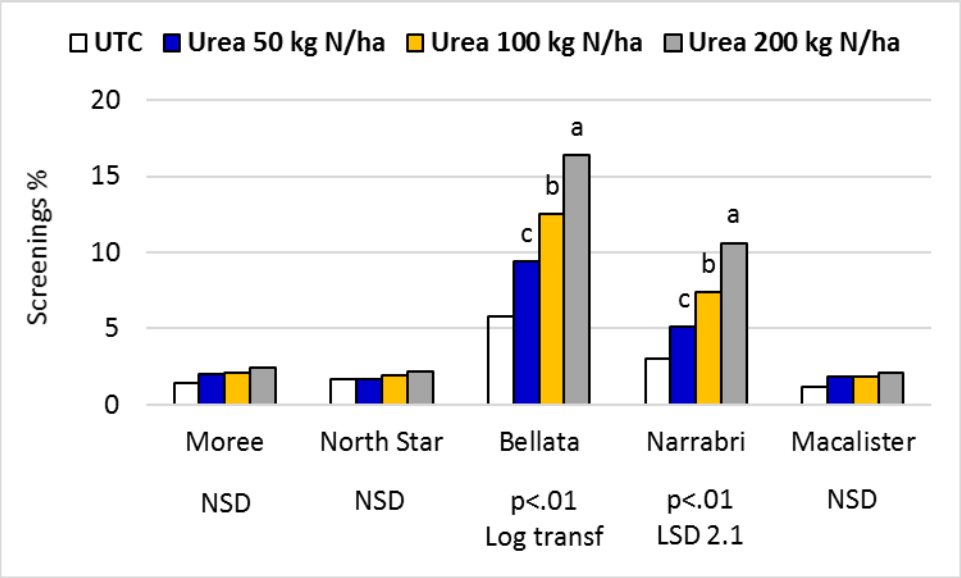

Figure 4 – Grain screenings responses to nitrogen rate by trial site

UTC= untreated (no additional nitrogen applied). UTC not able to be included in factorial analysis but graphed for reference. Treatments that share the same letter within each site are not significantly different at P=0.05

- **At both Bellata and Narrabri, increasing N application rates significantly increased grain screening levels**
- Although there was no significant N rate response at Macalister, 8 of the 19 individual treatments recorded significantly higher screenings than the untreated

Grain screenings data not presented

- There was no significant difference in grain screening levels between urea, ESN and Agrocote N39 at any site
- There was no significant difference in grain screening levels between application timing or method for urea when applied at 100kg N/ha at any site

Key points:

1. **Grain screening levels significantly increased with N rate at the two sites (Bellata and Narrabri) that recorded significant yield losses to applied N**
2. There was no apparent difference between the products at the rates and timings tested
3. Application timing and method differences were minor compared to N rate, however at Macalister the three rates of drilled preplant application of N resulted in significantly increased screenings compared to the same rates spread and IBS (by ~0.7%)
4. There was no reduction in screening levels when urea was spread at preplant or PSPE compared to the IBS application at any site
5. There was no reduction in screening levels when urea was split applied, with 50% at GS30, or when 100% applied in-crop

Grain nitrogen recovery (data not presented)

- Grain nitrogen recovery (yield t/ha x protein % x 1.75) was calculated to assess the efficiency of fertiliser use
- Using the 50 kg N/ha rate, the recovery levels at Narrabri and Moree were 20 and 26% respectively
- At Macalister the recovery level from the 50kg N/ha rate was 45%
- At North Star and Bellata, there was less N recovery in fertilised treatments than the untreated

Economics

Receival grade prices at the end of October 2015 had a wide range of ~$70/t between APH and HPS1 classifications. Figure 7 shows the net benefit/loss across all sites for rates of urea alone.

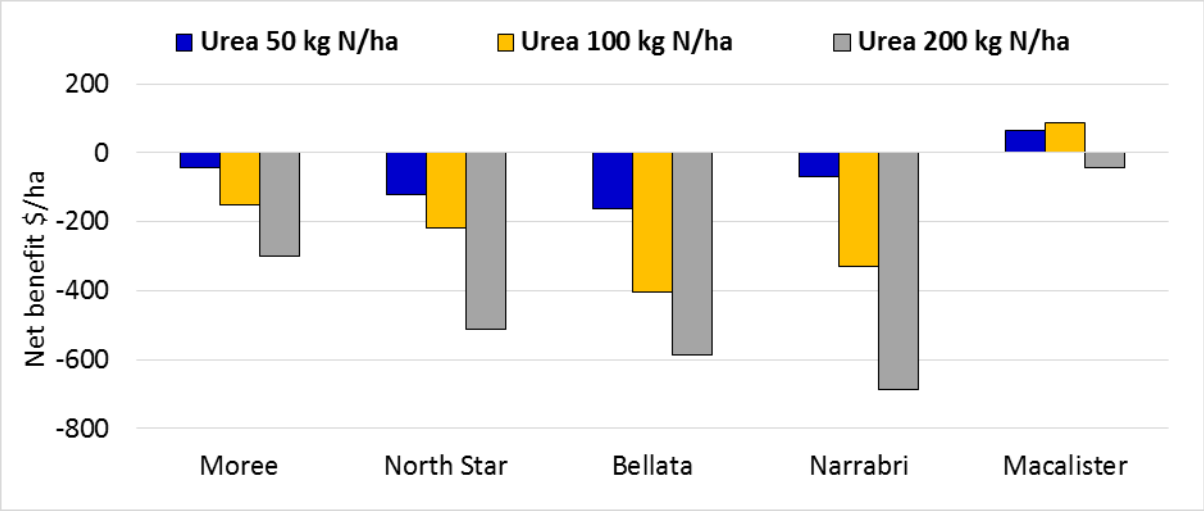

Figure 5 – Net benefit responses to nitrogen rate by trial site

Assumptions: urea at $1.30/kg N ($600/t), spreading cost of $25/ha/application, drilled application at $40/ha, grain prices delivered Moree 29/10/15: APH $267/t, H2 $250/t, APW $237/t, AUH2 $227/t, ASW $225/t, AGP $207/t and HPS $197/t

- **Despite all sites appearing N responsive during September, net benefits were only obtained from N application at the 50 or 100kg N/ha rates at the Macalister site**
- **The results reinforce the need to try to match N application rate with yield potential and soil moisture availability**
- At Macalister, 12 of the 19 individual treatments recorded a net benefit ranging from $1-$163/ha

Conclusions

The results in 2015 comparing urea with the polymer coated urea products were very similar to 2014. Despite all sites being responsive to increasing N rate for both crop growth and protein, there was no apparent benefit from the polymer coated products. However in four of the nine trials, ESN has recorded significantly lower protein than achieved with urea alone and indicates the polymer coating is clearly having an impact on N availability.

The rate of N applied has been the dominant factor affecting yield and grain quality across all nine trials in 2014 and 2015. Preplant application in 2015 appeared more vigorous in early winter assessment but only provided a significant benefit at the Macalister site.

The performance of urea spread and not mechanically incorporated has continued to provide equivalent results to incorporated urea at the same timings – unfortunately this also applied to situations where yield losses occurred! In 2015, useful levels of incorporating rain were received at all sites following the preplant applications however rainfall levels were much lower following the PSPE application and with a longer delay from application. Although spreading urea preplant or PSPE is certainly not being promoted, the results continue to support the N volatilisation results achieved by Dr Graeme Schwenke and indicate in-crop application may be less risky than previously considered in the northern region.

Acknowledgements

The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC, the authors would like to thank them for their continued support.

NGA would particularly like to acknowledge the assistance from Jason Schelberg, Ian Webster, Hugh Ball, Simon Doolin, Drew Penberthy and the Frater family for 2015 trial activity together with Kalyx staff for trial planting, maintenance and harvest. In addition we would like to thank Landmark, Impact Fertilisers and Pacific Seeds for product supply and technical support.

Contact details

Richard Daniel
Northern Grower Alliance
07 4639 5344
richard.daniel@nga.org.au