Optimising Irrigated Grains

Optimising Irrigated Grains (FAR1906-003RTX)

A Grains Research & Development Corporation (GRDC) investment

PROVISIONAL HARVEST RESULTS:

Irrigated Durum Wheat 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 Optimum Plant Population Under Overhead Irrigation

Protocol objective: Assess the performance of durum grown at different plant populations under overhead irrigation

Location: Finley IRC
FAR Code: FAR D20-01-1
Sown: 19 May
Cultivar: DBA Aurora and DBA Vittaroi
Harvested: 29th November 2020
Rotation position: Fallow (2019), Faba beans (2018), Wheat (2017)
Soil Management: Cultivation 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 Messages:

- *In a first wheat scenario following fallow in 2019 durum wheat yielded between 7.07 - 7.52t/ha with no significant difference in yield due to variety (DBA Aurora and DBA Vittaroi).*
- *With 19 May sowing there was no difference in yield from plant populations that varied from approximately 100 – 300 plants/m^2, although 150 - 200 plants/m^2 were associated with the highest yields in both varieties.*
- *As plant population increased with DBA Aurora it was associated with significantly more lodging. There was no lodging in DBA Vittaroi irrespective of plant population.*
- *There was significantly more tiller production at the highest plant populations tested (525-660 tillers/m^2 but it had no significant yield benefit in either cultivar.*
- *In DBA Aurora there was no significant difference in head numbers as a result of increasing plant population, although the trend suggested lower head numbers with lower populations.*
- *Although increasing plant population significantly increased dry matter production at pseudo stem erect (GS30) lower plant populations had compensated such that there was no difference when assessed at the start of grain fill (GS71) and harvest.*
- *Plant population had no significant effect on grain protein (range 13.4-14.5%) which averaged 13.9%*
- *DBA Aurora at 13.5% had significantly less grain protein than DBA Vittaroi at 14.3%.*

Durum wheat sown on 19 May produced yields of approximately 7 – 7.5t/ha (Table 1). Despite the production of higher biomass and tiller numbers earlier in the spring there was no significant difference in yield as a result of populations between approximately 100 – 300plants/m^2 (Table 2 & 3). Lodging during grain fill significantly increased with higher plant populations when growing DBA Aurora (Table 4).

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Table 1. Influence of seed rates (plant population) on grain yield (t/ha) with two different varieties grown under overhead irrigation.

		Yield			*Protein*		
Plants/m² (actual)		**Aurora**	***Vittaroi***	***Mean***	***Aurora***	***Vittaroi***	***Mean***
Aurora	**Vittaroi**	**t/ha**	***t/ha***	***t/ha***	***%***	***%***	***%***
110	90	7.04 -	*7.07* -	**7.06** -	*13.4* -	*14.2* -	**13.8** -
166	178	7.30 -	*7.25* -	**7.27** -	*13.5* -	*14.3* -	**13.9** -
191	231	7.52 -	*7.13* -	**7.32** -	*13.5* -	*14.5* -	**14.0** -
322	308	7.23 -	*7.10* -	**7.16** -	*13.5* -	*14.1* -	**13.8** -
Mean		**7.27** -	***7.14*** -		***13.5*** ***b***	***14.3*** ***a***	

LSD Cultivar p=0.05	ns	0.39
P val	0.175	0.007
LSD Seed Rate p=0.05	ns	ns
P val	0.221	0.303
LSD Seed Rate x Cultivar. P=0.05	ns	ns
P val	0.441	0.421

Table 2. Influence of plant population on canopy composition, plants/m² (GS21), tillers/m² (GS31) and heads/m² (GS87) – assessed GS21 (29 Jun), GS31 (13 Aug), GS87 (20 Nov).

Treatment	**Canopy composition**		
	Plants/m²	Tillers/m²	Heads/m²
DBA Aurora			
100 seeds/m²	110 -	510 bc	345 -
200 seeds/m²	166 -	537 b	387 -
300 seeds/m²	191 -	552 b	441 -
400 seeds/m²	322 -	661 a	447 -
DBA Vittaroi			
100 seeds/m²	90 -	333 d	
200 seeds/m²	178 -	442 c	
300 seeds/m²	231 -	535 b	
400 seeds/m²	308 -	526 b	
Mean	**200**	**512**	**405**
LSD Seed Rate x Cultivar. P=0.05	ns	73	79
P val	0.104	0.028	0.052

In depth assessment of DBA Aurora showed that high plant populations produce significantly more vegetative biomass up to GS30 but whilst the trend continued at later growth stages the differences were not statistically significant (Figure 1).

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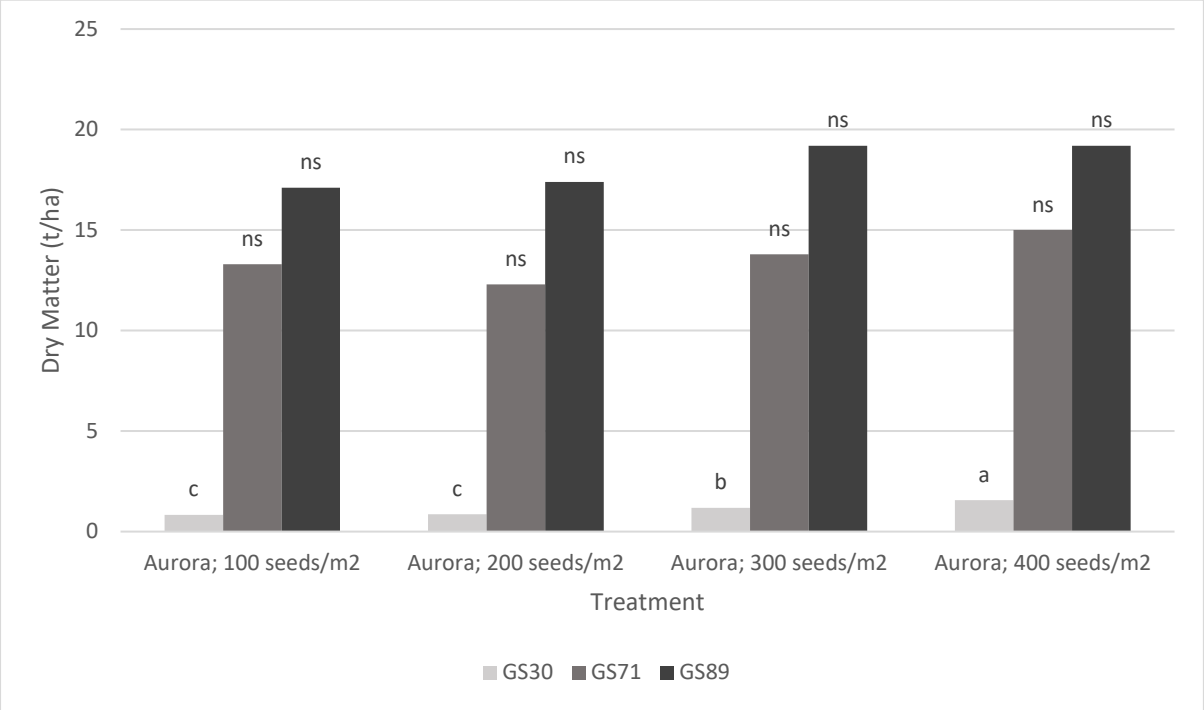

Figure 1. Influence of plant population on dry matter production (t/ha) at GS30, GS71 and harvest - assessed 31 July, 13 Oct, 20 Nov – cv DBA Aurora. GS30 P value=<0.001, LSD=0.22. GS71 P value=0.272. GS89 P value=0.211.

Table 3. Influence of plant population on crop lodging assessed by combining severity and % plot lodged on 0 – 500 scale at grain fill GS80, GS87 and harvest – (4 Nov, 17 Nov, 29 Nov)

Treatment	**Lodging Score (0-500)**		
	GS80	**GS87**	**Harvest**
DBA Aurora			
110 plants/m^2	0 -	11 -	39 c
166 plants/m^2	4 -	79 -	114 b
191 plants/m^2	33 -	115 -	171 b
322 plants/m^2	22 -	183 -	244 a
DBA Vittaroi			
90 plants/m^2	0 -	0 -	0 c
178 plants/m^2	0 -	0 -	0 c
231 plants/m^2	0 -	0 -	0 c
308 plants/m^2	0 -	0 -	0 c
Mean	**7**	**49**	**71**
LSD Seed Rate x Cultivar. P=0.05	36	90	63
P val	0.526	0.071	0.001

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Trial 2 Optimum Plant Population Under Flood Irrigation

Protocol objective: Assess the performance of durum grown at different plant populations under flood irrigation

Location: Finley IRC
FAR Code: FAR D20-01-2
Sown: 19 May
Cultivar: DBA Aurora and DBA Vittaroi
Harvested: 29th November 2020
Rotation position: Fallow (2019), Faba beans (2018), Wheat (2017)
Soil Management: Cultivation with speed disc in Autumn
Irrigation: Flood Irrigation 3 x 80mm in spring. Total applied 240mm (2.4 ML/ha)
GSR: April-October 244mm. Total water available 484mm

Key Messages:

- *In an identical trial to Trial 1 under flood bay irrigation DBA Aurora lodged severely and was significantly lower yielding than DBA Vittaroi.*
- *Though not statistically comparable (separate trials based on same site, same sowing date & management) yields were similar under overhead and flood irrigation but lodging at harvest was noted to be more severe where flood irrigation was used.*
- *DBA Aurora lodged significantly more at higher plant populations (150-300 plants/m^2) and was noted to start lodging earlier in grain fill (GS71). At harvest all plots of the variety had lodged irrespective of plant population.*
- *In contrast, lower levels of lodging were observed with DBA Vittaroi through grain fill, but yield trends suggested high plant populations were not advantageous.*
- *Lower plant populations were associated with lower dry matter production at early stem elongation (GS31) but later in the growing season there were no significant dufferences.*
- *Neither plant population or variety had any significant effect on grain protein (range 13.4-13.7%) which averaged 13.6%.*

Higher plant populations, tiller numbers and early dry matter production resulting from higher plant populations grown under flood irrigation produced no yield advantage (Table 1).

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Table 1. Influence of seed rates (plant population) on grain yield (t/ha) with two different varieties grown with flood irrigation.

		Yield t/ha			Protein		
Plants/m2 (actual)		**Aurora**	**Vittaroi**	**Mean**	**Aurora**	**Vittaroi**	**Mean**
Aurora	**Vittaroi**	**t/ha**	**t/ha**	**t/ha**	**%**	**%**	**%**
90	86	7.01 -	8.20 -	**7.6 a**	13.6 -	13.6 -	**13.6 -**
161	183	6.93 -	7.73 -	**7.3 ab**	13.4 -	13.8 -	**13.6 -**
240	230	6.54 -	7.60 -	**7.0 bc**	13.4 -	13.8 -	**13.6 -**
282	315	6.46 -	7.21 -	**6.8 c**	13.4 -	13.6 -	**13.5 -**
Mean		**6.73 b**	**7.69 a**		**13.4 -**	**13.7 -**	

LSD Seed Rate p = 0.05	0.44	ns
P val	0.011	0.752
LSD Cultivar p=0.05	0.67	ns
P val	0.021	0.270
LSD Seed Rate x Cultivar. P=0.05	ns	ns
P val	0.692	0.390

Table 2. Influence of plant population and variety on canopy composition, plants/m^2 (GS21), tillers/m^2 (GS31) and heads/m^2 (GS87) – assessed GS21 (29 Jun), GS31 (13 Aug), GS87 (24 Nov).

Treatment	**Canopy composition (m^2)**		
	Plants/m^2	Tillers/m^2	Heads/m^2
DBA Aurora			
90 plants/m^2	90 -	588 c	420 -
161 plants/m^2	161 -	693 b	451 -
240 plants/m^2	240 -	786 a	468 -
282 plants/m^2	282 -	829 a	468 -
DBA Vittaroi			
86 plants/m^2	86 -	385 d	
183 plants/m^2	183 -	642 bc	
230 plants/m^2	230 -	639 bc	
315 plants/m^2	315 -	680 b	
Mean	**198**	**655**	**452**
LSD Seed Rate x Cultivar. P=0.05	ns	62	ns
P val	0.455	0.014	0.410

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Table 3. Influence of plant population on dry matter production (kg/ha) at pseudo stem erect (GS30), watery ripe (GS71) and crop maturity (GS87) - assessed GS30 (31 July), GS71 (13 Oct), GS87 (24 Nov) cv. DBA Aurora.

Treatment	Dry Matter Production (kg/ha)		
	GS30	GS71	GS87
90 plants/m^2	0.62 b	13.14 -	18.36 -
161 plants/m^2	0.91 b	14.25 -	17.66 -
240 plants/m^2	1.31 a	14.10 -	15.99 -
282 plants/m^2	1.41 a	13.98 -	19.05 -
Mean	**1.06**	**13.9**	**17.76**
LSD Seed Rate P=0.05	0.343	ns	ns
P val	0.002	0.5121	0.1746

Table 4. Influence of plant population on crop lodging assessed during grain fill GS71, GS80 and at harvest – (15 Oct, 4 Nov and 29 Nov respectively).

Treatment	Lodging Score (0-500)		
	GS71	GS80	Harvest
DBA Aurora			
90 plants/m^2	11 d	179 c	326 -
161 plants/m^2	86 ab	304 ab	413 -
240 plants/m^2	68 bc	280 b	396 -
282 plants/m^2	125 a	364 a	445 -
DBA Vittaroi			
86 plants/m^2	0 d	0 d	15 -
183 plants/m^2	26 cd	38 d	83 -
230 plants/m^2	33 cd	41 d	73 -
315 plants/m^2	15 d	39 d	74 -
Mean	**46**	**156**	**228**
LSD	49	63	ns
P val	0.046	0.021	0.605

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

Trial 3 Nitrogen Use Efficiency Trial – Nitrogen Rates

Project Objective: To assess the impact of nitrogen (N) rate on durum wheat under overhead irrigation.

Location: Finley IRC
FAR Code: FAR D20-03-1
Sown: 19 May
Cultivar: DBA Vittaroi
Harvested: 29th November 2020
Rotation position: Fallow (2019), Faba beans (2018), Wheat (2017)
Soil Management: Cultivation 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 Messages:

- *Deep soil N cores taken prior to sowing revealed approximately 100kg N/ha in the top 30cm and 232kg N/ha in a profile as a whole (0 - 90cm) following fallow in 2019.*
- *With this level of fertility under overhead irrigation DBA Vittaroi gave no significant yield response to N fertiliser at levels between 0 – 350kg N/ha with yields ranging from 6.93 – 7.43t/ha.*
- *Grain protein content was significantly increased by stem elongation N application up to a level of 150kg N/ha applied, moving protein from 13% to 14.5%.*
- *Above 150 kg N/ha applied there was no effect of increasing N input on grain protein.*
- *Nitrogen application rate had no significant effect on dry matter (DM) production assessed at harvest with an average DM of 16.6t/ha (range 15.96 – 17.97t/ha).*
- *Applying nitrogen at GS39 had no significant effect on grain protein and the small lift in grain yield (recorded at 300kg N/ha) was not statistically significant.*
- *Nitrogen offtake in the crop canopy varied from 246 – 384kg N/ha as applied N increased, this trend was strong but not significant (p=0.07).*
- *The unfertilised crop removed 264kgN/ha in the canopy indicating an additional 32 kg N/ha supplied through mineralisation (232kg N/ha at sowing).*
- *There was no significant difference in harvest index (proportion of DM harvested as grain) due to nitrogen rate.*

In a scenario of high soil fertility increasing applied N rates (Urea 46% N) from 0 – 350 kg N/ha had no significant effect on grain yield but was noted to increase grain protein up to 150 kg N/ha applied (Table 1).

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

Table 1. Influence of applied nitrogen rate at stem elongation on Grain yield (t/ha) and Protein content (%).

	Application Timing				Grain yield and quality		
	GS30 Kg N/ha	GS32 Kg N/ha	GS39 Kg N/ha	Total kg N/ha	Yield t/ha	Protein %	H.I. %
1.	-	-	-	0	7.10 -	13.0 c	45.3 -
2.	50	50	-	100	7.17 -	13.9 b	41.4 -
3.	75	75	-	150	6.93 -	14.5 ab	43.6 -
4.	100	100	-	200	6.97 -	14.4 ab	44.2 -
5.	125	125	-	250	6.96 -	14.8 a	43.3 -
6.	150	150	-	300	7.05 -	14.9 a	42.5 -
7.	100	100	100	300	7.43 -	14.5 ab	43.7 -
8.	125	125	100	350	7.11 -	15.0 a	39.7 -
	Mean				**7.09**	**14.37**	**43.0**
	LSD				0.33	0.7	ns
	P val				0.087	<0.001	0.396

The starting soil nitrogen for the research site was high following fallow in 2019 and a failed faba bean crop in 2018. This resulted in a high level of soil mineral N being available to the trial on the date of sowing seven days later.

Soil Available Mineral N kg N/ha – recorded on 12th May

0 – 30cm	110
30 - 60cm	71
60 – 90cm	51
Total 0-90cm	**232**

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

Table 2. Influence of applied nitrogen rate at GS30, GS32 & GS39 on dry matter (DM) kg/ha and N offtake (kg N/ha) in grain at harvest.

Nitrogen Treatment Rate & Timing		Total Nitrogen	Dry matter & N offtake	
			Dry Matter	N removed
		N/ha	Kg/ha	Kg N/ha
1.	0 kg N/ha	0	15.96 -	261 -
2.	50 kg N/ha @ GS30 & 50 kg N/ha @ GS32	100	17.37 -	246 -
3.	75 kg N/ha @ GS30 & 75 kg N/ha @ GS32	150	15.93 -	278 -
4.	100 kg N/ha @ GS30 & 100 kg N/ha @ GS32	200	15.76 -	269 -
5.	125 kg N/ha @ GS30 & 125 kg N/ha @ GS32	250	16.12 -	347 -
6.	150 kg N/ha @ GS30 & 150 kg N/ha @ GS32	300	16.66 -	360 -
7.	100 kg N/ha @ GS30, 100 kg N/ha @ GS32 & 100 kg N/ha @ GS39	300	17.08 -	384 -
8.	125 kg N/ha @ GS30, 125 kg N/ha @ GS32 & 100 kg N/ha @ GS39	350	17.97 -	307 -
	Mean		**16.61**	
	LSD		ns	
	P val		0.259	

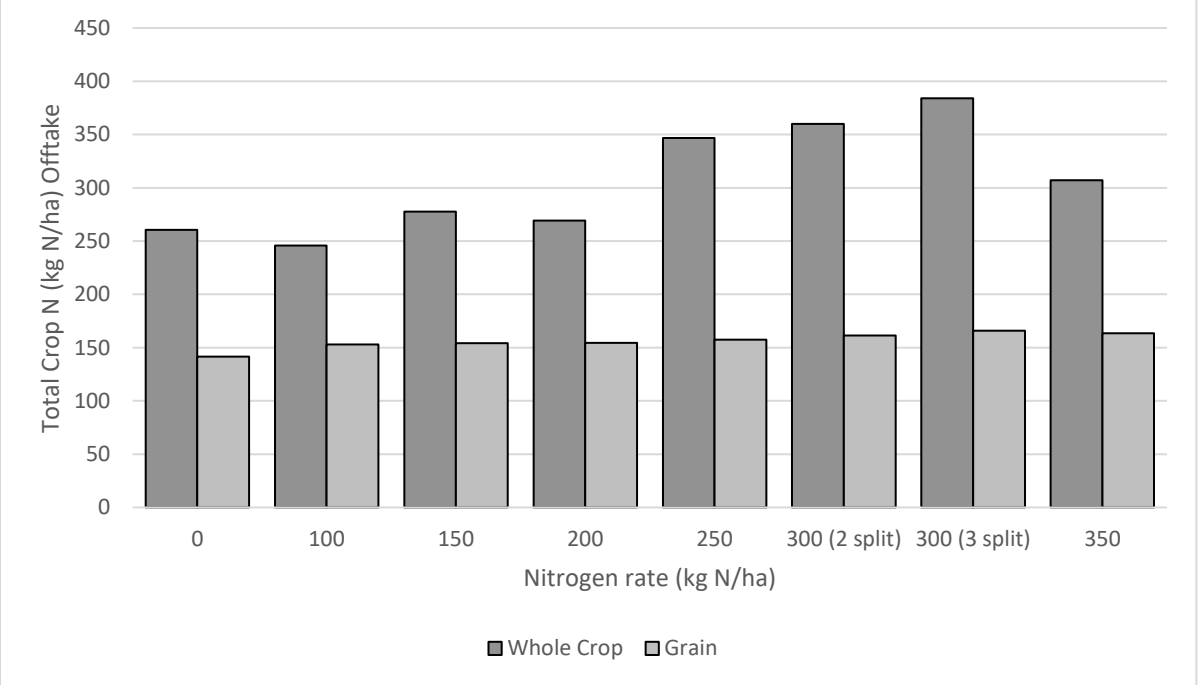

Figure 1. Nitrogen removed in the whole crop and grain when varying nitrogen rate.

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Water Use Efficiency (WUE)

Table 3. Maximum biomass (dry matter) at harvest, Grain yield t/ha, Harvest index (%), Water use efficiency (based on grain yield kg/ha divided by GSR mm, Irrigation mm & 30% stored Jan-March), Transpiration (mm), Estimated soil evaporation/other soil losses (mm) & Transpiration efficiency T.E. (seed) kg/mm (mean of both openers) - cv Hyola 50, Coreen, NSW.

N Rate	Dry Matter	Yield	H.I.	WUE[1]	Trans[2]	Evap[3]	T.E[4]
(kg N/ha)	Kg/ha	Kg/ha	%	Kg/mm	mm	Mm	mm
0	15960	6213	38.9	14.9	290	127	21.4
150	15930	6064	38.1	14.5	290	127	20.9
250	16120	6090	37.8	14.6	293	127	20.8
350	17970	6221	34.6	14.9	327	124	19.0

[1] Based on 244mm of GSR (Apr – Oct) plus 125mm irrigation and 30% of January – March rainfall as stored (48.3 mm) with no soil evaporation term included. Total 417.3mm of water available.

[2] Transpiration through the plant based on a maximum 55 kg biomass/ha.mm transpired.

[3] Difference between transpiration through the plant and GSR (mm).

[4] kg/ha grain produced per mm of water transpired through the plant.

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

Trial 4 Nitrogen Use Efficiency Trial – Nitrogen Timing Trial

Project Objective: To assess the impact of nitrogen (N) timing on durum wheat under overhead irrigation

Location: Finley IRC
FAR Code: FAR D20-04-1
Sown: 19 May
Cultivar: DBA Vittaroi
Harvested: 29th November 2020
Rotation position: Fallow (2019), Faba beans (2018), Wheat (2017)
Soil Management: Cultivation 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 Messages:

- *In this fertile scenario (232kg N/ha available 0-90cm) there was a significant interaction (p=0.03) between applied nitrogen timing and rate which suggested that increasing nitrogen had no negative yield effects when applied later in stem elongation compared to earlier N timings of the same amounts.*
- *However, the only benefit of applied nitrogen in the trial was significantly lifting grain protein from below 13% (12.36% mean) in zero N plots to 13.63% in those plots where 100kg N/ha was applied.*
- *The input of N fertiliser at $1.20kg N/ha was not economic in this trial, despite the premium differential due to protein (based on $19/t differential).*
- *Whilst applied nitrogen at 300kg N/ha significantly increased protein above 14% compared to lower levels of applied N this effect was uneconomic.*
- *There was an indication that N content of the canopy varied with N rate and timing at harvest with content varying from 250 -365 kg N/ha.*
- *N removal*
- *Applying higher rates of nitrogen had a significant impact on crop reflectance assessed as normalised differential vegetation index (NDVI) at early stem elongation, booting and flowering*

With high levels of available mineral N at sowing (232kg N/ha 0 -90cm) there was no economic yield or protein response to applied N fertiliser (Urea 46%N) (Table 1).

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

Table 1. Influence of N rate and timing strategies on grain yield (t/ha) based on split application rates (0 – 300kg N/ha).

	Nitrogen Application Rate			
	0kg/ha N	100kg/ha N	200kg/ha N	300kg/ha N
Nitrogen Timing	**Yield t/ha**	**Yield t/ha**	**Yield t/ha**	**Yield t/ha**
PSPE & GS30	7.25 a-e	7.43 abc	7.06 cde	7.16 b-e
GS30 & GS32	7.54 a	6.89 e	6.97 de	7.09 cde
GS32 & GS37	7.33 a-d	7.48 ab	7.50 ab	7.36 abc
Mean	**7.37 -**	**7.27 -**	**7.18 -**	**7.20 -**
LSD N Application Timing p=0.05	ns	**P val**	0.187	
LSD N Application Rate p=0.05	ns	**P val**	0.292	
LSD N Timing. x N Rate. P=0.05	0.38	**P val**	0.033	

PSPE – Post sow pre-emergence application - broadcast
In addition to N rates specified a standard MAP application meant that all treatments received 12 kg N/ha at sowing.

Table 2. Influence of N rate and timing strategies on grain protein (%) based on split application rates (0 – 300kg N/ha).

	Nitrogen Application Rate				
	0kg/ha N	100kg/ha N	200kg/ha N	300kg/ha N	
Nitrogen Timing	**Protein %**	**Protein %**	**Protein %**	**Protein %**	**Mean**
PSPE & GS30	12.7 de	13.5 c	13.4 cd	14.1 abc	13.4 -
GS30 & GS32	12.7 e	13.5 c	13.9 bc	14.5 ab	13.6 -
GS32 & GS37	11.7 f	13.8 bc	14.3 ab	14.8 a	13.6 -
Mean	**12.4 c**	**13.6 b**	**13.8 b**	**14.4 a**	
LSD N Application Timing p=0.05	ns	**P val**	0.703		
LSD N Application Rate p=0.05	0.46	**P val**	<0.001		
LSD N Timing. x N Rate. P=0.05	0.80	**P val**	0.030		

Table 3 Influence of N rate and timing strategies on N removal kg N/ha at harvest.

	Nitrogen removed at harvest (kg N/ha)			
	0kg/ha N	100kg/ha N	200kg/ha N	300kg/ha N
Nitrogen Timing				
PSPE & GS30	270 cde	324 abc	365 a	336 ab
GS30 & GS32	298 b-e	251 e	260 e	296 b-e
GS32 & GS37	266 de	320 a-d	287 b-e	319 a-d
Mean	**278 -**	**298 -**	**304 -**	**317 -**
LSD N Application Timing p = 0.05	39	**P val**	0.067	
LSD N Application Rate p=0.05	ns	**P val**	0.111	
LSD N Timing. x N Rate. P=0.05	55	**P val**	0.028	

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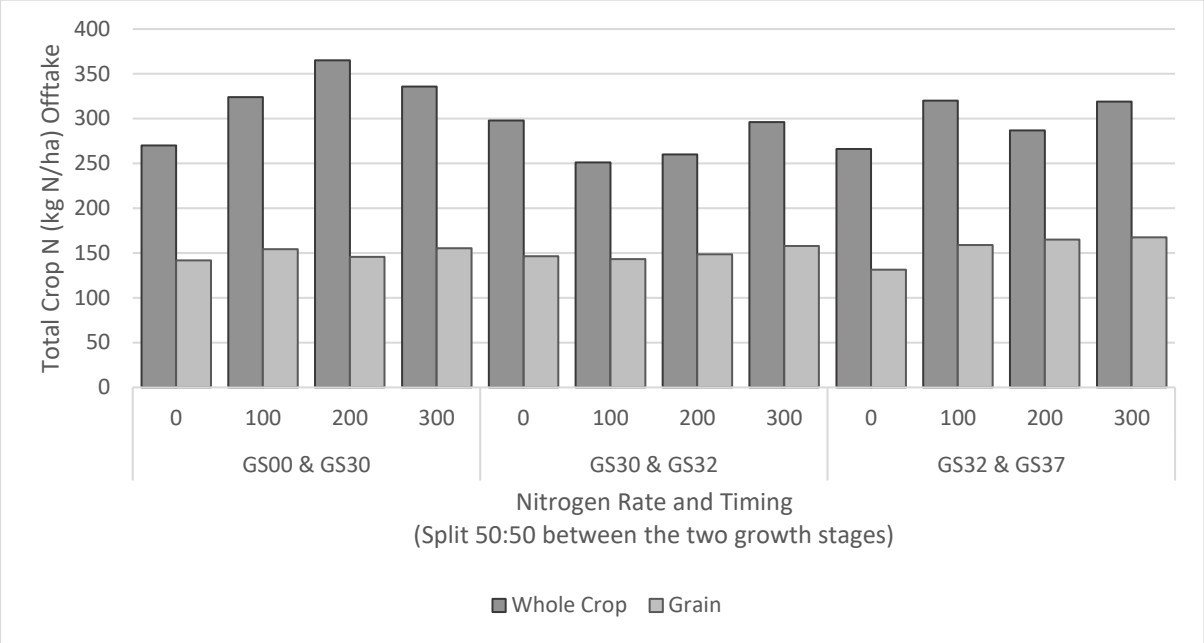

Figure 1. Influence of N rate and timing on nitrogen offtake in the crop canopy at harvest kg N/ha (straw and grain) – cv DBA Vittaroi.

Small but significant differences were observed in crop reflectance (Table 4) which indicated greener canopies where higher N rates were applied. However, overall the differences though significant are extremely small (Table 4).

Table 4. Influence of N rate (kg N/ha) on crop reflectance assessed as normalised differential vegetation index (NDVI) assessed 0 -1 scale. *Higher figures are indicative of greener canopies.*

	NDVI		
	GS32 (26 Aug)	**GS43 (14 Sep)**	**GS61 (29 Sep)**
Nitrogen Rate			
0 kg N/ha	0.790 c	0.814 b	0.813 b
100 kg N/ha	0.793 bc	0.814 b	0.815 b
200 kg N/ha	0.802 ab	0.822 a	0.824 a
300 kg N/ha	0.805 a	0.821 ab	0.823 a
Mean	**0.798**	**0.815**	**0.818**
LSD	0.010	0.007	0.007
P val	0.017	0.045	0.003

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

Trial 5 Germplasm Disease Management Interaction

Project objective: To assess the relative importance of fungicide input for DBA Aurora and DBA Vittaroi under overhead irrigation

Location: Finley IRC
Sown: 19 May
Harvested: 29th November 2020
FAR Code: FAR D20-07-1
Cultivar: DBA Aurora and DBA Vittaroi
Rotation position: Fallow (2019), Faba beans (2018), Wheat (2017)
Soil Management: Cultivation 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 Messages:

- *DBA Vittaroi developed higher levels of stripe rust infection than DBA Aurora (20% v less than1% on flag leaf at late grain fill)*
- *Fungicide strategy had no significant effect on grain protein (range 13.4-14.8%) which averaged 14.0% (not shown)*
- *DBA Aurora at 13.5% had significantly less grain protein than DBA Vittaroi at 14.5% (not shown)*

Table 1. Fungicide treatment list.

		Treatment mL/ha			
	Treatment	**At sowing 19 May**	**GS31 3 Aug**	**GS39 1 Sep**	**GS61 2 Oct**
1.	**Untreated**				
2.	**1 spray (GS31)**		Amistar Xtra 400		
3.	**1 spray (GS39)**			Radial 400	
4.	**2 spray**		Prosaro 300	Radial 400	
5.	**s.t. + 2 spray**	Systiva		Radial 400	Prosaro 300
6.	**3 spray**		Aviator 416	Radial 400	Prosaro 300

S.t. Seed treatment: Systiva applied at 150mL/100kg seed

Table 2. Grain yield under different fungicide strategies.

		Grain Yield		
		DBA Aurora	**DBA Vittaroi**	**Mean**
	Treatment	**Yield t/ha**	**Yield t/ha**	**Yield t/ha**
1.	**Untreated**	6.44 -	5.77 -	**6.10 bc**
2.	**1 spray (GS31)**	6.24 -	5.55 -	**5.90 c**
3.	**1 spray (GS39)**	6.57 -	6.06 -	**6.32 b**
4.	**2 spray**	6.77 -	6.57 -	**6.67 a**
5.	**s.t. + 2 spray**	6.58 -	6.22 -	**6.40 ab**
6.	**3 spray**	6.86 -	6.48 -	**6.67 a**
	Mean	**6.58 a**	**6.11 b**	
LSD Fungicide p = 0.05		0.3	**P val**	<0.001
LSD Cultivar p=0.05		0.17	**P val**	<0.001
LSD Fungicide x Cultivar P=0.05		ns	**P val**	0.4926

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

Table 3. Influence of variety and fungicide strategy on % Stripe rust leaf area infection (%LAI) on flag leaf, F-1 and F-2 at awn emergence (GS49) & soft dough (GS85) – Assessed 24 Sep and 6 Nov respectively.

		GS49 %LAI			GS 85 %LAI	
		Flag Leaf	Flag-1	Flag-2	Flag Leaf	Flag-1
	DBA Aurora					
1.	Untreated	0.0 -	0.2 c	0.8 -	0.6 b	1.3 b
2.	1 spray (GS31)	0.0 -	0.1 c	0.6 -	0.7 b	0.5 b
3.	1 spray (GS39)	0.0 -	0.4 c	0.7 -	0.2 b	0.0 b
4.	2 spray (GS31 & 39)	0.0 -	0.3 c	0.4 -	0.0 b	0.0 b
5.	S.t. + 2 spray (GS39 &	0.0 -	0.3 c	0.9 -	0.0 b	0.0 b
6.	3 spray (GS31, 39 & 61)	0.0 -	0.3 c	0.6 -	0.0 b	0.0 b
	DBA Vittaroi					
1.	Untreated	0.4 -	5.1 a	3.7 -	19 a	20 a
2.	1 spray (GS31)	0.2 -	2.6 b	2.4 -	15 a	17 a
3.	1 spray (GS39)	0.6 -	4.7 a	5.8 -	0.6 b	1.6 b
4.	2 spray (GS31 & 39)	0.1 -	1.9 b	2.2 -	0.7 b	0.5 b
5.	S.t. + 2 spray (GS39 &	0.6 -	4.7 a	4.7 -	1.0 b	2.0 b
6.	3 spray (GS31, 39 & 61)	0.2 -	1.9 b	2.2 -	0.6 b	0.4 b

LSD Cultivar p=0.05	0.1	0.5	0.8	2.1	2.7
P val	<0.001	<0.001	<0.001	<0.001	<0.001
LSD Fungicide x Cultivar	ns	1.3	2.0	5.0	6.5
P val	0.143	0.002	0.096	<0.001	<0.001

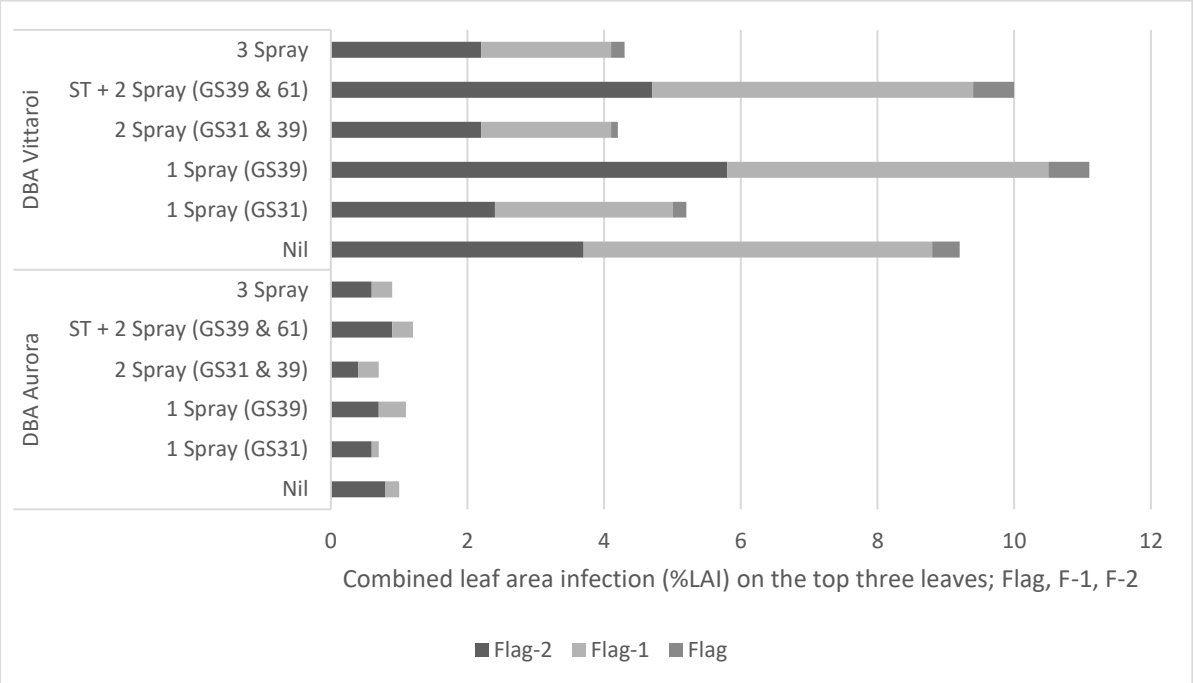

Figure 1. Influence of fungicide strategy on stripe rust infection (% leaf area infected) on flag, F-1 and F-2 at (GS49) in durum wheat grown under overhead irrigation. Note GS61 still to applied.

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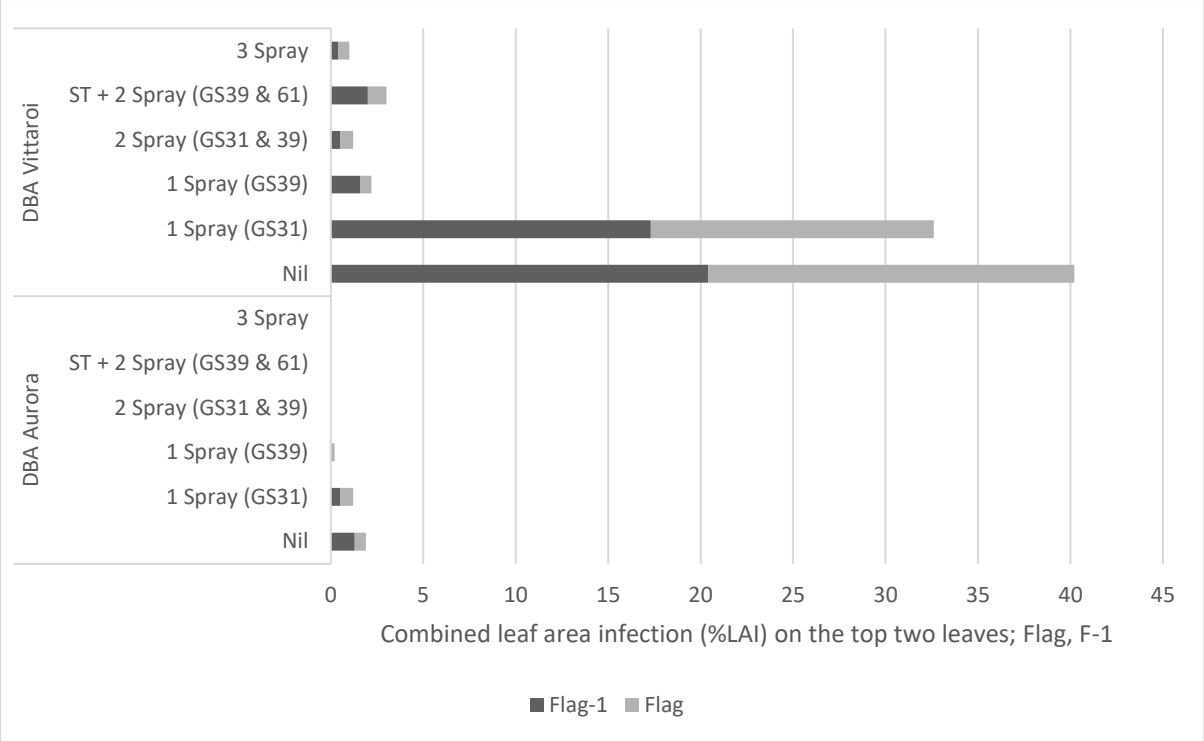

Figure 2. Influence of fungicide strategy on stripe rust infection (% leaf area infected) on flag, F-1 and F-2 at (GS85) in durum wheat grown under overhead irrigation.

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

Trial 6 Disease Management for Irrigated Crops – Products, Rates and Timings

Project objective: To assess the impact of fungicide management strategies with and without upfront at seeding fungicide options

Location: Finley IRC
FAR Code: FAR D20-08-1
Sown: 19 May
Cultivar: DBA Vittaroi
Harvested: 29th November 2020
Rotation position: Fallow (2019), Faba beans (2018), Wheat (2017)
Soil Management: Cultivation 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 Messages:

- *Fungicide strategies generated yield increases of between 0.29 – 0.77t/ha from the control of stripe rust (valued at $117 – 312/ha at $405/t).*
- *All fungicide strategies significantly increased yield.*
- *The stripe rust control data and yield results indicated that 2 spray foliar strategies or flutriafol plus a follow up foliar spray could be used to secure disease control and yield responses.*
- *Small benefits to a third foliar spray were not significantly better than the equivalent two spray programme.*
- *There was no significant difference in grain yield between treatments using Opus and Radial at GS31*
- *Systiva at sowing was just as effective in maintaining grain yield as Opus at GS31 but gave less effective stripe rust control than flutriafol and Jockey.*
- *Jockey and Flutriafol at sowing were not as effective in maintaining grain yield as Opus at GS31.*

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

Table 1. Influence of fungicide treatment on grain yield.

		Treatment mL/ha				Yield
	Treatment Name	At sowing	GS31	GS39	GS61	t/ha
1.	0 Units	Untreated				6.05 c
2.	Systiva + 1 Spray Unit	Systiva Seed Trt		Prosaro 300		6.96 b
3.	Jockey + 1 Spray Unit	Jockey Seed Trt		Prosaro 300		6.87 b
4.	Flutriafol + 1 Spray Unit	Flutriafol in furrow		Prosaro 300		6.82 b
5.	2 Spray (O + P)		Opus 500	Prosaro 300		7.11 ab
6.	2 Spray (O + A)		Opus 500	Aviator 416		6.87 b
7.	2 Spray (R + A)		Radial 840	Aviator 416		6.87 b
8.	3 Spray (O+P+O)		Opus 500	Prosaro 300	Opus 250	7.30 a
9.	3 Spray (O+A+O)		Opus 500	Aviator 416	Opus 250	6.99 b
10.	3 Spray (R+A+O)		Radial 840	Aviator 416	Opus 250	6.97 b
	Mean					6.93
	LSD					0.365
	P val					0.0321

Table 2. Influence of fungicide treatment on grain quality - protein content (%), test weight (kg/hl) and screenings (%).

Treatment		Grain quality		
		Protein %	Test Weight Kg /hL	Screenings %
1.	Untreated	14.3 -	76.3 -	1.2 -
2.	S.t. fb 1 Spray	14.3 -	77.2 -	1.1 -
3.	Jockey fb 1 Spray	14.1 -	77.1 -	1.0 -
4.	Fl fb 1 Spray	14.5 -	77.3 -	1.1 -
5.	2 Spray (O + P)	14.1 -	77.4 -	1.1 -
6.	2 Spray (O + A)	14.4 -	76.6 -	1.4 -
7.	2 Spray (R + A)	14.4 -	77.3 -	1.2 -
8.	3 Spray (O+P+O)	14.2 -	77.8 -	1.0 -
9.	3 Spray (O+A+O)	14.5 -	77.6 -	1.2 -
10.	3 Spray (R+A+O)	14.5 -	77.0 -	1.2 -
	Mean	**14.3**	**77.2**	**1.1**
	LSD	ns	ns	Ns'[
	P val	0.503	0.366	0.313

Fb – followed by

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

Table 3. Influence of fungicide treatment on stripe rust infection assessed at GS49 (23-Sep) and GS65 (8-Oct).

Treatment		Stripe rust infection (% LAI)					
		Infection at GS49			Infection at GS65		
	Treatment Name	Flag	Flag-1	Flag-2	Flag	Flag-1	Flag-2
1.	Untreated	0.2 -	1.5 ab	3.2 a	11.5 a	15.1 a	29.6 a
2.	S.t. fb 1 Spray	0.2 -	1.2 abc	2.0 a b	2.7 b	3.0 b	5.6 b
3.	Jockey fb 1 Spray	0.1 -	0.7 bcd	1.4 bc	2.2 bcd	1.9 bc	2.2 bc
4.	Fl fb 1 Spray	0.0 -	0.3 d	0.3 c	0.7 d	0.9 c	1.5 c
5.	2 Spray (O + P)	0.2 -	0.8 a-d	1.8 b	1.8 bcd	1.8 bc	3.2 bc
6.	2 Spray (O + A)	0.1 -	0.8 a-d	1.8 b	1.0 cd	2.9 b	2.5 bc
7.	2 Spray (R + A)	0.0 -	1.6 a	1.4 bc	1.5 bcd	1.9 bc	3.6 bc
8.	3 Spray (O+P+O)	0.1 -	1.1 abc	1.5 bc	1.3 bcd	1.7 bc	1.8 c
9.	3 Spray (O+A+O)	0.2 -	1.3 ab	1.0 bc	2.4 bc	2.8 b	3.8 bc
10.	3 Spray (R+A+O)	0.0 -	0.4 cd	1.0 bc	2.3 bc	1.7 bc	2.9 bc
	Mean	**0.1**	**1.0**	**1.5**	**2.7**	**3.4**	**5.7**
	LSD	0.3	0.8	1.3	1.5	1.8	3.4
	P val	0.685	0.029	0.017	<0.001	<0.001	<0.001

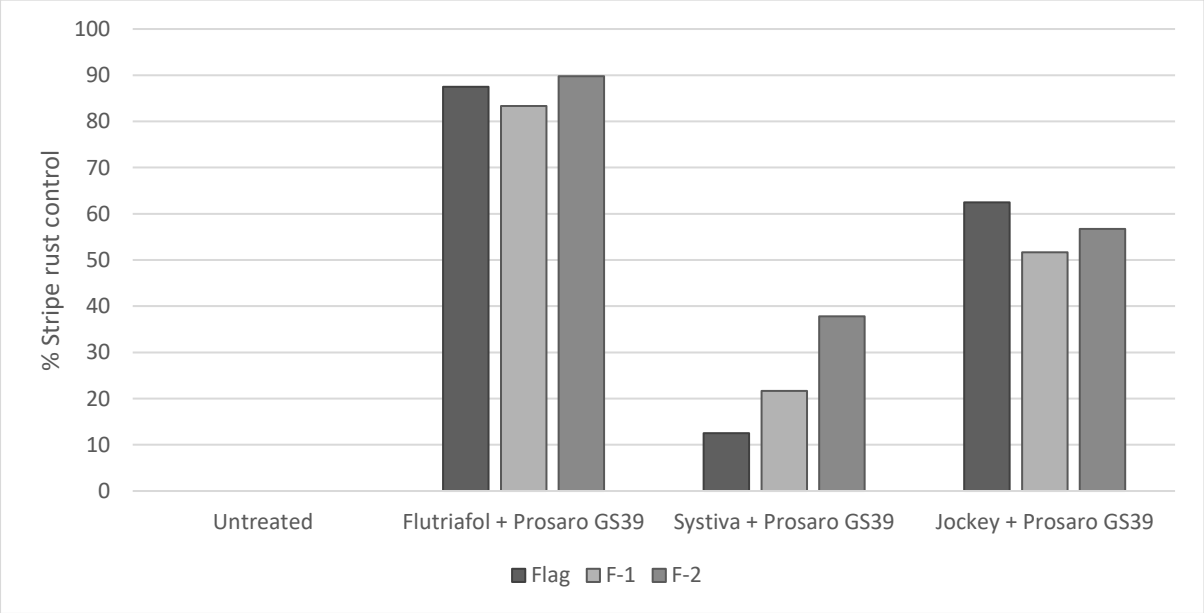

Figure 1. Stripe rust control (% with untreated set as 0% control) of at sowing treatments. Assessed 23/9 (GS49).

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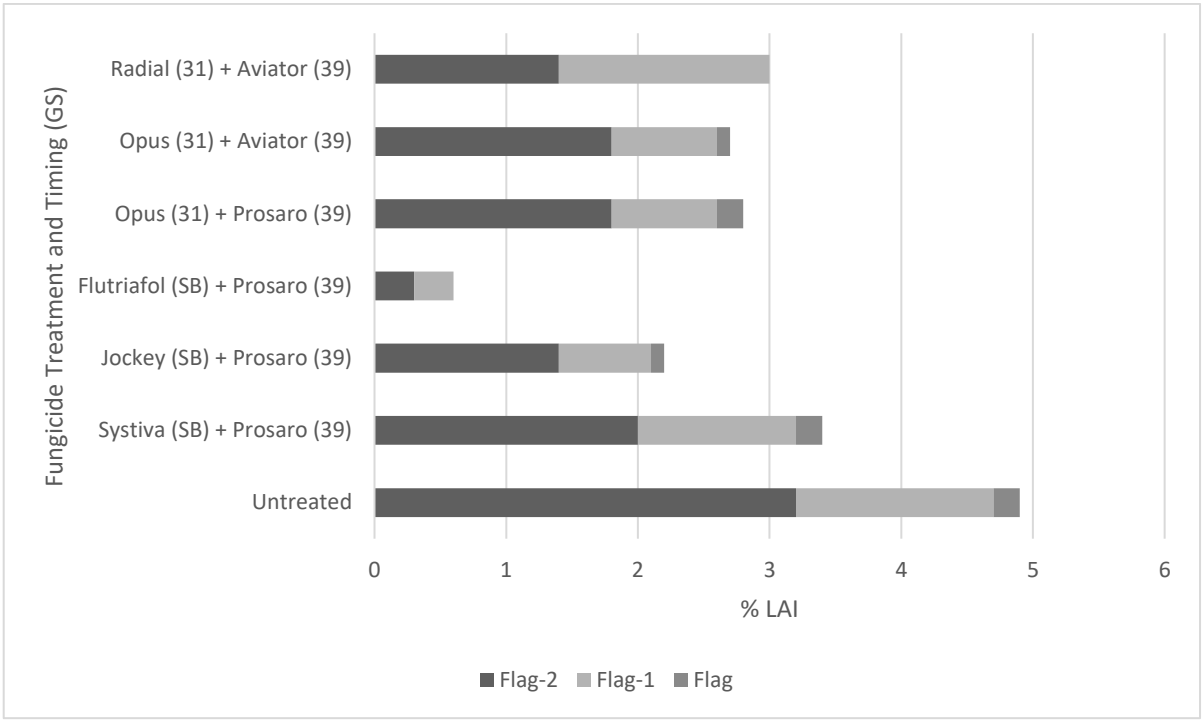

Figure 2. Stripe rust infection (% leaf area infected) at GS49 (23-Sep).
SB – Seedbed at sowing.

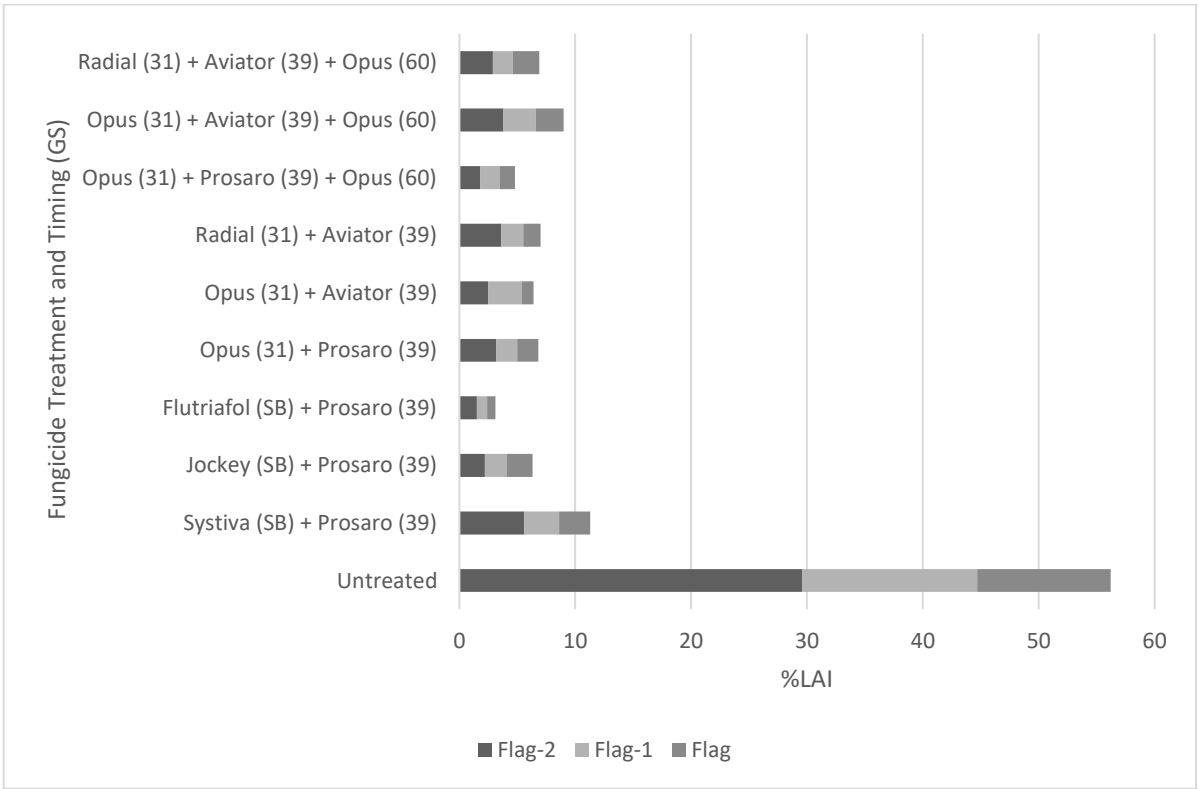

Figure 3. Stripe rust infection (% leaf area infected) at GS65 (8-Oct).

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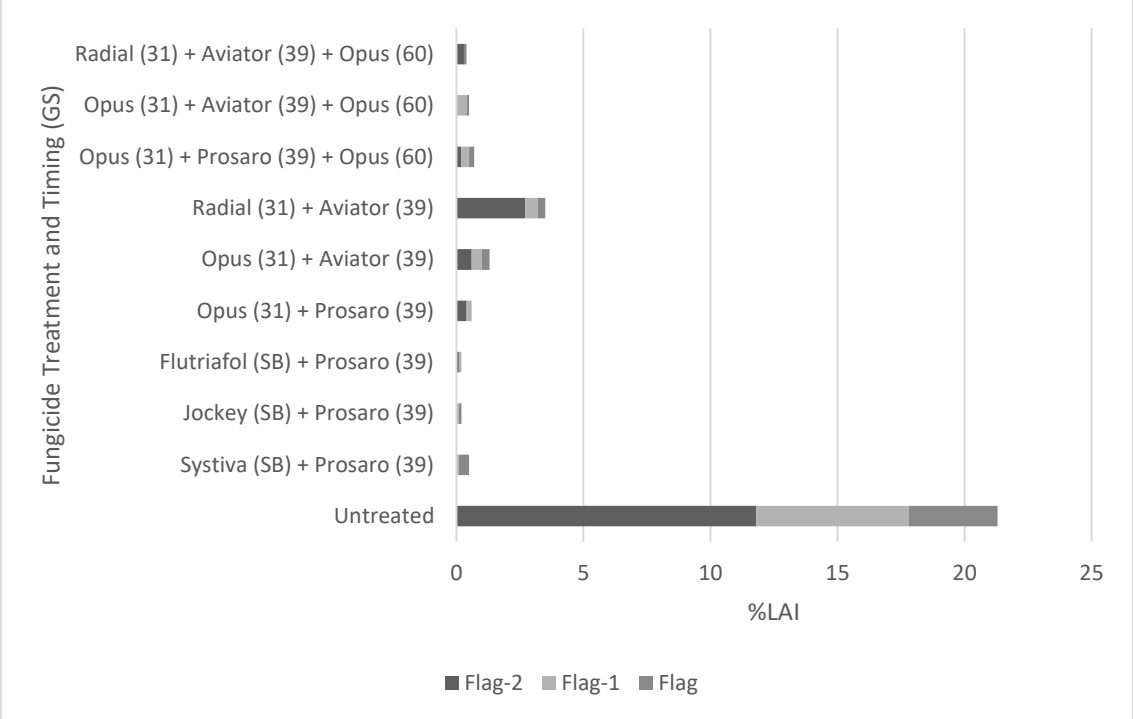

Figure 4. Stripe rust infection (% leaf area infected) at GS83 (29-Oct).

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

Trial 7 Influence of Plant Growth Regulation on Durum Yield and Profitability under Irrigation

Location: Finley IRC
FAR Code: FAR D20-09-1
Sown: 19 May
Cultivar: DBA Aurora
Harvested: 29th November 2020
Rotation position: Fallow (2019), Faba beans (2018), Wheat (2017)
Soil Management: Cultivation 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 Messages:

- *A number of PGR strategies based on Moddus Evo (trinexapac ethyl), Errex (chlormequat) and a coded PGR were noted to significantly reduce lodging in irrigated DBA Aurora.*
- *Reduction in lodging whilst significant did not significantly increase yield relative to the untreated control, a factor associated with later occurrence of the lodging in grain fill (GS87 late dough).*
- *Grazing twice at tillering and at pseudo stem erect (GS22 &30) prevented lodging and was more effective than a number of PGR programmes, however it significantly reduced yield relative to the control.*
- *Sequences of PGR treatment with the first application at GS30 gave significantly better lodging control than the untreated, single applications of PGR were less effective.*
- *Small significant reductions in grain screenings were observed as a result of some treatments*

Table 1. Influence of PGR strategy on Grain yield (t/ha) and Screening (%).

PGR Treatment			Grain yield and quality	
			Yield	Screenings
No.	**Product and Rate**	**Timing**	**t/ha**	**%**
1.	Untreated		7.50 ab	3.6 a
2.	Moddus Evo 200mL/ha + Errex 1.3L/ha	GS31-32	7.50 ab	2.8 c
3.	Moddus Evo 100mL/ha + Errex 0.65L/ha Moddus Evo 100mL/ha + Errex 0.65L/ha	GS30 GS32	7.65 ab	2.5 cd
4.	Errex 1.3L/ha Moddus Evo 200mL/ha	GS30 GS32	7.69 ab	2.6 cd
5.	Errex 0.65L/ha Moddus Evo 200mL/ha + Errex 0.65L/ha	GS30 GS32	7.71 ab	2.8 c
6.	Moddus Evo 200mL/ha + Errex 1.3L/ha FAR PGR 20/01 0.75 L/ha	GS31-32 GS39	7.80 a	2.7 c
7.	Moddus Evo 100mL/ha + Errex 0.65L/ha Moddus Evo 100mL/ha + Errex 0.65L/ha FAR PGR 20/01 0.75 L/ha	GS30 GS32 GS37	7.77 a	2.7 c
8.	FAR PGR 20/01 0.75 L/ha	GS39	7.61 ab	3.0 bc
9.	Grazing (twice GS22 & GS30)	GS22 & GS30	6.63 c	2.1 d
10.	FAR PGR 20/01 0.75 L/ha + Errex 1.3 L/ha	GS32	7.28 b	3.4 ab
	Mean		**7.51**	**2.81**
	LSD		0.435	0.52
	P val		<0.001	<0.001

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

Table 2. Dry matter removed (kg/ha) and timing of mechanical defoliation.

	Grazing Defoliation		
Growth Stage	GS23	GS31	**Total**
Date	14 July	31 July	
Dry Matter removed (kg/ha)	233	345	578

Table 3. Influence of PGR treatment and grazing on lodging index score (% plot area lodged x severity 0-5 scale (0-500)).

			Lodging	
			17 Nov (GS87)	**29 Nov (Harvest)**
No.	**Product and Rate**	**Timing**	**Score (0-500)**	**Score (0-500)**
1.	Untreated		109 -	223 a
2.	Moddus Evo 200mL/ha + Errex 1.3L/ha	GS31-32	90 -	134 ab
3.	Moddus Evo 100mL/ha + Errex 0.65L/ha	GS30		
	Moddus Evo 100mL/ha + Errex 0.65L/ha	GS32	47 -	71 bc
4.	Errex 1.3L/ha	GS30		
	Moddus Evo 200mL/ha	GS32	24 -	39 bc
5.	Errex 0.65L/ha	GS30		
	Moddus Evo 200mL/ha + Errex 0.65L/ha	GS32	11 -	56 bc
6.	Moddus Evo 200mL/ha + Errex 1.3L/ha	GS31-32		
	FAR PGR 20/01 0.75 L/ha	GS39	29 -	73 bc
7.	Moddus Evo 100mL/ha + Errex 0.65L/ha	GS30		
	Moddus Evo 100mL/ha + Errex 0.65L/ha	GS32		
	FAR PGR 20/01 0.75 L/ha	GS37	14 -	56 bc
8.	FAR PGR 20/01 0.75 L/ha	GS39	40 -	85 bc
9.	Grazing (twice GS22 & GS30)	GS22 & GS30	0 -	0 c
10.	FAR PGR 20/01 0.75 L/ha + Errex 1.3 L/ha	GS32	79 -	145 ab
	Mean		**44.3**	**88.1**
	LSD		77	110
	P val		0.097	0.019

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

Kerang VIC

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

Trial 1 Optimum Plant Population Under Sprinkler Irrigation

Location: Kerang, Victoria
FAR Code: ICC D20-01-3
Sown: 29 May
Cultivar: DBA Aurora and DBA Vittaroi
Harvested: 11 December 2020
Rotation position: Dryland vetch/brown manure 2019
Soil Type: Neutral medium grey clay
Irrigation: Overhead sprinkler irrigation 8 applications totalling 208mm (2.08 ML/ha)
GSR: April-October 250mm. Total water available 458mm

Key Messages:

- *The average establishment rate for the trial averaged 6%.*
- *There were differences in biomass at GS31, with the trend to lower biomass at lower seeding rates and this was reflected in shoot numbers.*
- *Yield was not influenced by plant population in either variety.*
- *Yield was below expectations which appears to be due to inadequate irrigation although the amount of irrigation applied exceeded the evaporation in the spring period.*
- *The lowest sowing rate of 100 seeds/m^2 equates to a plant population of approximately 76 plants/m^2 or*
- *Harvest Index ranged from 0.33 to 0.39 with the exception of one treatment.*
- *Water use efficiency was 15.5 kg/mm*

Table 1. Establishment - Plant population (plants/m^2) established from four seed rates with two different cultivars grown under overhead irrigation.

	Established Population		
Seed Rate	**DBA Aurora**	**DBA Vittaroi**	**Mean**
	Plants/m^2	**Plants/m^2**	**Plants/m^2**
100 seeds/m^2	68.0 d	76.8 cd	**72.4 d**
200 seeds/m^2	148.0 bc	113.5 c	**130.8 c**
300 seeds/m^2	176.5 b	177.8 b	**177.1 b**
400 seeds/m^2	230.5 a	219.5 a	**225.0 a**
Mean	**155.8**	**146.9**	151.3

LSD Seed Rate p = 0.05	26.21	**P val**	<0.001
LSD Cultivar p=0.05	18.53	**P val**	0.331
LSD Seed Rate x Cultivar.	37.06	**P val**	0.336

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

Table 2. Influence of plant population on canopy composition, plants/m^2 (GS21), tillers/m^2 (GS31) and heads/m^2 (GS87) – assessed GS21 (29 Jun), GS31 (13 Aug), GS87 (12 Dec).

Treatment	Canopy composition		
	Plants/m^2	Tillers/m^2	Heads/m^2
DBA Aurora			
100 seeds/m^2	68.0 d	558 c	322.9 e
200 seeds/m^2	148.0 bc	670 bc	432.0 ab
300 seeds/m^2	176.5 b	784 ab	460.4 ab
400 seeds/m^2	230.5 a	833 a	485.4 a
DBA Vittaroi			
100 seeds/m^2	76.8 cd		344.5 de
200 seeds/m^2	113.5 c		359.8 cd
300 seeds/m^2	177.8 b		404.2 bcd
400 seeds/m^2	219.5 a		425.7 abc
Mean	**151**		**404**
LSD Seed Rate x Cultivar. P=0.05	37.06	121.3	69.98
P val Seed Rate x Cultivar. P=0.05	0.336		0.052
P val Seed Rate P=0.05	<0.001	0.003	<0.001
P val Cultivar. P=0.05	0.331	-	0.022

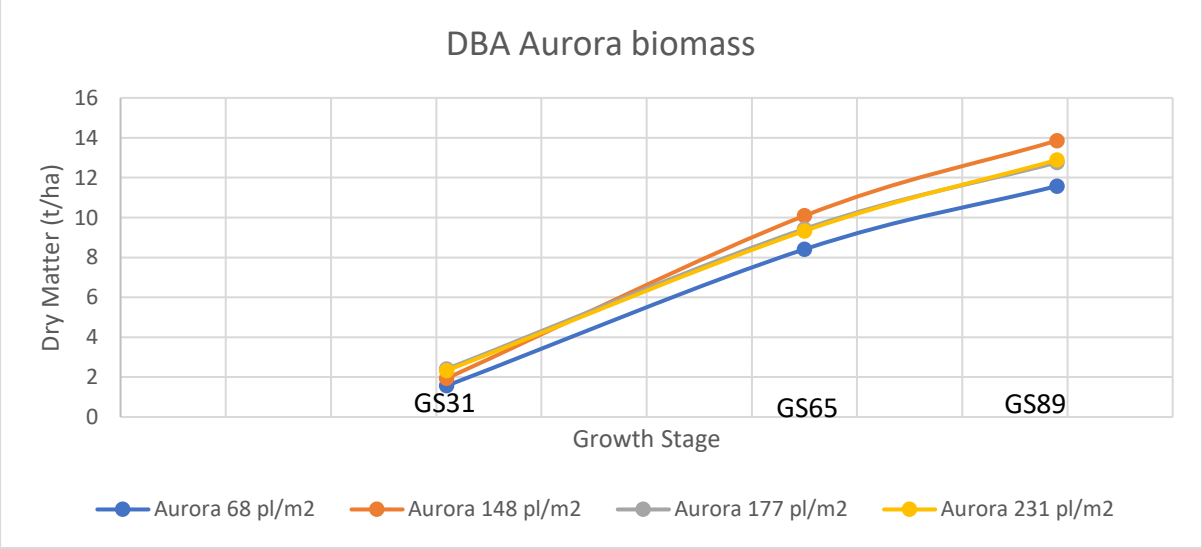

Figure 1. Influence of plant population on dry matter production (t/ha).

There were differences in biomass measured at GS31, reflecting shoot number and seeding rate. By flowering, there were no differences in biomass.
Maximum biomass achieved at harvest was 13.86 t DM/ha by DBA Aurora sown at 200 seeds/m2, or although this was not statistically different to any other treatment.

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

Table 3. Influence of seed rates (plant population) on grain yield (t/ha) with two different varieties grown under overhead irrigation.

		Yield			*Protein*		
Plants/m² (actual)		**Aurora**	***Vittaroi***	***Mean***	***Aurora***	***Vittaroi***	***Mean***
Aurora	**Vittaroi**	**t/ha**	***t/ha***	***t/ha***	***%***	***%***	***%***
68	77	4.76 -	4.96 -	***4.86*** -	16.4 b	16.2 a	**16.3** -
148	114	6.10 -	5.42 -	***5.76*** -	15.5 b	16.4 a	***15.9*** -
177	178	5.92 -	4.97 -	***5.45*** -	15.5 b	16.4 a	***15.9*** -
231	220	5.72 -	5.12 -	***5.42*** -	15.6 b	16.3 a	***15.9*** -
Mean		**5.62** -	**5.12** -		**15.7 b**	**16.3 a**	

LSD Cultivar p=0.05	ns	0.38
P val	0.072	0.006
LSD Seed Rate p=0.05	ns	ns
P val	0.149	0.490
LSD Seed Rate x Cultivar. P=0.05	ns	0.77
P val	0.474	0.131

Table 4. Influence of seeding rate on harvest Index.

Sowing Rate (seeds/m²)	**100**	**200**	**300**	**400**
	Harvest Index			
Aurora	0.36 b	0.33 b	0.38 b	0.38 b
Vittaroi	0.36 b	0.37 b	0.39 b	0.45 a

p_{var} = 0.016, p $_{rate}$ = 0.010, p_{vxr} = 0.213, lsd $_{vxr}$ = 0.055, cv% = 9.9

Grain yield was not significantly different from either variety or seeding rate.

Protein was not significantly different due to seeding rate in Vittaroi, but the low rate in Aurora was. This may be due to the low yield being reflected in higher protein.

Harvest Index was similar in all treatments apart from the high seeding rate in Vittaroi. Overall, the harvest index was relatively low.

The average yield for the trial was 5.4 t/ha. This represents a WUE of 15.5 kg/mm.

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

Trial 2 Optimum Plant Population Under Flood Irrigation

Location: Kerang, Victoria
FAR Code: ICC D20-01-4
Sown: 29 May
Cultivars: DBA Aurora and DBA Vittaroi
Harvested: 10 December 2020
Rotation position: Dryland vetch/brown manure 2019
Soil Type: Neutral medium grey clay
Irrigation: Flood irrigation 4 applications totalling 430mm (4.3 ML/ha)
GSR: April-October 250mm. Total water available 680mm

Key Messages:

- *The average establishment rate for the trial averaged 70% ranging from 59 – 83%, trending to higher establishment with lower seeding rates.*
- *Biomass at GS31 showed a trend to higher biomass generated by higher shoot numbers as seeding rate (plant population) increased.*
- *There was no difference in biomass at mid-flowering in DBA Aurora due to the different plant populations having similar heads numbers across all 4 seeding rates..*
- *Biomass at harvest was influenced by variety and seeding rate in DBA Vittaroi only and at a seeding rate of 300 seeds/m^2 or 194 plants/m^2. This could possibly be due to sampling variability.*
- *Seeding rate, and hence plant population had little influence on grain yield. A seeding rate of 100 seeds/m^2 is the equivalent of approximately 60 kg/ha seeding rate or an establishment of 70 plants/m^2.*
- *Protein content was influenced by variety more than seeding rate.*
- *Water use efficiency was 16.5 kg/mm*

Table 1. Establishment - Plant population (plants/m^2) established from four seed rates with two different cultivars grown under flood irrigation.

	Established Population		
Seed Rate	**DBA Aurora**	**DBA Vittaroi**	**Mean**
	Plants/m^2	**Plants/m^2**	**Plants/m^2**
100 seeds/m^2	83.2 d	72.0 d	**77.6 d**
200 seeds/m^2	148.2 c	166.0 c	**157.1 c**
300 seeds/m^2	198.2 bc	193.8 bc	**196.0 b**
400 seeds/m^2	243.8 a	235.0 ab	**239.4 a**
Mean	**168.4**	**166.7**	167.5

LSD Seed Rate p = 0.05	<0.001	**P val**	28.46
LSD Cultivar p=0.05	0.863	**P val**	20.12
LSD Seed Rate x Cultivar.	0.707	**P val**	40.24

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

Table 2. Influence of plant population on canopy composition, plants/m^2 (GS21), tillers/m^2 (GS31) and heads/m^2 (GS87) – assessed GS21 (29 Jun), GS31 (13 Aug), GS87 (12 Dec).

Treatment	Canopy composition		
	Plants/m^2	Tillers/m^2	Heads/m^2
DBA Aurora			
100 seeds/m^2	83.2 d	524 c	370.0 bcd
200 seeds/m^2	148.2 c	681 b	381.0 bc
300 seeds/m^2	198.2 bc	715 ab	429.0 ab
400 seeds/m^2	243.8 a	836 a	454.8 a
DBA Vittaroi			
100 seeds/m^2	72.0 cd		295.0 e
200 seeds/m^2	166.0 c		320.8 de
300 seeds/m^2	193.8 bc		386.2 bc
400 seeds/m^2	235.0 ab		331.2 cde
Mean	**167.5**		**371**
LSD Seed Rate x Cultivar. P=0.05	40.24	127.4	59.50
P val Seed Rate x Cultivar. P=0.05	0.707		0.251
P val Seed Rate P=0.05	<0.001	0.003	0.004
P val Cultivar. P=0.05	0.863	-	<0.001

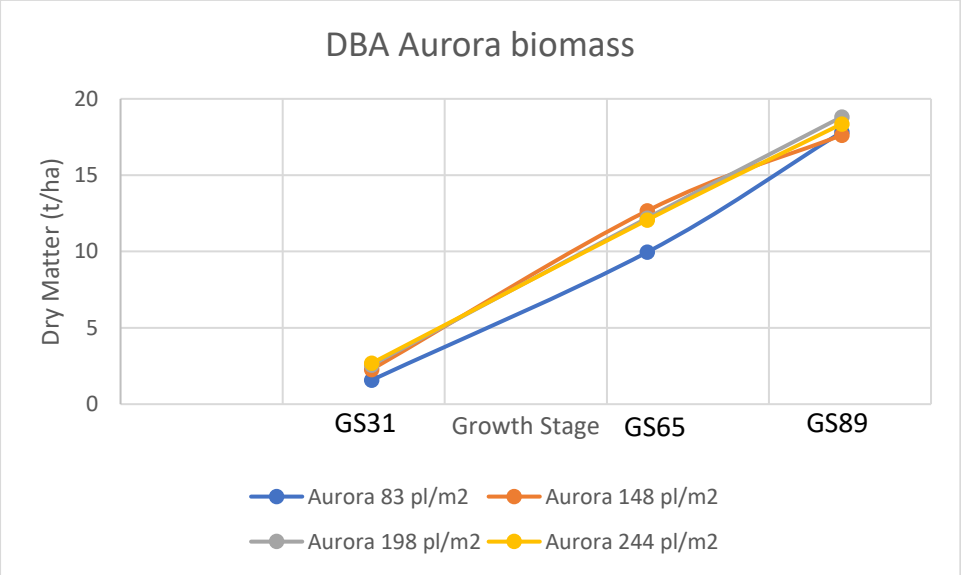

Figure 1. Influence of plant population on dry matter production (t/ha).

There were differences in biomass and shoots measured at GS31, with higher the plant population, the trend was for higher biomass and shoots/m^2.
Biomass at mid-flowering saw no difference in either head numbers or biomass in DBA Aurora.
Maximum biomass achieved at harvest was 18.54 t DM/ha in DBA Vittaroi at the 300 seeds/m2 seeding rate. Seeding rate made no difference to biomass in DBA Aurora.

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

Table 3. Influence of seed rates (plant population) on grain yield (t/ha) with two different varieties grown under flood irrigation.

		Yield			*Protein*		
Plants/m² (actual)		**Aurora**	***Vittaroi***	***Mean***	***Aurora***	***Vittaroi***	***Mean***
Aurora	**Vittaroi**	**t/ha**	***t/ha***	***t/ha***	***%***	***%***	***%***
83	72	9.67 ab	8.85 d	**9.2 -**	14.4 bcd	15.4 a	**14.9 -**
148	166	9.79 ab	9.52 abc	**9.6 -**	14.2 cd	15.0 abc	***14.6*** **-**
198	194	9.96 a	9.18 cd	**9.5 -**	14.0 d	14.4 bcd	***14.2*** **-**
244	235	9.67 ab	9.26 bcd	**9.4 -**	14.2 cd	15.2 ab	***14.7*** **-**
Mean		**9.77 a**	**9.20 b**		**14.2 b**	**15.0 a**	

LSD Cultivar p=0.05	0.307	0.413
P val	<0.001	<0.001
LSD Seed Rate p=0.05	ns	ns
P val	0.294	0.107
LSD Seed Rate x Cultivar. P=0.05	0.614	0.827
P val	0.485	0.719

Table 4. Influence of seeding rate on harvest Index.

Grain Yield (t/ha)				
Sowing Rate (seeds/m²)	100	200	300	4000
Harvest Index				
Aurora	0.48 -	0.49 -	0.47 -	0.44 -
Vittaroi	0.48 -	0.58 -	0.44 -	0.52 -
p_{var} = 0.035, p_{rate} = 0.016, p_{vxr} = 0.048, lsd_{vxr} = NS, cv% = 16.2				

Highest yield grain was from the 300 seeds/m2 rate with Aurora. No seeding rate in Aurora was significantly different. Similarly, all Vittaroi seeding rates were not statistically different.

Protein was generally lower in Aurora, with no treatment influencing protein.

Harvest Index was variable, but there was interaction between rate and variety that means analysis is not possible.

The average yield for the trial was 9.4 t/ha. This represents a WUE of 16.5 kg/mm.

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

Trial 3 Nitrogen Use Efficiency Trial – Nitrogen Rates

Location: Kerang, Victoria
FAR Code: ICC D20-03-2
Sown: 29 May 2020
Cultivar: DBA Vittaroi
Harvested: 10 December 2020
Rotation position: Dryland vetch/brown manure 2019
Soil Type: Neutral medium grey clay
Irrigation: Flood irrigation 4 applications totalling 430mm (4.3 ML/ha)
GSR: April-October 250mm. Total water available 680mm

Key Messages:

- *Relatively high soil N at sowing (130kg N/ha 0-60cm) saw the zero N control treatment (#1) accumulate 174 kg N/ha at harvest.*
- *Applied N saw increases in accumulated plant N approximating the amount applied as urea.*
- *Maximum yield was achieved by applying 300 kg N/ha split as two topdressings at GS32 and GS37.*
- *Grain protein exceeded the required 13% with 200 kg N/ha applied as a split application at GS32 and GS37.*
- *Highest grain protein was achieved with an application of 100 kg N/ha at GS55 on top of earlier applications of 200 and 250 kg N split at GS 32 and GS 55, but not significantly different to that of the 300 kg N/ha @ GS32/37 treatment.*

Table 1: Treatment Summary – N application rates (kg N/ha) and timing (Growth Stage).

	Treatments			
Intended N application	GS30	GS32	GS39	
Actual stage*	GS32	GS 37	GS55	
Date	8 September	18 September	4 October	Total N applied
Treatment 1	0	0		0
Treatment 2	50	50		100
Treatment 3	75	75		150
Treatment 4	100	100		200
Treatment 5	125	125		250
Treatment 6	150	150		300
Treatment 7	100	100	100	300
Treatment 8	125	125	100	350

All treatments received 22 kg N/ha as starter fertiliser.
***:** Topdressing was delayed by lack of rainfall at GS30, and so further treatments were subsequently delayed.

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

Table 2. Canopy measurements – NDVI, dry matter and accumulated plant N.

	GS31		GS 65		Harvest	
Trt	DM (t/ha)	Accumulated N (kg N/ha)	DM (t/ha)	Accumulated N (kg N/ha)	DM (t/ha)	Accumulated N (kg N/ha)
1	2.06 -	80.5 -	8.60 a	98.9 a	14.51 c	174.1 d
2					16.01 bc	279.4 c
3	1.94 -	67.1 -	10.89 b	218.1 b	16.59 bc	300.3 c
4					15.81 bc	310.2 bc
5					18.82 a	363.6 a
6	1.96 -	68.0 -	10.82 b	228.9 b	17.49 ab	359.0 ab
7					16.38 bc	400.6 a
8					17.29 ab	376.9 a
P val	0.461	0.099	0.004	<0.001	0.026	<0.001
LSD	NS	NS	1.11	18.49	2.199	49.5
cv%	6.9	11.2	6.3	5.9	9.0	10.5

Soil N at sowing was 130 kg N/ha (0-60cm). This was sufficient N to allow even canopy development until at least to GS31, as indicated by similar biomass across all treatments. However, differences were apparent at flowering where Treatment 1 had begun to suffer from reduced growth, whereas treatments 3 and 6 were similar despite double the amount of N being applied to 6.
Maximum biomass at harvest was attained by Treatment 5 (250 kg N/ha). The extra 100 kg N/ha applied to treatments 7 and 8 saw no increase in biomass over their 'sister' treatments 4 and 5 that had similar amounts of N applied up to GS 37.
Uptake of N at harvest by treatment 1 was 174 kg N/ha, which is close to expectations given 130 kg N/ha in the soil to 60 cm and 25 kg N/ha as starter fertiliser.
Highest N uptake was by treatment 7 at 400.6 kg N/ha from a total of 474 kg N/ha supplied (300 kg N/ha applied as urea plus assuming the amount of N in treatment 1 uptake (174 kg N/ha) was supplied by the soil and starter N).

Table 3. Yield and grain quality.

Treatment	Grain Yield (t/ha)	Protein (%)	Screenings (%)	Test Weight (kg/hl)	Harvest Index
1	7.82 d	11.0 d	0.6	82.8	0.48
2	8.73 c	11.8 cd	0.7	82.4	0.50
3	9.46 b	12.9 bcd	0.5	82.1	0.46
4	9.57 b	13.5 abc	0.5	81.9	0.52
5	9.57 b	12.8 bcd	0.6	82.5	0.51
6	10.40 a	14.4 ab	0.5	81.0	0.47
7	9.59 b	15.1 a	0.5	81.6	0.54
8	9.70 b	15.4 a	0.6	81.3	0.53
p	0.352	<0.001	0.0.456	0.200	0.155
lsd	NS	1.885	NS	NS	NS

Released:24 February 2021

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

cv%	12.8	9.6	33.1	1.2	8.7

Highest yield was attained by Treatment 6, with a total of 300 kg N/ha applied at GS32 and GS37.
As durum wheat is about meeting the minimum specification of 13% protein, Treatment 4, with a total of 200 kg N/ha applied at GS32 and GS37, was the treatment with the lowest applied N to exceed 13% protein, although it was not significantly different to treatments 2 and 3 which received 50 and 100 kg N/ha less.
Late application of 100 kg N/ha at GS55 did boost grain protein, but not significantly above that achieved with treatment 6.

While there were differences in the Harvest Index, these were not statistically significant.

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

Trial 4 Nitrogen Use Efficiency Trial – Nitrogen Timing Trial

Location: Kerang, Victoria
FAR Code: ICC D20-04-2
Sown: 29 May 2020
Cultivar: DBA Vittaroi
Harvested: 10 December 2020
Rotation position: Dryland vetch/brown manure 2019
Soil Type: Neutral medium grey clay
Irrigation: Flood irrigation 4 applications totalling 430mm (4.3 ML/ha)
GSR: April-October 250mm. Total water available 680mm

Key Messages:

- *No N timing strategy stood out as a clear winner.*
- *The earlier the N was applied tended to see higher biomass produced.*
- *The later the N was applied tended to see higher accumulation of N.*
- *Delayed application of nitrogen resulted in yield reduction but higher grain protein.*
- *Harvest index averaged 0.49 and was not influenced by treatment.*

Table 1: Treatment Summary – N application rates (kg N/ha) and timing (Growth Stage).

Treatments					
Intended N application	Sowing	GS30	GS32	GS39	
Actual stage		GS32	GS 37	GS55	
Date	29 May	8 September	18 September	4 October	Total N applied
Treatment 1	0	0	0		0
Treatment 2	50	50			100
Treatment 3	100	100			200
Treatment 4	150	150	0		300
Treatment 5		0	0		0
Treatment 6		50	50		100
Treatment 7		100	100		200
Treatment 8		150	150		300
Treatment 9			0	0	0
Treatment 10			50	50	100
Treatment 11			100	100	200
Treatment 12			150	150	300

All treatments received 22 kg N/ha as starter fertiliser.
***:** Topdressing was delayed by lack of rainfall at GS30, and so all treatments were subsequently delayed.

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

Table 2. Dry matter (t/ha) and accumulation of N (kg N/ha).

	GS31		GS 65		Harvest	
Treatment	DM (t/ha)	Accumulated N (kg N/ha)	DM (t/ha)	Accumulated N (kg N/ha)	DM (t/ha)	Accumulated N (kg N/ha)
1	2.27 -	85.9 b	9.95 b	153.9 b	14.45 cd	191.2 ef
2	2.66 -	92.0 b			16.27 bc	236.6 de
3	2.87 -	115.7 a	11.87 a	253.8 a	18.97 a	282.3 cd
4	2.75 -	105.1 ab			17.24 ab	274.9 de
5					13.63 d	138.9 f
6					15.43 bcd	260.4 d
7			9.90 b	183.8 b	17.61 ab	335.4 bc
8					16.32 bc	342.8 bc
9					15.61 bcd	199.4 ef
10					15.72 bcd	325.0 bc
11			9.90 b	160.7 b	15.89 bcd	377.0 b
12					17.17 ab	442.8 a
P val	0.072	0.033	0.038	<0.001	0.001	<0.001
LSD	NS	19.9	1.50	18.5	2.27	60.6
cv%	11.0	11.2	9.0	5.9	9.1	15.0

While biomass at GS 31 was not influenced by rate, accumulated N was higher in treatments 3 (100 kg N/ha) and 4 (150 kg N/ha) applied at sowing.

Dry matter assessments at GS65 showed, that at the rate of 200 kg N/ha, early application increased biomass and N accumulation.

Maximum biomass at harvest was attained by Treatment 3 (200 kg N/ha split between sowing and GS32). However this treatment was not significantly different to treatments 4 (300 kg N/ha split between sowing and GS32), 7 (200 kg N/10 split between GS 32 & GS37) and 12 (300 kg N/ha split between GS37 and GS55). Treatment 12 did have the highest N accumulation at 442.8 kg N/ha. If the amount of N available from the soil is the average of the treatments 1, 5 and 9 (where no N was applied apart from starter N at sowing) or 177 kg N/ha, then treatment 12 took up 265 kg N/ha of the applied 300 kg N.

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

Table 3a. Influence of N timing on yield and grain quality.

Timing	Grain Yield (t/ha)	Protein (%)	Screenings (%)	Test Weight (kg/hl)	Harvest Index
Sowing/GS32	9.04	11.6 b	0.5	82.6	0.48
GS32/GS37	9.02	12.1 b	0.5	82.5	0.51
GS37/GS55	8.51	13.0 a	0.5	82.1	0.47
P val	*	0.012	0.63	0.081	0.068
LSD		0.864	NS	NS	NS
cv%		9.8	34.1	0.7	9.9

*: Yield data is presented as treatment means only as there was significant interaction between N rate and timing.

Table 3b. Influence of N rate on yield and grain quality.

N rate (kg N/ha)	Grain Yield (t/ha)	Protein (%)	Screenings (%)	Test Weight (kg/hl)	Harvest Index
0	7.62	9.9 b	0.5	82.6 a	0.46
100	8.97	11.7 b	0.5	82.6 a	0..50
200	9.38	13.2 a	0.5	82.2 ab	0.48
300	9.45	14.2 a	0.5	81.9 b	0.49
P	*	<0.001	0.963	0.022	0.178
LSD		0.998	NS	0.497	NS
cv%		9.8	34.1	0.7	9.9

Table 4. Rate by Timing results for grain yield and protein.

	Yield (t/ha)			
	0 kg N/ha	100 kg N/ha	200 kg N/ha	300 kg N/ha
Sowing/GS32	7.73	9.17	9.40	9.85
GS32/GS37	7.34	9.29	9.47	9.99
GS37/GS55	7.78	8.45	9.28	8.52
p_{timing} = 0.010, p_{rate} = <0.001, p_{txr} = 0.029, lsd_{txr} = NS, cv% = 8.9				

	Protein (%)							
	0 kg N/ha		100 kg N/ha		200 kg N/ha		300 kg N/ha	
Sowing/GS32	10.4	d	10.7	cd	12.2	c	13.3	bc
GS32/GS37	10.0	d	11.9	c	13.2	bc	13.4	bc
GS37/GS55	9.4	d	12.5	bc	14.1	b	15.8	a
p_{timing} = 0.012, p_{rate} = <0.001, p_{txr} = 0.77, lsd_{txr} = 1.73, cv% = 9.8								

Yield trended higher as the rate of N was increased, but trended lower as N application was delayed. The interaction between timing and rate in the trial makes statistical analysis not possible. Logically, if the amount of N in the soil cannot sustain the crop until topdressing occurs, then yield will be compromised.

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

Grain protein trended higher as the rate of N increased, as well as the later the N was applied. Given the target protein for durum wheat is 13%, early N application needed to be at the 300 kg N/ha rate, while delayed application of 200 kg N/ha split at GS32/GS37 saw grain protein exceed the 13% threshold. The highest grain protein achieved in the trial was at a N rate of 300 kg/ha and applied at the GS37/GS55 stages, but. this was at the cost of yield.

While there were differences in the Harvest Index, these were not statistically significant

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

Trial 5 Germplasm Disease Management Interaction

Location: Kerang, Victoria
FAR Code: ICC D20-07-2
Sown: 29 May
Cultivar: DBA Aurora and DBA Vittaroi
Harvested: 10 December 2020
Rotation position: Dryland vetch/brown manure 2019
Soil Type: Neutral medium grey clay
Irrigation: Flood irrigation 4 applications totalling 430mm (4.3 ML/ha)
GSR: April-October 250mm. Total water available 680mm

Key Messages:

- *Stripe rust was present in the trial but infection was observed in the lower canopy and not on the flag leaf.*
- *Fungicide strategy did not affect yield or grain quality.*
- *Variety choice played a role in grain quality based on higher proteins in Vittaroi.*

Table 1. Treatment summary – application timing, product and rate.

Treatments	GS31 (24 August)	GS39 (21September)	GS61 (12 October)
Untreated			
2 Spray	0.3 l/ha Prosaro	0.4 l/ha Amistar Xtra	
Systiva* + 2 Spray		0.4 l/ha Amistar Xtra	0.3 l/ha Prosaro
3 Spray	0.4 l/ha Aviator	0.4 l/ha Amistar Xtra	0.3 l/ha Prosaro
GS 31	0.4 l/ha Amistar Xtra		
GS 39		0.4 l/ha Amistar Xtra	

*Systiva applied to the seed at 150ml/100 kg seed.
The treatments were applied to DBA Aurora and DBA Vittaroi

Table 2. Canopy measurements – % of green leaf loss due to stripe rust infection assessed on 13 October.

Treatments	DBA Aurora		DBA Vittaroi	
	Flag Leaf	Lower canopy	Flag Leaf	Lower canopy
Untreated	5	5	5	30
2 Spray	< 5	< 5	< 5	5
Systiva + 2 Spray	< 5	5	< 5	10
3 Spray	< 5	< 5	< 5	< 5
GS 31	< 5	< 5	10	20
GS 39	< 5	< 5	< 5	10

Stripe rust was first detected on the trial site on 28 August in the MS-S rated bread wheats. The durum trials were at approximately GS32 at this stage.
Conditions during September were drier than average and further infections were limited. When the assessments were conducted on 13 October, very few new infections (active sporulation) were observed.
Infection was more prevalent in the lower canopy, with all treatments showing minimal green leaf loss on the flag.

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

Table 3. Yield and grain quality.

Treatment	GS31	GS39	2 Spray	3 Spray	Sys+2	Untreated
Aurora	10.33	10.11	10.20	9.56	9.77	9.81
Vittaroi	9.39	9.96	10.10	10.25	9.59	9.28
	p_{var} = 0.242, p_{fun} = 0.358, p_{vxf} = 0.163, lsd $_{vxf}$ = NS, cv% = 6.0					
	Protein (%)					
Aurora	13.8	14.0	13.8	14.0	14.0	13.9
Vittaroi	14.8	15.1	14.9	14.8	15.1	14.6
	p_{var} = <0.001, p_{fun} = 0.345, p_{vxf} = 0.796, lsd $_{vxf}$ = NS, cv% = 2.5					

Grain yield was not influenced by either variety or fungicide strategy.
Grain protein was influenced by variety rather than fungicide strategy. It was a similar trend for test weight and screenings (not published).

The average yield for the trial was 9.86 t/ha. This represents a WUE of 14.2 kg/mm.

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

Trial 6 Disease Management for Irrigated Crops – Products, Rates and Timings

Location: Kerang, Victoria
FAR Code: ICC D20-08-2
Sown: 29 May
Cultivar: DBA Vittaroi
Harvested: 10 December 2020
Rotation position: Dryland vetch/brown manure 2019
Soil Type: Neutral medium grey clay
Irrigation: Flood irrigation 4 applications totalling 430mm (4.3 ML/ha)
GSR: April-October 250mm. Total water available 680mm

Key Messages:

- *Stripe rust was present in the trial but infection was observed in the lower canopy and not on the flag leaf.*
- *Fungicide strategy did not affect yield or grain quality.*

Table 1. Treatment summary – application timing, product and rate.

Treatments	GS00 29 May	GS31 24 August	GS39 21September	GS65 12 October
1.Untreated				
2	Systiva 150ml/100kg		Prosaro 0.3 l/ha	
3	Jockey 450 ml/100kg		Prosaro 0.3 l/ha	
4	Flutriafol 400 ml/100kg		Prosaro 0.3 l/ha	
5	Vibrance 180 ml/100kg	Opus 0.5 l/ha	Prosaro 0.3 l/ha	
6	Vibrance 180 ml/100kg	Opus 0.5 l/ha	Aviator 0.4 l/ha	
7	Vibrance 180 ml/100kg	Radial 0.84 l/ha	Aviator 0.4 l/ha	
8	Vibrance 180 ml/100kg	Opus 0.5 l/ha	Prosaro 0.3 l/ha	Opus 0.25 l/ha
9	Vibrance 180 ml/100kg	Opus 0.5 l/ha	Aviator 0.4 l/ha	Opus 0.25 l/ha
10	Vibrance 180 ml/100kg	Radial 0.84 l/ha	Aviator 0.4 l/ha	Opus 0.25 l/ha

***Systiva applied to the seed at 150ml/100 kg seed.

The treatments were applied to DBA Aurora and DBA Vittaroi

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

Table 2. Canopy measurements – % of green leaf loss assessed on 13 October.

Treatments	Visual Assessment 13 October		NDVI 15 November
	Flag Leaf	Lower canopy	NDVI
1 Untreated	10	40	0.53 d
2	5	10	0.62 ab
3	< 5	10	0.60 bc
4	< 5	5	0.61 ab
5	< 5	5	0.55 cd
6	< 5	5	0.63 ab
7	< 5	5	0.60 b
8	< 5	< 5	0.61 b
9	< 5	5	0.59 bc
10	< 5	5	0.66 a
			p_{ndvi} = 0.001, lsd = 0.055, cv% = 6.3

Stripe rust was first detected on the trial site on 28 August in the MS-S rated bread wheats. The durum trials were at approximately GS32 at this stage.
Conditions during September were drier than average and further infections were limited. When the assessments were conducted on 13 October, very few new infections (active sporulation) were observed.
Infection was more prevalent in the lower canopy, with all treatments showing minimal green leaf loss on the flag.
NDVI assessment on 15 November saw some differences in canopy 'greenness', with the treatment 10 having the highest NDVI reading and the untreated, the lowest.

Table 3. Yield and grain quality.

Treatment	Yield (t/ha)	Protein (%)	Screenings (%)	Test Weight (kg/hl)
1 Untreated	9.56	15.1	0.5	79.7
2	10.49	15.5	0.5	79.9
3	10.49	15.4	0.5	80.0
4	10.13	14.9	0.4	80.7
5	9.81	15.1	0.4	79.6
6	10.22	15.0	0.4	80.5
7	10.28	15.2	0.5	80.6
8	10.46	15.3	0.5	80.3
9	10.17	15.2	0.4	80.2
10	10.55	15.3	0.5	80.5
P val	0.099	0.555	0.948	0.533
LSD	NS	NS	NS	NS
cv%	4.6	2.3	38.4	1.0

Grain yield was not influenced by fungicide strategy.

Released:24 February 2021

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

The average yield for the trial was 10.2 t/ha. This represents a WUE of 15.0 kg/mm

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

Trial 7 Influence of Plant Growth Regulation on Durum Yield and Profitability under Irrigation

Location: Kerang, Victoria
FAR Code: ICC D20-09-2
Sown: 29 May
Cultivar: DBA Aurora
Harvested: 10 December 2020
Rotation position: Dryland vetch/brown manure 2019
Soil Type: Neutral medium grey clay
Irrigation: Flood irrigation 4 applications totalling 430mm (4.3 ML/ha)
GSR: April-October 250mm. Total water available 680mm

Key Messages:

- *Some of the trial treatments did result in reduced plant height but this did not necessarily result in reduced lodging.*
- *Grazing was not effective in reducing crop height but yield was similar to the highest yielding treatment.*
- *Application of PGRs at label rates, either as a single or split application resulted in the highest yields.*
- *There was some variation in grain protein due to the treatments but not enough to affect DR1 classification.*

Table 1. Treatment summary – application timing, product and rate.

Treatments	GS30	GS31-32	GS32	GS37	GS39
1 Untreated					
2		E 1.3 l/ha M E 0.2 l/ha			
3	E 0.65 l/ha M E 0.1 l/ha		E 0.65 l/ha M E 0.1 l/ha		
4	E 1.3 l/ha		M E 0.2 l/ha		
5	E 0.65 l/ha		M E 0.1 l/ha		
6		E 1.3 l/ha M E 0.2 l/ha			PGR 0.75l/ha
7	E 0.65 l/ha M E 0.1 l/ha		E 0.65 l/ha M E 0.1 l/ha	PGR 0.75l/ha	
8					PGR 0.75l/ha
9			Grazed GS22&32		
10			E 1.3 l/ha		PGR 0.75l/ha

E = Errex 750 582 g/l chlormequat
M E = Modus Evo 250 g/l trinexapac-ethyl
PGR = Product not registered for use in Australia on wheat

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Table 2. Canopy measurements – Plant height on 13 October and lodging score assessed on 10 December.

Treatments	Plant Height (cm)	Lodging Score
1 Untreated	100 a	4.5
2	83 ef	5.0
3	81 f	4.0
4	86 de	4.5
5	98 ab	5.0
6	81 f	4.5
7	84 ef	4.5
8	98 ab	6.0
9	91 cd	5.3
10	95 bc	6.0
P val	<0.001	0.63
LSD	4.52	NS
cv%	4.0	30.5

Lodging Score - 0 = no lodging, 9 = Completely lodged

In relation to reducing crop height, treatment 6 was the most effective, with treatments 2, 3 and 7 being statistically similar.

Treatments 1, 5 and 8 were least effective.

However no treatment was effective in controlling lodging, with the data being highly variable.

Table 3. Yield and grain quality.

Treatments	Yield (t/ha)	Protein (%)	Screenings (%)	Test Weight (kg/hl)
1 Untreated	7.61 d	14.2 ab	1.1	80.7
2	9.49 ab	14.5 a	0.9	80.7
3	9.59 ab	14.2 ab	1.1	81.1
4	9.65 a	14.1 ab	1.1	81.0
5	8.17 cd	14.2 ab	0.8	80.5
6	9.64 a	14.1 ab	1.0	80.0
7	8.95 abc	14.0 b	1.0	80.1
8	7.81 d	13.9 b	1.0	79.7
9	8.61 abcd	13.7 b	1.1	80.7
10	8.53 bcd	14.2 ab	1.1	80.5
p	0.001	0.048	0.627	0.334
lsd	1.08	0.428	NS	NS
cv%	8.5	2.1	22.6	1.0

Highest yield was from treatment 4, statistically similar to treatments 2, 3, 6, 7 and 9.

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While protein was influenced by treatments, all protein levels were sufficient to meet DR1 specification.
Screenings and test weight were not affected by treatment.

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