Optimising
Irrigated Grains

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

FAR AUSTRALIA

Irrigated Cropping Council
Promoting irrigated agriculture

Key Learnings (Durum)

2020 and 2021

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SOWING THE SEED FOR A BRIGHTER FUTURE

Durum under irrigation

i) Nitrogen (N) strategy for yield and quality

Key Points:

- ***The ability to use irrigation to improve the efficiency of later N timings is ideal for producing a crop that requires high protein levels to achieve the grade required.***
- ***Provisional results illustrate that later N timings of main N doses in durum maintain yield potential whilst at the same time giving high proteins.***
- ***The ability to delay all the N until GS32 (second node) and GS37 (flag leaf just visible) will need to be considered in the light of available soil N in the profile at late tillering and GS30.***
- ***Very low levels of soil N available at GS30 may require a small late tillering dose in order to feed the crop (40N). With high levels of available of soil N this can be delayed until GS32.***
- ***In 2020 at Finley high soil fertility (232kg N/ha in the 0-90cm soil profile at sowing) resulted in no response to applied N fertiliser with no significant difference in grain yield between 28-378kg N/ha applied.***
- ***In a scenario of lower soil fertility in 2021 (measured 47kg N/ha in the soil, 0-90cm, 23rd August) increasing applied N rates (Urea 46% N) from 0-350kg N/ha had no significant effect on grain yield above 100kg N/ha, but to be certain of having 13% grain protein for DR1, N levels had to be increased to 200kg N/ha since 150kg N/ha achieved only 12.5% grain protein.***
- ***A separate adjacent nitrogen timing trial demonstrated that protein above 13% could be achieved with 100kg N/ha by delaying the timing to GS32 and GS37 (Table 1).***
- ***The same trials at Kerang (2020 & 2021), with starting soil N 77-130 kg N/ha, showed that maximum yield was achieved with N rates of 100-200kg N/ha and 13% protein could be achieved with no more than 200kg N/ha if timing was delayed to GS32 & GS37.***

Durum has been an important crop in the OIG research programme over the last two years. The research has covered all aspects of agronomy, but nutrition has been a key component of the work. How can we reliably achieve 7t/ha plus with protein levels that meet the 13% level? Work has been centred on N rates and N timing. In 2020 high residual soil N (232N-0-90cm profile) built up from the drier previous seasons resulted in no yield response for N applied above starter N (28N). In 2021 soil available N was much lower at the start of spring (47N-0-90cm) and there were yield responses up to 100kg N/ha with 13% grain protein achieved at 200kg N/ha applied (Figure 1). A separate adjacent nitrogen timing trial demonstrated that protein above 13% could be achieved with 100kg N/ha by delaying the timing to GS32 and GS37 without sacrificing yield. (Table 1). At both Kerang and Finley similar findings have been identified with regards to later N timings under surface and overhead irrigation whereby later N timings give the optimum combinations of yield and grain protein.

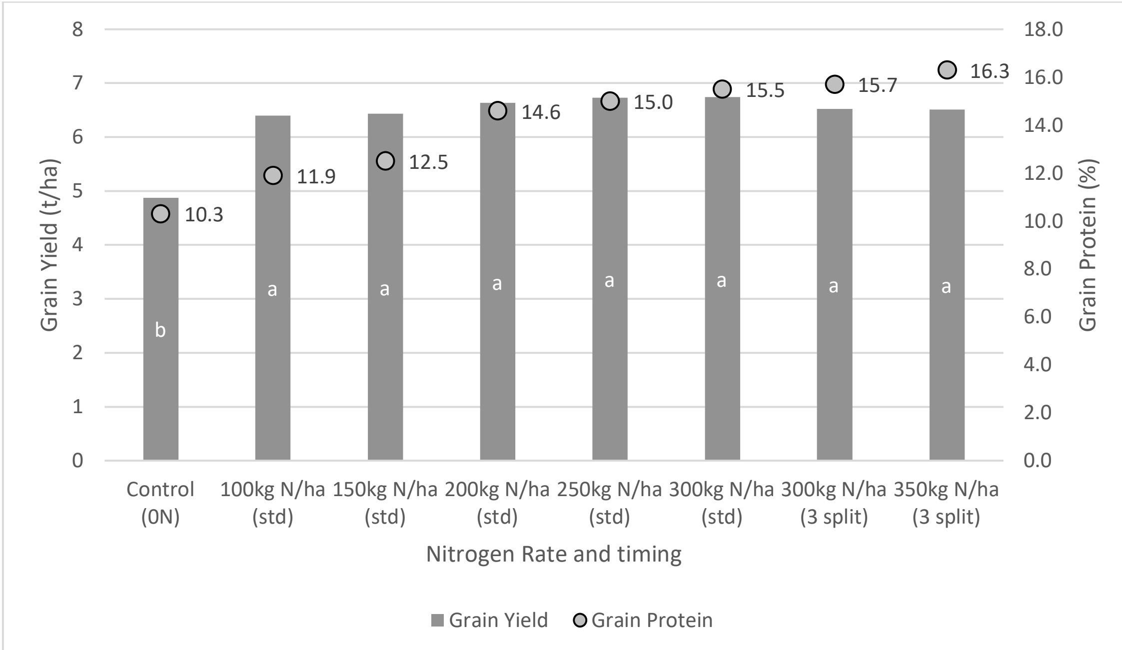

Figure 1. Influence of applied nitrogen at stem elongation on grain yield (t/ha) and protein content (%). – Finley 2021 Notes. Std – nitrogen split 50:50 between GS30 and GS32. 3 split – 100kg of nitrogen withheld until GS39 with the remainder split 50:50 between GS30 and GS32. *Yield bars with different letters are considered statistically different*

Table 1. 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**		**Mean**	
Nitrogen Timing	**Protein %**		**Protein %**		**Protein %**		**Protein%**		**Protein%**	
PSPE & GS30	10.9	-	12.4	-	13.8	-	15.0	-	**13.0**	**b**
GS30 & GS32	10.6	-	12.5	-	13.7	-	15.0	-	**13.0**	**b**
GS32 & GS37	10.9	-	13.4	-	15.3	-	16.4	-	**14.0**	**a**
Mean	**10.8**	**d**	**12.8**	**c**	**14.3**	**b**	**15.5**	**a**		
N Timing			LSD		0.4		**P val**		<0.001	
N Rate			LSD		0.5		**P val**		<0.001	
N Timing x N			LSD		ns		**P val**		**0.235**	

Soil N available – 47kg N/ha 0-90cm

ii) Crop lodging control and use of PGRs

Key Points:

- ***Aurora durum is prone to greater lodging problems during grain fill than Vittaroi.***
- ***PGR applications at Finley and Kerang in 2020 and 2021 in Aurora have consistently resulted in a reduction in both crop height and lodging during grain fill.***
- ***At Kerang in 2021, treatments where Moddus at 200ml/ha and Errex at 1.3l/ha were applied at various timings gave an average yield increase of 1.97t/ha over the untreated control plots (Table 1).***

Four trials were conducted at 2 sites (Finley and Kerang) over 2 years (2020 and 2021). Moddus Evo mixed with Errex and an unregistered experimental product were used at various rates and timings. A grazing treatment was added where plots were mowed twice (GS22 and GS30) to simulate grazing. Responses to plant growth regulator (PGR) chemicals have resulted in a reduction in crop height and reduced lodging. The yield results have varied from 0-2.04t/ha. In most cases grazing has led to a reduction in lodging, however it almost always led to reduction in yield compared to the highest yielding plots in each trial. Table 1 illustrates the trial where the biggest penalty to not using a PGR occurred.

Table 1. Influence of PGR strategy on Grain yield (t/ha) and Screening (%) - Kerang 2020 cv Aurora.

PGR Treatment			**Grain yield and quality**			
			Yield		**Plant Height**	
No.	**Product and Rate**	**Timing**	**t/ha**		**cm**	
1.	Untreated		7.61	d	100	a
2.	Moddus Evo 200mL/ha + Errex 1.3L/ha	GS31-32	9.49	ab	83	ef
3.	Moddus Evo 100mL/ha + Errex 0.65L/ha Moddus Evo 100mL/ha + Errex 0.65L/ha	GS30 GS32	9.59	ab	81	f
4.	Errex 1.3L/ha Moddus Evo 200mL/ha	GS30 GS32	9.65	a	86	de
5.	Errex 0.65L/ha Moddus Evo 100mL/ha	GS30 GS32	8.17	cd	98	ab
6.	Moddus Evo 200mL/ha + Errex 1.3L/ha FAR PGR 20/01 0.75 L/ha	GS31-32 GS39	9.64	a	81	f
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	8.95	abc	84	ef
8.	FAR PGR 20/01 0.75 L/ha	GS39	7.81	d	98	ab
9.	Grazing (twice GS22 & GS30)	GS22 & GS30	8.61	abcd	91	cd
10.	FAR PGR 20/01 0.75 L/ha + Errex 1.3 L/ha	GS32	8.53	bcd	95	bc
	Mean		**8.81**		**89.7**	
	LSD		1.08		4.52	
	P val		0.001		<0.001	

Pre irrigation – it's not just 'add water' and enjoy the high yields

Key Learnings:

- **Water savings can be made with improved irrigation infrastructure such as overhead sprays.**
- **Irrigation districts have varying access to water during the winter season, with some irrigators having no access from mid-May to mid-August.**
- **Not having sufficient soil moisture going into winter may leave the crop susceptible to 'winter drought', that can have a negative impact on yield.**
- **Similarly, having a full soil profile at the beginning of winter may increase the risk of waterlogging, particularly with surface irrigation in systems that don't drain well.**
- **Soil type, location and appetite for risk all play a part in irrigators' decisions regarding pre-irrigation.**

Two years of GRDC's Optimising Irrigated Grains (OIG), on top of research conducted under the 'Smarter Irrigation for Profit' project, have highlighted the irrigation decisions that need to be made by irrigators on how and when to use their irrigation water to set up their irrigated crops to be the most profitable.

The changing irrigation environment has seen irrigation water become an input where the price can be highly variable based on seasonal conditions and allocations. Efforts to make irrigation more efficient has seen investment in improved layouts and infrastructure such as overhead sprinklers or fast flow surface irrigation, giving irrigators flexibility in the amount of water applied and the choice of crops.

Pre-irrigation (where fallow paddocks are irrigated prior to the sowing of a crop) has always been a judgment call by irrigators, based on timing to enable timely sowing and adequate moisture for the crop to develop over winter. Using surface irrigation, this could mean using anywhere between 0.75 to 2.0 Mega litres/ha (75-200mm/ha) to wet up the soil profile. The timing of pre-irrigation must be considered in order to allow the paddock to dry sufficiently to enable sowing on time, but not to dry too much and then be at the mercy of 'the autumn break' for sowing similar to a dryland grower. Many irrigators have a story about the pre-irrigation that went badly – where it rained, and sowing couldn't proceed or winter waterlogging was detrimental to the crop as the soil profile was full going into winter. However, pre-irrigation does provide soil moisture over winter as some irrigation regions do not have access to water between 15 May and 15 August to allow the water authorities to service and repair the water delivery network.

Irrigators have installed overhead irrigation as a means to be able to have more control over the amount of water applied. Instead of the large volume of water applied via surface irrigation as a pre-irrigation, irrigators can apply enough water to ensure timely establishment of their crop. This can be a considerable saving of water but does then run the risk of a 'winter drought' if the winter period is dry and winter rainfall is inadequate to meet the needs of the crop. In these cases, yield potential is lost before the irrigation water becomes available in the spring. In shorter season crops or in warmer regions where spring growth occurs earlier (before mid-August) yield potential starts to be reduced since crops are stem elongating but without the water reserve to sustain this period of rapid development.

The OIG project, with its geographically diverse project partners, has illustrated the different thinking that drives irrigators decision making on irrigation. Higher rainfall regions are unlikely to pre-irrigate due to the risk of autumn irrigating leading to waterlogging if they go into winter with a full profile.

Similarly, those in the east of the Murray and Murrumbidgee valleys are more confident of a timely break for sowing and follow-up winter rainfall to get the crop through to the spring when irrigation can commence. Those to the west who have soils (e.g. grey clays) that require more water to fill the profile, are less confident of the break being in late April/early May and have lower winter rainfall to tide them over until the irrigation season opens in the spring. Depending on the crop type, restoration of yield potential with spring irrigation following a winter drought can be more limited with early maturing wheat, since it has already started developing rapidly whilst the crop is under spring drought conditions. In some cases, the restoration of yield potential is adequate (e.g. faba beans) but this does depend on whether heat stress was additional to the lack of soil moisture and becomes part of the yield equation. These geographical differences also manifest themselves in the responses to disease management where irrigation does not appear to favour conditions that promote the fungal diseases compared to the naturally more disease prone high rainfall zones.

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