Durum Agronomy

The aim of the trials is to examine various treatments that may assist in ensuring high protein, high yielding durum wheat from irrigation.
The key to successful durum production is grain quality – DR1 requires greater than 13% protein as well as meeting grain colour and vitreous kernel specifications.
The trials are supported by GRDC in 2017 and 2018.

Background

Growing high yielding cereals requires large amounts of nitrogen to produce high grain protein.
The first management strategy we have chosen is to pursue is to follow a pulse crop for the “free” nitrogen fixed and then released in the following season. Another reason to follow a pulse is for disease control as the durums are very susceptible to the cereal stubble borne disease crown rot.
Understanding the quantity and timing of the nitrogen released from pulse stubbles has been challenging. Because the N only becomes available when the faba stubble is broken down, summer rainfall leading up to sowing plays an important part of how much N is present at sowing and how much will be released during the growing season.

Based on experience from the past three seasons, it seems that there is likely to be about 120 kg N/ha released by the faba stubble from a 6 t/ha crop. Theoretically a 6 t/ha bean crop would be produced from a total biomass of 13 t/ha, and 7 tonnes of stubble would produce 140 kg N/ha. As our stubble is not incorporated, then achieving 120 kg N/ha is close to the maximum achievable (Some of our biomass cuts over the years have seen total up to 20 t/ha and the ratio of beans to biomass ranges from 0.34 to 0.54 or 6 t/ha beans could be produced from a total biomass of 11 to 18 t/ha or potential N released of 100 to 280 kg N/ha).
But when this N is released depends on the amount of summer rainfall. In 2017, the durum trials started with soil N of 74 kg N/ha following 54mm of post-harvest rainfall compared to 40 kg N/ha from 34mm in 2016.
The protein results in 2016 were excellent and the grain achieved DR1. In 2017, yields were higher than expected but using the same N budget and assuming 120 kg N/ha from the stubble in-crop, grain protein was short by 1.5%. So what was different? Making some assumptions about N efficiencies, it seemed that the stubble only released 80 kg N/ha in-crop in 2017. But looking at the soil N figures in another way, it seems we have a base starting N of around 40 kg N/ha at the Trial Block and then depending on the stubble and rainfall, this varies between 40 and 80 kg N/ha before pre-irrigation in April. So looking at 2017, we did get 120 kg N/ha from our stubble, just we got 40 kg N/ha before pre-irrigation and the rest in crop. The mistake I made in the N budget was to assume the 120 kg N would be delivered in-crop. The other observation from 2017 was that the stubble broke down rapidly in the autumn, and didn’t release much N in the spring. Similarly, 2018 saw starting soil N of 76 kg N/ha prior to pre-irrigation and 124 kg N/ha at sowing.

We have tried various strategies based on the assumption of durum wheat requires 50 kg N/t (compared with APW at 40 kg N/t):

1. Standard: N applied throughout the season, starting late tillering, aiming to maximise yield.
2. Late N: A late application at head emergence aiming to increase grain protein.
3. High N: Similar to the standard, but at higher rates to ensure an adequate supply of N.
4. Late application of liquid N aiming to increase grain protein.

Another aspect of durum agronomy is time of sowing (ToS). Advice from the northern node of the Durum Breeding Australia project suggested a sowing date later in May than for the main season bread wheats. This was tested in 2017 where sowing was delayed until May 29th and June 23rd due to rainfall on top of pre-irrigation and yields exceeded 10 t/ha at both sowing dates. Grain protein was improved by the later sowing as well.

These strategies formed the basis of two durum trials in 2018, one trial using DBA Aurora looking at time of sowing and various N strategies including late foliar application and the other to compare BBA Vittaroi and DBA Aurora and their response to PGRs, N management and sowing rate.

Trial 1: N strategies to achieve DR1 specification

This trial focussed on different N strategies, including post flowering N applications to target increased grain protein. DBA Aurora was used for all treatments. Aurora was sown at 143 kg/ha targeting 160 plants/m^2, with 125 kg DAP/ha following pre-irrigation (1.5 Ml/ha). Sowing date was either “early” on May 8th or “late” on May 29th.

Nitrogen budget for the standard (control) treatment:

Yield Target	8.5	t/ha
N Required/t	50	kg N/t
N Required/ha	425	kg N/ha
Soil N (faba stubble)	76	kg N/ha
Starter fertiliser	20	kg N/ha
Mineralised N*	80	kg N/ha
Topdressing required	249	kg N/ha

*: Assumes that 40 kg N/ha of a potential 120 kg N/ha has already being mineralised raising the soil N to 76 kg N/ha.

Target yield was 8.5 t/ha. The major weakness of preparing a nitrogen budget is getting the yield target wrong. If yield exceeds the target, the likelihood is lower protein than expected. The “high N” strategy is an attempt to reduce this risk.

Nitrogen Strategies

Treatment	N Application		Treatment	1	2	3	4	5	6	7	8
	Stage	ToS1 8/5	ToS2 29/5	Control	Late N	Late N(2)	Post Fl Stream	Post Fl Flat	Post Fl Flat(2)	High N	High Post Fl Flat
Topdress 1	<30	4-Jul	2-Aug	80	80	60	40	40	80	80	80
Topdress 2	32	17-Aug	5-Sep	80	90	60	40	40	80	100	80
Topdress 3	37	5-Sep	8-Oct	90		65	65	65	50	150	80
Topdress 4	55	8-Oct	8-Oct		80	65	65	65			70
Foliar Application	69	17-Oct	29-Oct				40	40	40		20
Total N Applied				250	250	250	250	250	250	330	330

As winter topdressing relies on rainfall events, some of the planned topdressings did not occur on the planned dates as can be seen in the strategies table.

Post flowering N strategies were applied on October 17th to ToS1 and on 29th October to ToS2. Easy N was applied undiluted at 95 l/ha to supply 40 kg N/ha to all but one of the post flowering treatments. The “High N Post-flowering” treatment received 20 kg N/ha. The degree of leaf burn was assessed by NDVI measurement.

ToS1
Application date: 17/10/2018
Weather conditions: 14°C, 87% RH, wind 4 km/hr northerly, overcast

ToS2
Application date: 29/10/2018
Weather conditions: 12°C, 55% RH, wind 9 km/hr SSW, sunny

The trial was irrigated 4 times in spring (29/8, 20/9, 9/10 and 28/10) for a spring total 3.8 Ml/ha.

The trial was harvested on December 11th.

Results

Summary of NDVI measurements post application

ToS1: Applied October 17th.

ToS1	NDVI Reading		NDVI Reading	
Treat	29-Oct		5-Nov	
Control	73.3	a	63.3	NS
Late N (1)	73.0	a	59.0	
Late N (2)	74.3	a	64.3	
Streaming	68.3	bc	59.3	
Flat Fan (1)	68.0	bc	60.3	
Flat Fan (2)	66.3	c	56.3	
High N	74.7	a	66.7	
High N + Flat Fan	71.3	a	66.3	
p	0.004		0.051	
lsd	4.262		6.872	
cv%	3.4		6.3	

NDVI measurements taken 12 days post application on October 29th showed that some leaf scorching had occurred (a decrease in the NDVI measurement). The NDVI measurements fell into 3 groups – highest readings were from treatments that did not receive the foliar application, the most affected plots were those that received 40 kg N/ha via either flat fan or streaming nozzles and the treatment that received 20 kg N/ha was in-between. However NDVI measurements taken 19 days post application showed no difference between any treatments.

ToS2

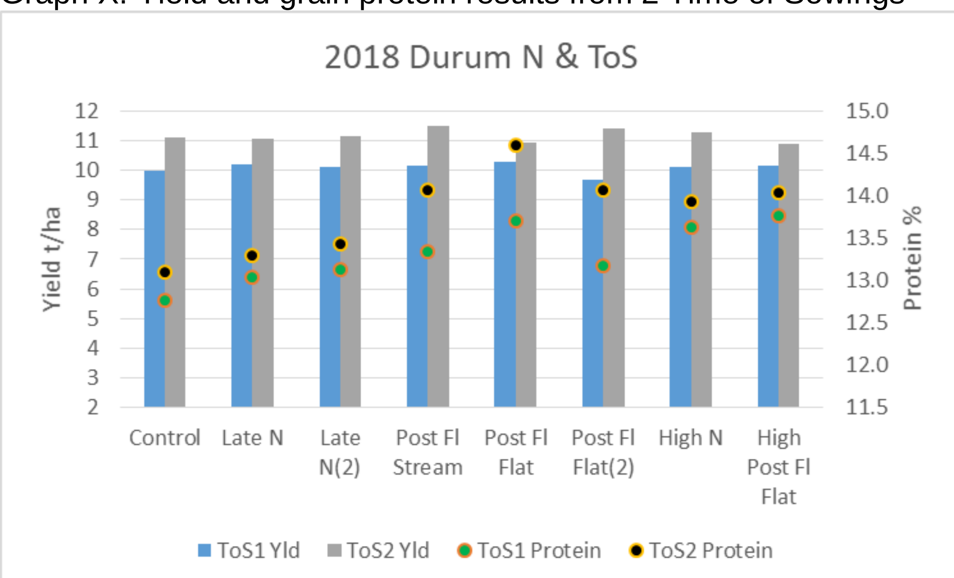
ToS1	NDVI Reading	
Treat	5-Nov	
Control	78.0	a
Late N (1)	78.0	a
Late N (2)	77.7	a
Streaming	74.3	c
Flat Fan (1)	73.7	c
Flat Fan (2)	73.3	c
High N	78.0	a
High N + Flat Fan	75.3	b
p	<0.001	
lsd	1.404	
cv%	1.1	

It was a similar situation in the second time of sowing with NDVI measurements taken 7 days post application. The treatments that received 40 kg N/ha either flat fan or streaming nozzles were affected by more leaf burn than the treatment that received 20 kg N/ha.

Overall the leaf burn was lower than anticipated. This could be partly due to the upright nature of the Aurora flag leaf that resulted in any burning being confined to the flag tips and some damage on the awns.

Leaf burn from 40 kg N/ha applied using flat fan nozzles, 7 days after application.

Graph X: Yield and grain protein results from 2 Time of Sowings



Yields

ToS1 averaged 10.1 t/ha while ToS2 average 11.2 t/ha, which was a statistically significant difference ($p<0.001$, lsd = 0.25, cv% = 4.0). Yield at each ToS was not affected by the N treatments, which is unsurprising given that the N applied in all situations was more than adequate to maximise yield. All but one N treatment (Post-flowering N applied @ 40 kg N/ha via flat fan nozzle) saw yields significantly higher in the second time of sowing. Compared to “Flat Fan (2)”, this treatment saw lower rates of N earlier in the season.

Grain Protein

Grain protein was significantly higher in the second ToS, with the average from all treatments being 13.3% for ToS1 and 13.8% for ToS2 (0.001, lsd = 0.18, cv% = 2.3)

N Treatment	ToS1	Significance	ToS2	Significance
Control	12.8	a	13.1	a
Late N	13.0	ab	13.3	a
Late N(2)	13.1	ab	13.4	ab
Post Flowering Flat Fan(2)	13.2	ab	14.1	bc
Post Flowering Streaming	13.3	bc	14.1	bc
High N	13.6	cd	13.9	b
Post Flowering Flat Fan (1)	13.7	cd	14.6	c
High N Post Flowering Flat Fan	13.8	d	14.0	bc
p	0.001		0.002	
lsd	0.4188		0.6012	
cv	1.8		2.5	

Looking at the protein results from ToS1, either the high N alone or higher N rates later in the season plus a post flowering foliar application resulted in protein responses of up to 1% above the control. Comparing the two 40 kg N/ha "Flat Fan" treatments, the (2) treatment was not significantly different to the control whereas the (1) treatment was. The difference lies in when the majority of the N was topdressed – the (2) treatment had the majority topdressed earlier in the season. The "Flat Fan (1)" treatment also achieved similar grain protein to the "High" treatments but with 80 kg N/ha less applied N.

ToS2 had a similar story where all foliar and "High N" treatments resulted in grain protein levels higher than that of the control.

What does it mean?

A better understanding of mineralisation following a faba stubble has resulted in a more accurate nitrogen budget.

Later time of sowing resulted in an increase in yield as well as higher grain protein.

Foliar N application can help achieve DR1 quality, but still needs a high level of N availability to the roots late in the season.