Optimising Irrigated Grains

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

FAR AUSTRALIA

Irrigated Cropping Council
Promoting irrigated agriculture

GRAIN MAIZE

GOOD MANAGEMENT GUIDELINES for Irrigated Crops:

2020 to 2022

SOWING THE SEED FOR A BRIGHTER FUTURE

Introduction

Good management guidelines for irrigated grain maize

This good management guidelines summary for grain maize has been taken from the results of the Optimising Irrigated Grain (OIG) research project, a GRDC investment conducted in south-east Australia ((FAR1906-003RTX) from 2019-23. The guidelines are laid out as key points with a small amount of supporting data taken from the trials conducted over these three years. ***Please note these guidelines only cover agronomy topics that were researched during the project (2020 – 2022), it is not intended to be a complete guide to growing irrigated crops. Instead, it carries key points noted to be instrumental in growing productive and profitable irrigated crops.*** These guidelines can be supplemented by reading the *Good Management Guidelines for Irrigated Crops* produced as a result of the project.

What did we do in the GRDC Optimising Irrigated Grains project?

This GRDC investment Optimising Irrigated Grains (OIG) (FAR1906-003RTX) was set up to identify gaps in our knowledge regarding the true economically attainable yield potential of winter and summer crops grown in south-eastern Australian irrigated farming systems. The focus was on crops where there was less knowledge of upper end yield potential, particularly in light of newer germplasm, management advances and innovations in soil amelioration.

The field research team (FAR Australia and Irrigated Cropping Council (ICC)) was charged with conducting over 60 individual trials per annum, in six crops, over a three-year research period (2020 – 2022). To conduct such a large number of trials, field experiments were consolidated into two major Irrigated Research Centres (IRCs) based at Kerang in Victoria and Finley in southern NSW. Most trials focussed on crop agronomy and were conducted on a grey clay soil at Kerang using predominately surface irrigation (flood), and at Finley on a red duplex using overhead and surface irrigation in collaboration with Southern Growers, NSW DPI and the Maize Association of Australia. Three satellite sites carried a smaller number of trials in the north midlands of Tasmania, south-eastern Australia and Griffiths in NSW in collaboration with Irrigation Research and Extension Committee (IREC), Riverine Plains Inc, Southern Farming Systems, South Australian Research and Development Institute (SARDI) and MacKillop Farm Management Group.

The research programmes were uniquely developed to evaluate crop specific agronomic management practices in irrigated environments in order to ascertain their effects on system productivity and profitability.

Crop specific agronomic practices were focussed on maximising system profitability through:

1. Understanding the yield potential of irrigated crops in the principal environments where research was taking place.
2. Understanding how to consistently optimise yield for the crops where gaps in knowledge were most apparent.
3. Optimising the return on nitrogen through improved nitrogen use efficiency (grain maize, canola, barley and durum).

ACKNOWLEDGEMENTS

FAR Australia would like to place on record their grateful thanks to the Grains Research and Development Corporation (GRDC) for providing the investment for this project, in particular, we would like to thank GRDC's Senior Manager Dr Kaara Klepper for her input, guidance and support in the oversight of the project.

In addition, we would like to acknowledge the collaborative support of our principal trials research partner Irrigated Cropping Council (ICC). We would also like to acknowledge all the OIG partners and collaborators in the project, University of Tasmania, Southern Growers, NSW DPI and the Maize Association of Australia, Irrigation Research and Extension Committee (IREC), Riverine Plains Inc, Southern Farming Systems, South Australian Research and Development Institute (SARDI) and MacKillop Farm Management Group.

GRAIN MAIZE

Nitrogen rates and timing targeting 20t/ha for irrigated grain maize

Key point summary

a) ***Nitrogen fertilisers***

- ***Grain maize crops yielding 16 – 19t/ha with dry matters of 33 – 35t/ha commonly remove 400kg N/ha from the soil, but in results generated over the duration of this project (2020-2022), these crops did not respond significantly to N fertiliser inputs greater than approximately 250kg N/ha.***
- ***Of the nitrogen removed by the crop canopy at harvest, approximately 30 – 35% of the N is returned to the soil as stover residues, so based on a 400kg N offtake approximately 120 - 140kg N/ha was returned to the soil as harvest residues.***
- ***Applications of nitrogen in excess of 250kg N/ha with up to 550kg N/ha experimented upon in the project were largely uneconomic; these applications lost up to $400/ha (in the season of application) depending on the price of N fertiliser and the exact rates of N applied.***
- ***If the additional N fertiliser is "N banked" in the soil, then it may be concluded that a proportion of the excess N fertiliser is recovered the following year, but in terms of economics for the grain maize it was not economic to exceed 250kg N/ha applied.***
- ***Fertility of the farming systems as a whole was shown to provide the additional N nutrition required to produce high yielding crops of 33 – 35t/ha biomass and 16 – 19t/ha grain yields.***
- ***Whilst in an irrigated system it is unclear how much of the excess N is available the following season, research conducted indicates that we need to re-think the profitability of such large N doses in excess of 250kg N/ha, or at a minimum take account of soil mineralisation for nitrogen applications in irrigated summer crops, which logically will be higher in wet and warm soils.***
- ***Whilst we cannot "mine" our soils without regard to this contribution, the research has illustrated that in-crop mineralisation in the summer months is an extremely significant contributor to the N budget calculations under irrigation.***
- ***Additionally, if the farming system is returning grain maize residues to the soil these typically contain 120 - 140kg N/ha with high yielding crops.***
- ***The fertility of the farming system will clearly influence how much mineralisable N can be sourced by the crop, however the work conducted in OIG would suggest that growers need to be circumspect with regards to N applications in excess of 300kg N/ha.***
- ***N timing has failed to generate significant yield effects but there has been some evidence to suggest split applications, with an emphasis on later applications (up to tasselling), has been associated with higher grain protein.***
- ***In addition, if large applications were made at sowing as single doses, there was evidence to suggest nitrification inhibitors (eNpower) have a role, but yield increases were not statistically significant.***

Clearly, the level of organic carbon in the soil will vary and contribute different amounts of soil N supply through the course of a season, however the key finding from the OIG project has been our inability to generate significant yield responses up to the levels of fertiliser being applied on farm (250 – 500kg N/ha. The following example graphs indicate at Peechelba (Red loam over clay) and Kerang (Grey clay) in Victoria the grain yield response to applied nitrogen and the partition of N between stover residue and grain at harvest.

A) Peechelba East, Victoria – Overhead Irrigation (6.08 Mega L/ha applied)

Table 1: *Grain yield (t/ha @ 14% moisture) test weight (kg/hL) and harvest index (HI %), 31 May 2020. – Peechelba East, Victoria cv Pioneer hybrid 1756.*

Treatment				**Seed Yield and Quality**					
	Pre-drill kg N/ha	**Post drill* kg N/ha**	**Total kg N/ha**	**Yield t/ha**		**Test Wt kg/hL**		**H.I %**	
1	0	207	**207**	18.12	-	81.0	-	49.8	-
2	45	207	**252**	18.80	-	81.0	-	50.3	-
3	90	207	**297**	18.32	-	81.3	-	46.7	-
4	135	207	**342**	19.02	-	81.2	-	45.8	-
5	180 (Farm)	207	**387**	18.63	-	81.3	-	44.9	-
6	225	207	**432**	18.12	-	81.6	-	46.2	-
7	270	207	**477**	18.54	-	80.8	-	47.1	-
8	315	207	**522**	18.34	-	81.2	-	52.3	-
	LSD			NS		NS		NS	
	Mean			18.49		81.1		47.8	
	P Val			0.991		0.926		0.296	
	CV			8.82		1.01		8.99	

** Post sowing nitrogen (207 N) was applied via fertigation with applications on V4 (46N), V8 (60N), pre-tasselling (101 N) on 10 Dec, 26 Dec, 14 Jan and Jan 15. Available soil N assessed prior to sowing 33 kg N/ha (0-60cm) Harvest index based on grain and stover recorded at 0% moisture. Previous crop: Oaten hay*

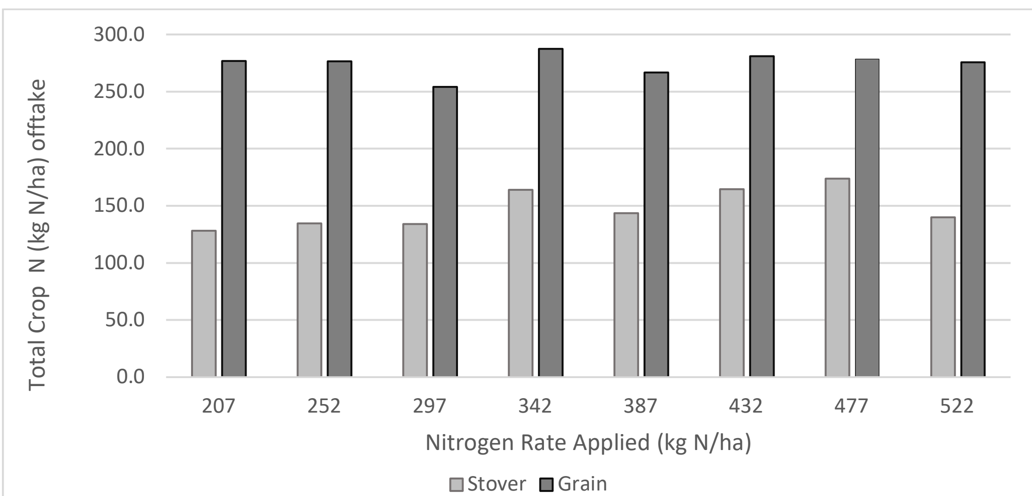

Figure 1. *Total crop N (kg N/ha) offtake at harvest in the stover (stalks, leaves, husk) and grain 31 May 2020. Peechelba East, Victoria cv Pioneer hybrid 1756.*

B) Kerang, Victoria – Flood Irrigation (9.6 Mega L/ha applied)

Table 2: *Grain yield (t/ha @ 14% moisture), dry matter (t/ha), test weight (kg/hl) and harvest index, 20 May 2022 cv Pioneer hybrid 1756.*

Treatment				**Grain Yield, Dry Matter Yield and Quality**					
				Yield		**DM**		**Test Wt**	**H.I**
	Pre-drill	**Post drill**	**Total kg**	**t/ha**		**t/ha**		**kg/hL**	
1	0	0	**Nil**	10.34	d	22.64	d	81.7	0.40
a	40	40	**80**	11.98	c	29.33	c	82.7	0.36
3	80	80	**160**	15.05	bc	33.94	bc	83.0	0.39
4	120	120	**240**	17.13	a	31.42	ab	82.0	0.47
5	160	160	**320**	16.66	ab	32.53	ab	80.0	0.44
6	200	200	**400**	17.76	a	35.56	ab	80.7	0.43
7	200	200	**480**	17.04	a	33.66	a	81.1	0.44
8	280	280	**560**	17.03	a	34.28	a	80.9	0.43
LSD Yield	**(p=0.05)**		1.659	**P Val**		<0.001		cv%	7.3
LSD DM	**(p=0.05)**		3.398	**P Val**		<0.001		cv%	5.8
LSD Test Wt	**(p=0.05)**		ns	**P Val**		0.094		cv%	1.8
LSD HI	**(p=0.05)**		ns	**P Val**		0.059		cv%	11.0

Figures followed by different letters are considered to be statistically different (p=0.05) Available Soil N prior to sowing and watering up was 34 kg N/ha (0-60cm). The nil control N offtake at harvest was 241 kg N/ha, suggesting in-crop mineralisation resulted in 207 kg N/ha of the N taken up. Previous crop: Grass dominant pasture (3 years).

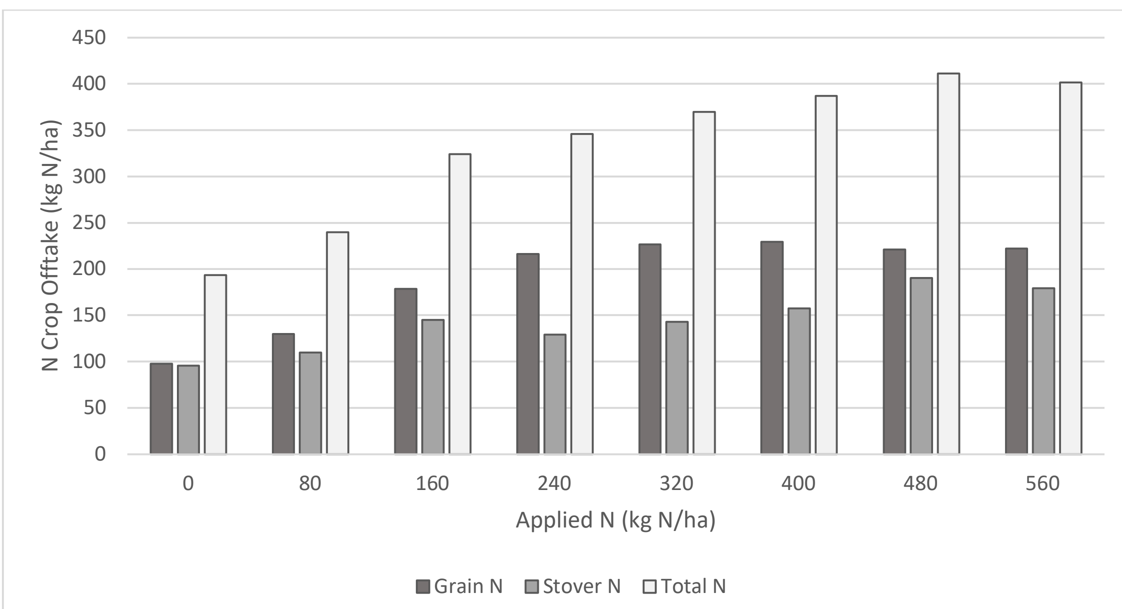

Figure 2. *Total crop N (kg N/ha) offtake at harvest in the stover (stalks, leaves, husk) and grain 31 May 2022. Kerang, Victoria cv Pioneer hybrid 1756.*

Key point summary

b) ***Foliar feeding and additional basal fertiliser***

- ***The project, with the assistance and support of industry, evaluated a number of different foliar applications of both macro and micronutrients in 2021 and 2022 applied in addition to grower standard practice.***
- ***These liquid fertilisers (based on calcium nitrate and Natures K), whilst influencing biomass were not observed to increase grain yield.***

Crop structure and Plant population

Key point summary

- ***Results suggested no disadvantage to narrower 500mm row spacing compared to 750mm in OIG project work.***
- ***Advantages of narrower row spacing was more pronounced when plant population was increased, since narrower rows gave better plant spacing within the row compared to wider rows.***
- ***However, the differences in biomass and grain yield between narrow row and wider row spacing were rarely statistically significant.***
- ***For the highest yielding scenarios (18 – 19t/ha) experienced in the project, the optimum population for a cost-effective return with Pioneer hybrid 1756 was approximately 90-93,000 plants/ha.***
- ***Lower yielding maize on maize rotation positions gave optimum populations no higher than this when using the 1756 hybrid.***
- ***Later sowing of grain maize (Pioneer hybrid 9911) in the third week of December did not respond to increasing plant population between 78,000 and 102,000 plants/m^2.***

Fungicide application in grain maize

Key point summary

- ***In the five fungicide trials conducted on grain maize there was no benefit from using either DMI triazole fungicides (prothioconazole) or QoI strobilurin (pyraclostrobin) fungicides in OIG grain maize trials.***
- ***There were no significant yield effects of fungicide application at either V8 (8 leaf) or V14 in the absence of noticeable disease.***
- ***Despite strobilurin fungicides being associated with greater green leaf retention in cereals, no such effects were observed in these trials.***

NOTES

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