Optimising Irrigated Grains (FAR1906-003RTX)
A Grains Research & Development Corporation (GRDC) investment

PROVISIONAL HARVEST RESULTS:

Irrigated Winter and Spring Barley Trials

Released:24 February 2021

The GRDC Optimising Irrigated Grains Project is a collaborative project including the following project partners:

Finley Irrigated Research Centre NSW

Irrigated trials conducted at the Finley irrigated research centre 2020 were managed by FAR Australia, hosted by Southern Growers.

Trial 1 Nitrogen Use Efficiency Trial – Nitrogen Rates

Protocol Objective:

To evaluate nitrogen use efficiency in winter barley under different rates of applied N fertiliser applied as pre drill urea (46% N) grown under overhead irrigation (travelling lateral).

Location: Finley IRC
FAR Code: FAR B20-03-1
Sown: 24 April
Cultivar: Cassiopee
Harvested: 28th November 2020
Rotation position: Fallow (2019), Faba bean (2018), Wheat (2017)
Soil Management: Cultivated with speed disc in Autumn
Irrigation: Overhead lateral irrigation 5 x 25mm in spring. Total applied 125mm (1.25 ML/ha)
GSR: April-October 244mm. Total water available 369mm

Key Points:

Winter barley germplasm cv Cassiopee following fallow with an estimated 226 kg N/ha available soil mineral N (0-90cm) gave no response to applied nitrogen fertiliser (Urea 46% N).

- *There was no significant difference in yield due to nitrogen rate (0-320kg N/ha), with a trend suggesting declining yield as more N was applied that was linked to earlier lodging.*
- *The longer season and later flowering of Cassiopee and crop lodging were also contributory factors to lower grain yields and harvest indices.*
- *High inherent soil fertility resulted combined with 24 April sowing produced high dry matter at harvest but very poor harvest indices, ranging from 24.2% to 29.4%.*
- *The longer season and later flowering of Cassiopee and crop lodging were also contributory factors to lower grain yields and harvest indices.*
- *Protein was very high and significantly increased as more nitrogen fertiliser was applied, up to 200kg N/ha.*
- *There was no clear trend or significant difference in total dry matter assessed at harvest due to nitrogen rate with an average dry matter production of 20t/ha (range 19 – 21.5t/ha).*
- *Nitrogen offtake in the crop canopy at harvest (grain & straw) ranged from 232 - 333kg N/ha with the lower figure recoded in the zero 0 plots. Differences were not significant (p=0.059)*
- *N offtake in the crop canopy peaked at 333kg N/ha when 120kg N/ha was applied.*

Winter barley yields produced relatively modest grain yields (5.73 – 6.52t/ha) in this first cereal situation following fallow (Table 1) with no yield response to applied nitrogen fertiliser (urea 46% N).

Table 1. Influence of applied nitrogen (N) rate on grain yield (t/ha) and % protein when fertiliser was applied at GS30 and GS32.

Nitrogen Treatment Rate & Timing		Total	Grain yield and quality			
		Nitrogen	**Yield**		**Protein**	
		N/ha	**t/ha**		**%**	
1.	0kg N/ha	0	6.52	-	16.2	d
2.	40kg N/ha@GS30 & 40kg N/ha@GS32	80	6.09	-	17.2	cd
3.	60kg N/ha@ GS30 & 60kg N/ha@ GS32	120	6.24	-	17	d
4.	80kg N/ha@ GS30 & 80kg N/ha@ GS32	160	5.95	-	17.3	bcd
5.	100kg N/ha@ GS30 & 100kg N/ha@ GS32	200	6.02	-	18.2	abc
6.	120kg N/ha@ GS30 & 120kg N/ha@ GS32	240	5.73	-	18.5	ab
7.	140kg N/ha@ GS30 & 140kg N/ha@ GS32	280	5.84	-	18.7	a
8.	160kg N/ha@ GS30 & 160kg N/ha@ GS32	320	5.76	-	19.1	a
	Mean		6.01		17.76	
	LSD		ns		1.18	
	P val		0.138		<0.001	

Lower grain yields were in contrast to high final harvest dry matter (grain and straw combined) at harvest which averaged approximately 20t/ha, an indication of a poor ability to convert dry matter produced into grain (Table 2). High dry matter production combined with later flowering (compared to RGT Planet spring barley) and lodging reduced the yield of the winter barley in this trial relative to spring barley grown in the same trials.

Table 2. Influence of applied nitrogen (N) rate on total dry matter (grain and straw) (t/ha) and nitrogen offtake (kg N/ha) at harvest when fertiliser was applied at GS30 and GS32.

Nitrogen Treatment Rate & Timing		Total				
		Nitrogen	**Dry matter**		**N offtake**	
		N/ha	**t/ha**		**Kg/ha**	
1.	0kg N/ha	0	19.87	-	232	-
2.	40kg N/ha@GS30 & 40kg N/ha@GS32	80	19.00	-	235	-
3.	60kg N/ha@ GS30 & 60kg N/ha@ GS32	120	19.94	-	333	-
4.	80kg N/ha@ GS30 & 80kg N/ha@ GS32	160	21.51	-	266	-
5.	100kg N/ha@ GS30 & 100kg N/ha@ GS32	200	19.41	-	317	-
6.	120kg N/ha@ GS30 & 120kg N/ha@ GS32	240	18.83	-	253	-
7.	140kg N/ha@ GS30 & 140kg N/ha@ GS32	280	21.23	-	265	-
8.	160kg N/ha@ GS30 & 160kg N/ha@ GS32	320	19.94	-	279	-
	Mean		**19.97**		**273**	
	LSD		ns		69	
	P val		0.64		0.0592	

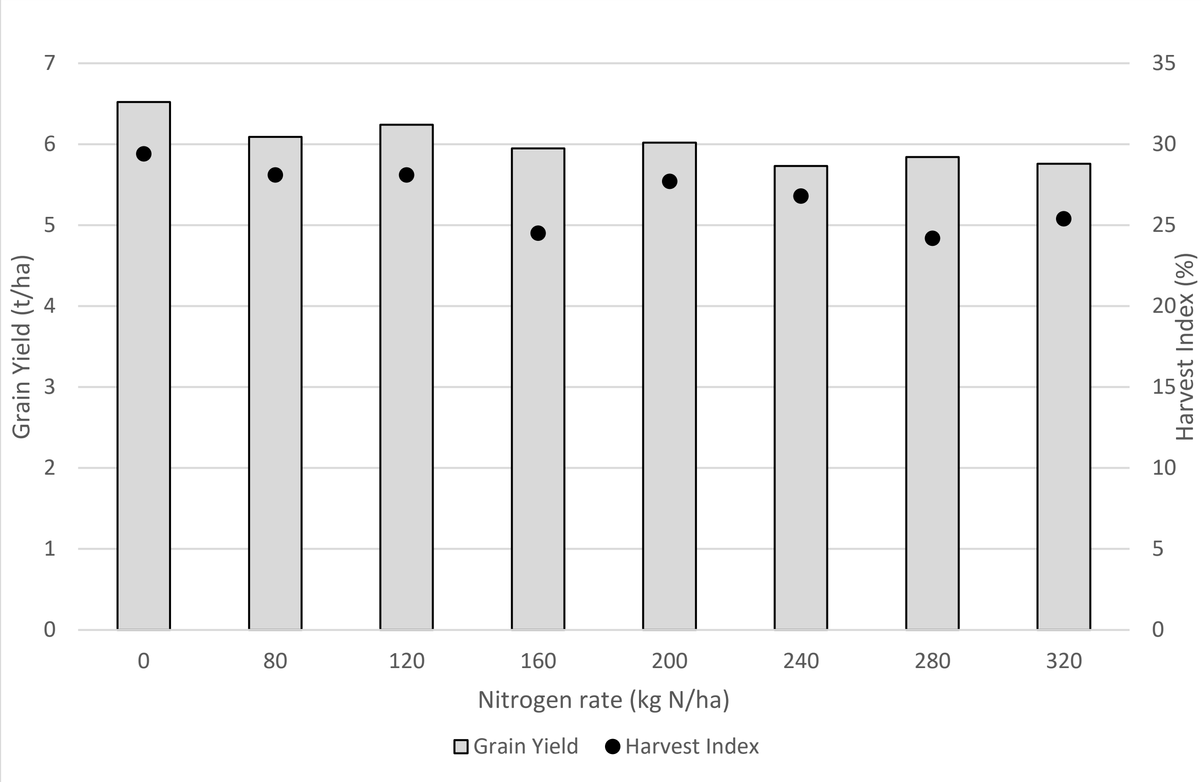

Figure 1. Grain yield and harvest index when varying nitrogen rate.

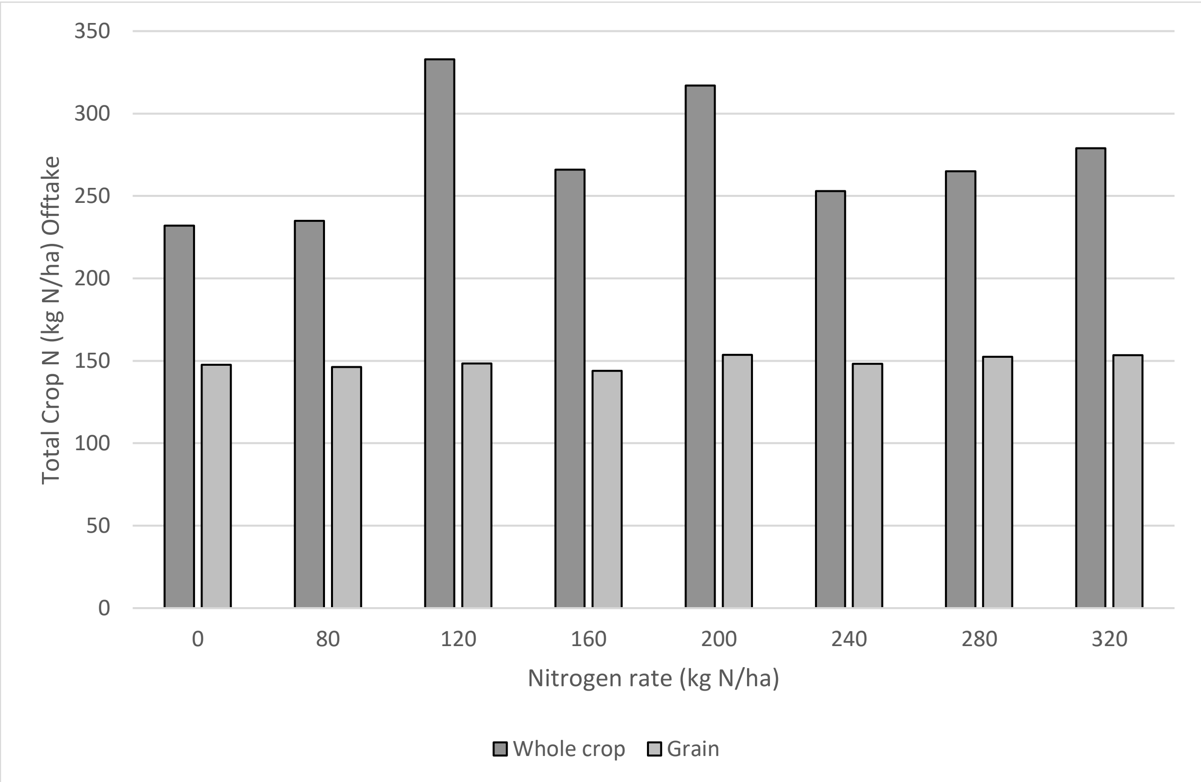

Figure 2. Nitrogen offtake when varying nitrogen rate.

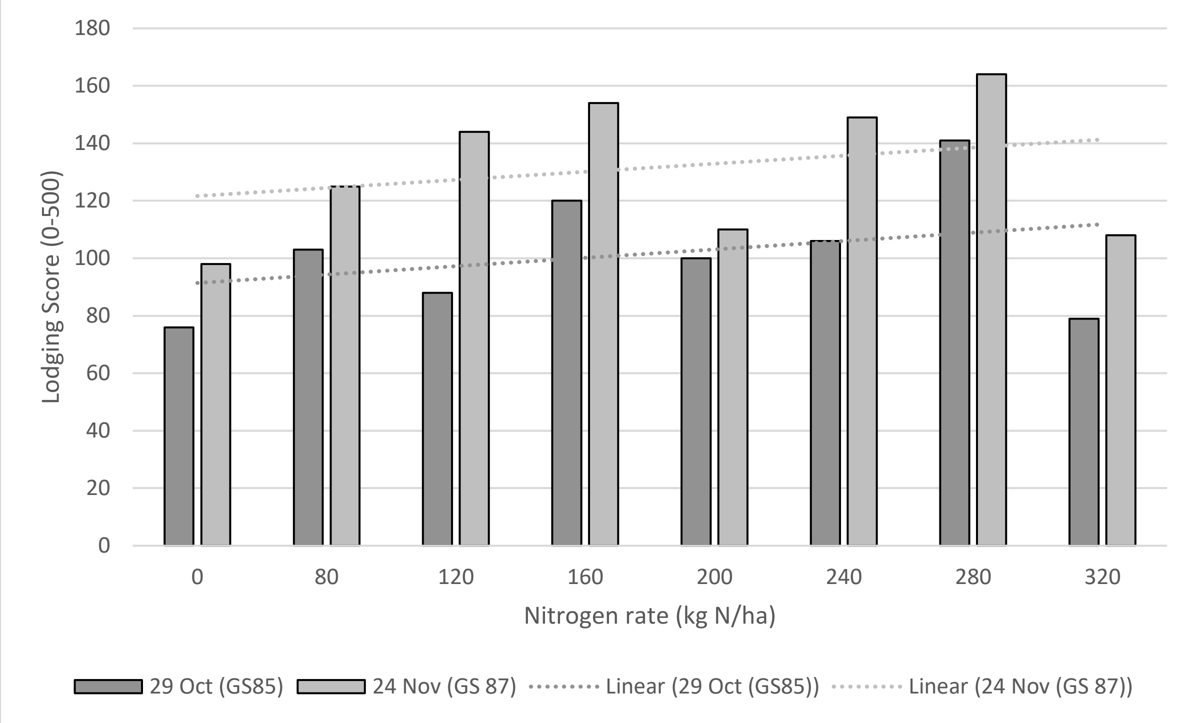

Figure 32. Lodging score (lodging index 0 – 500) when varying nitrogen rates from 0 – 320kg N/ha.

Trial 2 Nitrogen Use Efficiency Trial – Nitrogen Timing Trial

Protocol Objective:
To evaluate nitrogen use efficiency in winter barley under different rates and timings of applied N fertiliser applied as pre drill urea (46% N) grown under overhead irrigation (travelling lateral).

Location: Finley IRC
FAR Code: FAR B20-04-1
Sown: 24 April
Cultivar: Cassiopee
Harvested: 28th November 2020
Rotation position: Fallow (2019), Faba bean (2018), Wheat (2017)
Soil Management: Cultivated with speed disc in Autumn
Irrigation: Overhead lateral irrigation 5 x 25mm in spring. Total applied 125mm (1.25 ML/ha)
GSR: April-October 244mm. Total water available 369mm

Key Points:

- *With high soil fertility following fallow (226 kg N/ha available mineral N (0-60cm)) there was no significant difference in grain yield N timing (at N rates between 80 – 240kg N/ha).*
- *There was a trend for grain yields to decline with higher rates of applied N ; with a significant reduction in yield at the highest rate of N applied (240kg N/ha)..*
- *Grain proteins were very high in all treatments and increased as higher rates of N were applied, but significantly where the N timing split was early (sowing/ tillering (GS23)) there was no effect of N rate on protein.*
- *With the later N timing split (pseudo stem erect/third node (GS30-33)) higher rates of N were noted to significantly increase grain protein.*
- *There was a significant interaction between nitrogen rate and timing on grain protein; higher protein was achieved with higher rates of nitrogen at the later timings, compared to the early timing application where N rate had no impact on grain protein.*
- *Nitrogen rate or timing had no significant impact on harvest dry matter with an average of just over 20t/ha in the trial.*
- *N offtake in the grain and straw indicated more N recovery in the N timing applied at tillering/pseudo stem erect (GS23/GS30) although this produced no significant difference in yield, grain protein or dry matter production.*

Winter barley grain yields ranged from 6.14 – 6.79t/ha and were significantly higher when less nitrogen was applied (Table 1) with 0 and 80kg N/ha being significantly higher yielding than 240kg N/ha.

Table 1. Influence of different split N application timings (50:50 splits) and N rates on grain yield (t/ha).

	Nitrogen Application Rate							
	0kg N/ha		80kg N/ha		160kg N/ha		240kg N/ha	
	Yield t/ha		Yield t/ha		Yield t/ha		Yield t/ha	
Sowing & GS23	6.79	-	6.65	-	6.29	-	6.16	-
GS23 & GS30	6.59	-	6.44	-	6.46	-	6.27	-
GS30 & GS33	6.45	-	6.58	-	6.38	-	6.14	-
Mean	**6.61**	**a**	**6.56**	**a**	**6.38**	**ab**	**6.19**	**b**
LSD N Application Timing p = 0.05			ns		**P val**		0.778	
LSD N Application Rate p=0.05			0.23		**P val**		0.004	
LSD N Timing. x N Rate. P=0.05			ns		**P val**		0.587	

Grain proteins were very high (15-18.3%) and there was a significant interaction between applied N rate and timing (p=0.016) that suggested that N rate had no effect on grain protein when fertiliser application was made early but had a significant effect when N timings were made later (Table 2).

Table 2. Protein (%) of nitrogen application rates split equally at three different application timings.

	Nitrogen Application Rate							
	0kg N/ha		80kg N/ha		160kg N/ha		240kg N/ha	
	Protein (%)		Protein (%)		Protein (%)		Protein (%)	
Sowing & GS23	16.5	de	17.2	cd	17.3	bcd	17.2	cd
GS23 & GS30	15.8	ef	17.3	cd	18.0	abc	18.3	ab
GS30 & GS33	15.3	f	16.7	de	18.0	abc	18.3	a
Mean	**15.8**	**c**	**17.1**	**b**	**17.8**	**a**	**17.9**	**a**
LSD N Application Timing p = 0.05			ns		**P val**		0.563	
LSD N Application Rate p=0.05			0.56		**P val**		<0.001	
LSD N Timing. x N Rate. P=0.05			0.96		**P val**		0.039	

Protein figures followed by different letters are considered to be statistically different (p=0.05)

Dry matter production at harvest averaged 20.34t/ha but there was no significant differences due to timing or N rate, indicating that at higher rates of applied N fertiliser harvest indices were reduced (a smaller proportion of the dry matter produced was turned in grain) (Table 3.) Nitrogen offtake in the crop canopy as a whole was significantly higher when N application was timed at GS23 and GS30 (Table 4).

Table 3. Harvest dry matter (t/ha) of nitrogen application rates split equally at three different application timings.

	Nitrogen Application Rate							
	0kg N/ha		**80kgN/ha**		**160kg N/ha**		**240kg N/ha**	
	DM t/ha		**DM t/ha**		**DM t/ha**		**DM t/ha**	
Sowing & GS23	20.72	-	18.59	-	20.58	-	21.75	-
GS23 & GS30	20.2	-	21.17	-	20.65	-	19.77	-
GS30 & GS33	21.52	-	20.06	-	18.49	-	20.58	-
Mean	**20.81**	**-**	**19.94**	**-**	**19.90**	**-**	**20.70**	**-**
LSD N Application Timing p = 0.05			ns		**P val**		0.958	
LSD N Application Rate p=0.05			ns		**P val**		0.543	
LSD N Timing. x N Rate. P=0.05			ns		**P val**		0.197	

DM figures followed by different letters are considered to be statistically different (p=0.05)

Table 4. Nitrogen offtake (kg/ha) of nitrogen application rates split equally at three different application timings.

	Nitrogen Application Rate									
	0kg/ha N		**80kg/ha N**		**160kg/ha N**		**240kg/ha N**		**Mean**	
	N offtake kg/ha		**N offtake kg/ha**		**N offtake kg/ha**		**N offtake kg/ha**		**N offtake kg/ha**	
Sowing & GS23	221	-	277	-	269	-	240	-	**252**	**b**
GS23 & GS30	305	-	376	-	311	-	387	-	**345**	**a**
GS30 & GS33	255	-	213	-	271	-	305	-	**261**	**b**
Mean	**260**	**-**	**289**	**-**	**284**	**-**	**311**	**-**		
LSD N Application Timing p = 0.05			50		**P val**				0.007	
LSD N Application Rate p=0.05			ns		**P val**				0.113	
LSD N Timing. x N Rate. P=0.05			71		**P val**				0.070	

Nitrogen offtake figures followed by different letters are considered to be statistically different (p=0.05)

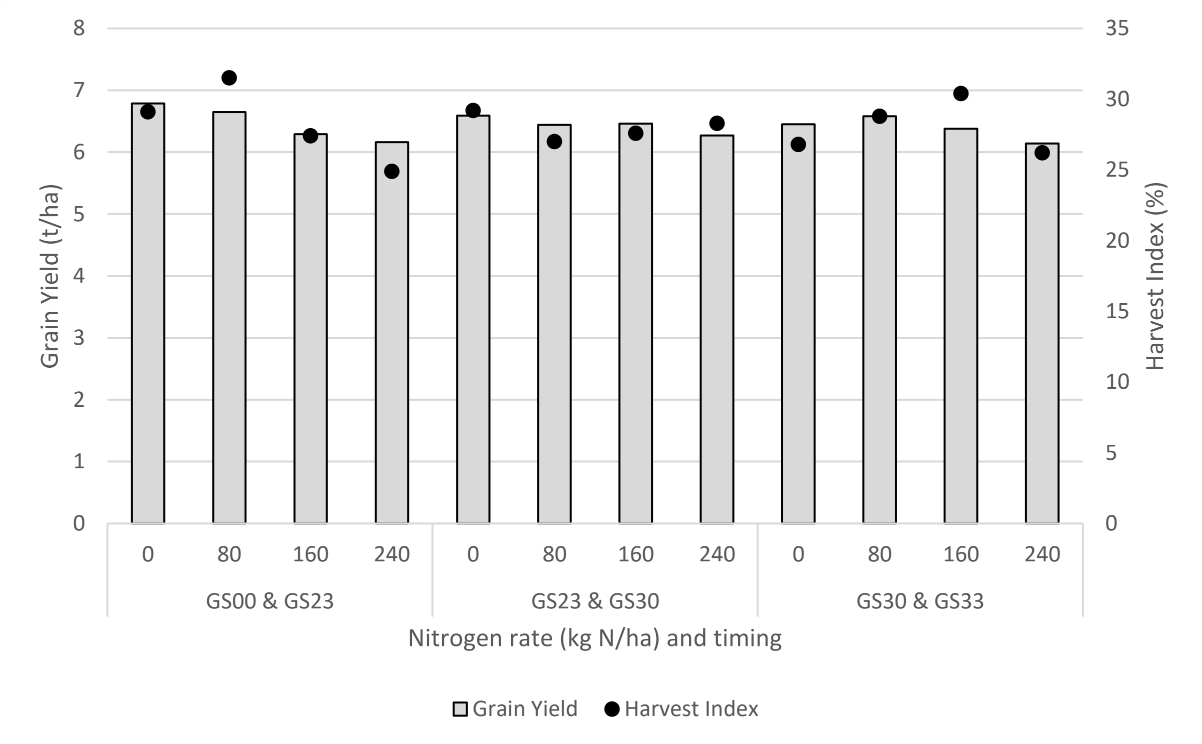

Figure 1. Grain yield and harvest index.

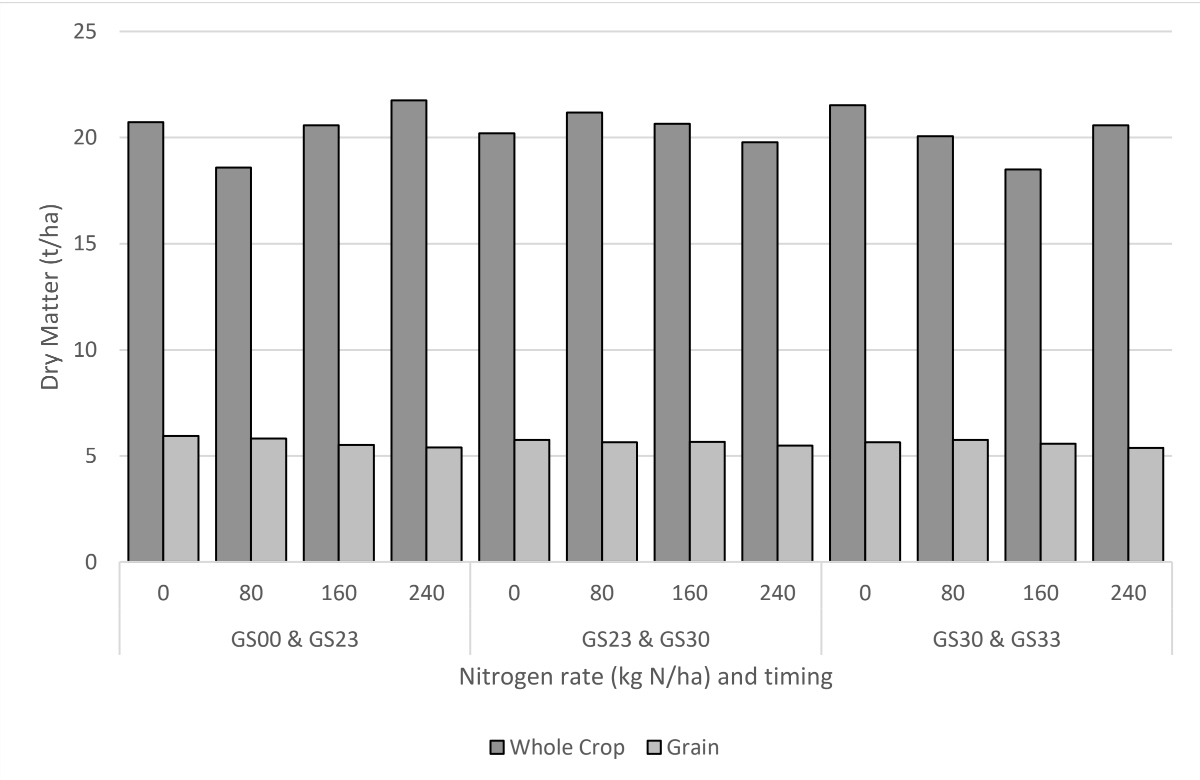

Figure 2. Dry matter offtake when varying nitrogen rate and timing.

The GRDC Optimising Irrigated Grains Project is a collaborative project including the following project partners:

Trial 3 Lodging Control in Irrigated Crops – Winter and Spring Barley

Protocol Objective:
To compare and contrast plant growth regulation strategies in winter and spring barley germplasm.

Location: Finley IRC
FAR Code: FAR B20-09-1
Sown: 24 April
Cultivar: RGT Planet & Cassiopee
Harvested: 28th November 2020
Rotation position: Fallow (2019), Faba bean (2018), Wheat (2017)
Soil Management: Cultivated with speed disc in Autumn
Irrigation: Overhead lateral irrigation 5 x 25mm in spring. Total applied 125mm (1.25 ML/ha)
GSR: April-October 244mm. Total water available 369mm

Key Pointss:

- *Under overhead irrigation in a fertile rotation position (first barley after fallow) the spring barley RGT Planet (7.27t/ha) significantly out yielded the winter cultivar Cassiopee (6.13t/ha).*
- *Cassiopee was subject to significantly more lodging and showed responses to PGR applications of Moddus Evo in terms of reduced crop height, lodging control and yield (although yield effects of PGRs were only statistically significant when both varieties were considered).*
- *In contrast, PGR application had only small effects on RGT Planet (small reductions in crop height and small differences in brackling and small increases in yield) that were in the main not significant.*
- *Grazing Cassiopee achieved a significant reduction in crop height (18cm) at flowering; compared to Moddus Evo at either rate which achieved a 13cm reduction in crop height*
- *There was significant interaction between PGR strategy and variety on plant height assessed at GS 63 (Cassiopee) and GS65 (RGT Planet)*
- *Grazing winter barley at GS30 produced significantly more dry matter than grazing spring barley that reached GS30 earlier in the winter*
- *There was no significant difference between lodging among treatments however there was a trend to less lodging with any treatment compared to the untreated.*

The spring barley RGT Planet was significantly higher yielding than the winter barley Cassiopee grown under overhead irrigation. Cassiopee was later to develop in the spring and subject to greater lodging (Table 1 & 3). PGR application based on Moddus Evo (Trinexapac ethyl) significantly reduced crop height and lodging but greater benefit in the winter barley Cassiopee which was more lodging prone (Table 2 & 3). Grazing had similar effects on crop height and lodging but the influence was greater on Cassiopee than RGT Planet, primarily as a result of later defoliation (took longer to reach GS30) and greater dry matter (Table 3 & 4).

Table 1. Influence of variety (winter v spring barley), PGR strategy and grazing on grain yield (t/ha).

	Cultivar					
	RGT Planet		**Cassiopee**		**Mean**	
	Yield t/ha		**Yield t/ha**		**Yield t/ha**	
Untreated	7.15	-	5.32	-	**6.23**	**b**
200ml/ha Moddus Evo	7.27	-	6.57	-	**6.92**	**a**
400ml/ha Moddus Evo	7.33	-	6.43	-	**6.88**	**a**
Grazed at GS30	7.33	-	6.19	-	**6.76**	**a**
Mean	**7.27**	**a**	**6.13**	**b**		
LSD Cultivar p = 0.05	0.30		**P val**		<0.001	
LSD PGR Strategy p=0.05	0.39		**P val**		0.033	
LSD Cultivar x PGR P=0.05	ns		**P val**		0.154	

Yield figures followed by different letters are considered to be statistically different (p=0.05)

Table 2. Influence of variety (winter v spring barley), PGR strategy and grazing on plant height (cm) - 29th September.

	Cultivar and growth stage					
	RGT Planet (GS65)		**Cassiopee (GS63)**		**Mean**	
	Height cm		**Height cm**		**Height cm**	
Untreated	108	b	115	a	**111**	**a**
200ml/ha Moddus Evo	105	bc	102	c	**104**	**b**
400ml/ha Moddus Evo	101	c	102	c	**102**	**b**
Grazed at GS30	104	bc	97	d	**101**	**b**
Mean	**105**	**-**	**104**	**-**		
LSD Cultivar p = 0.05	ns		**P val**		0.4787	
LSD PGR Strategy p=0.05	6.3		**P val**		0.0182	
LSD Cultivar x PGR P=0.05	4.1		**P val**		0.0012	

Height figures followed by different letters are considered to be statistically different (p=0.05)

Table 3. Influence of variety (winter v spring barley), PGR strategy and grazing on crop lodging (0 – 500 scale) - 28th October.

	Cultivar					
	RGT Planet		**Cassiopee**		**Mean**	
	Lodging 0-500		**Lodging 0-500**		**Lodging 0-500 Yield t/ha**	
Untreated	71	-	225	-	**148**	**-**
200ml/ha Moddus Evo	10	-	62	-	**36**	**-**
400ml/ha Moddus Evo	0	-	114	-	**57**	**-**
Grazed at GS30	26	-	34	-	**30**	**-**
Mean	**27**	**b**	**109**	**a**		
LSD Cultivar p = 0.05	57.7		**P val**		0.009	
LSD PGR Strategy p=0.05	ns		**P val**		0.119	
LSD Cultivar x PGR P=0.05	ns		**P val**		0.271	

The winter barley Cassiopee produced more dry matter at GS30 than RGT Planet with almost 2000kg/ha dry matter produced (Table 4). This is primarily the result of a longer vegetative period up to GS30 for dry matter production. The spring variety RGT Planet reached psuedo stem erect (GS30) (cut off for grazing in the vegetative phase) on 26th June Whilst Cassiopee reached the same growth stage on 31st July

Table 4. Influence of variety (winter v spring barley) on a single dry matter removal at GS30 (kg/ha DM).

		Dry matter (kg/ha)					
Cultivar	**Grazing date and GS**	**Pre-graze**		**Post Graze**		**DM Removed**	
		kg/ha		**kg/ha**		**kg/ha**	
RGT Planet	26 June - GS30	1.14	-	0.43	b	0.72	-
Cassiopee	31 July - GS30	2.83	-	0.89	a	1.94	-
LSD p=0.05		1.75		0.29		ns	
P val		0.054		0.021		0.106	

Kerang VIC

Irrigated trials conducted at the Kerang irrigated research centre 2020 were managed by the Irrigated Cropping Council.

Trial 1 Nitrogen Use Efficiency Trial – Nitrogen Rates

Protocol Objective:
To compare and contrast plant growth regulation strategies in winter and spring barley germplasm.

Location: Kerang, Victoria
FAR Code: ICC B20-03-2
Sown: 17 April 2020
Cultivar: Cassiopee
Harvested: 8 December 2020
Rotation position: Dryland vetch/brown manure 2019
Soil Type: Neutral medium red clay
Irrigation: Flood irrigation 4 applications totalling 400mm (4.0 ML/ha)
GSR: April-October 250mm. Total water available 650mm

Key Messages:

- *By GS33 visual responses to the applied N were apparent (crop height). However shoot numbers were consistent across all treatments*
- *Shoot loss between GS33 and GS65 was approximately 60% across the 0, 160 and 320 kg N/ha treatments – higher rates of N did not maintain shoot numbers.*
- *Lodging began shortly after flowering, beginning with the high N plots. By harvest all plots were affected by either lodging, brackling or both.*
- *Highest yielding treatments were those that received 80 – 200 kg N/ha. 0 or high rates of N decreased yield.*
- *As a general trend, higher applied N resulted in higher grain protein and lower retention.*

Table 1. Dry matter and shoot numbers and accumulated plant N for selected treatments assessed at GS30 (5 August), GS33 (10 September) and GS65 (9 October).

Treatments						
Applied N	GS30	GS33		GS65		
	DM (t/ha)	DM (t/ha)	Shoots/m^2	DM (t/ha)	Shoots/m^2	Accumulated N (kg N/ha)
0 kg N/ha	2.23	7.37	1006	12.09	352	134 a
160 kg N/ha	----	7.54	940	14.13	357	244 b
320 kg N/ha	----	8.02	1040	13.61	390	325 c
P val		0.803	0.272	0.06	0.356	<0.001
LSD		NS	NS	NS	NS	34.3
cv%		18.4	6.2	7.4	10.3	8.5

Soil N at sowing was 97 kg N/ha (0-60 cm) and at GS30, had been reduced to 20 kg N/ha in the '0' treatment plots prior to the first N application.

The N content of the '0' treatment at GS65 of 134 kg N/ha seems consistent with the amount of N in the soil and that added with the starter fertiliser. Assuming the '0' treatment as the base, then the

‘320 kg N/ha’ treatment took up 191 kg N/ha (60%) and the ‘160 kg N/ha’ treatment took up 110 kg N/ha (69%) of the N applied, calculated by subtracting the ‘base N’ from that measured in the ‘320’ and ‘160’ treatments.

Higher N application did not result in higher grain yield and generally contributed to poorer retention.

Table 2. Yield and grain quality.

Treatment	Yield (t/ha)		Protein (%)		Retention (%)		Test Weight (kg/hl)
0 kg N/ha	6.25	bc	9.8	d	94.5	a	62.0
80 kg N/ha	7.15	a	11.3	c	87.5	ab	62.5
120 kg N/ha	7.15	a	12.3	c	86.9	ab	62.0
160 kg N/ha	6.89	ab	13.8	b	86.7	abc	62.9
200 kg N/ha	6.89	ab	14.8	b	82.9	bcd	62.5
240 kg N/ha	6.06	c	15.7	ab	79.0	cd	61.8
280 kg N/ha	6.26	bc	16.1	a	76.3	d	61.5
320 kg N/ha	6.20	bc	16.1	a	80.8	bcd	63.6
P val	0.012		<0.001		0.003		0.594
LSD	0.713		1.115		7.783		NS
cv%	7.3		5.5		6.3		2.4

Figure 1. Taken 20 October – GS 77. ‘320 kg N/ha plot on the left, ‘120 kg N/ha’ plot on the right.

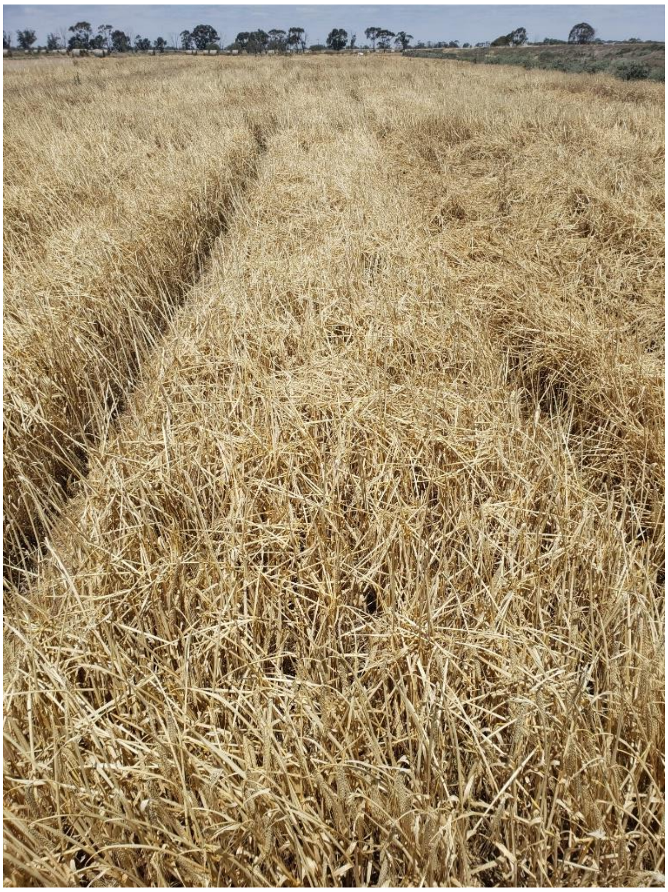
Figure 2. Brackling in the ’80 kg N/ha’ treatment prior to harvest. The plot on the right is a ‘320 kg N/ha) treatment demonstrating lodging as well.

SOWING THE SEED FOR A BRIGHTER FUTURE

Field Applied Research (FAR) Australia

HEAD OFFICE: Shed 2/ 63 Holder Road
Bannockburn
VIC 3331
Ph: +61 3 5265 1290

97-103 Melbourne Street
Mulwala
NSW 2647
Ph: 03 5744 0516

9 Currong Street
Esperance
WA 6450
Ph: 0437 712 011

Email: faraustralia@faraustralia.com.au
Web: www.faraustralia.com.au

Released:24 February 2021

The GRDC Optimising Irrigated Grains Project is a collaborative project including the following project partners: