Irrigated Cropping Council

Promoting irrigated agriculture

Irrigated Cropping Council

SPRING RESEARCH FIELD DAY

September 2022

Contents

Support from our sponsors is greatly appreciated to enable us to provide high quality information to growers to optimise their irrigated grain systems.

About Irrigated Cropping Council

The Irrigated Cropping Council (ICC) is a not-for-profit farming systems group, committed to improving the profitability and long-term viability of mixed farmers and croppers through practical research, development and extension that leads to best practice. The ICC is a membership organisation providing members with access to our variety trial results within days from harvest, regular research updates and discounted entry to ICC run events.

Our Region

Our region spanning across the Murray River from the northern Victorian irrigation regions to Southern Riverina in NSW presents a unique opportunity to build a knowledge base across many regions, environmental conditions, crop types, management systems and irrigation systems.

Our Trial Site

Our irrigated research site situated just outside of Kerang Victoria provides the perfect base to conduct local research providing relevant information to growers across the region. Research trials conducted at the site focus on all aspects of irrigated grain production including agronomy, irrigation scheduling, plant nutrition, crop diseases, weed and pest management and risk management.

Our Projects

- Irrigated Variety Trials, some of the only fully irrigated wheat, canola, barley and faba bean variety trials nationally. Results of these are shared exclusively with ICC members with yield results coming out within days of harvest. Funded by ICC Memberships, Pioneer, Pacific Seeds, AGT, BASF, Nuseed, Seed Force, Seednet, Intergrain, University of Adelaide
- Optimising Irrigated Grains, small plot research investigating the agronomic levers to increase yields of maize, canola, durum, barley, faba beans and chickpeas. Delivered in collaboration with FAR Australia, funded by GRDC
- Irrigated Discussion Groups, meet 4 times a year to discuss topics of relevance to the members. The
- focus has been on farm visits to see how irrigators in our region are responding to the high opportunity cost of water and built-in flexibility to their systems. Funded by GRDC
- Fodder for the Future, researching the balance between quantity and quality for winter cereal, winter pulse and summer fodder options. In collaboration with Marry Dairy this project is funded by Federal Government under the Murray–Darling Basin Economic Development Program.
- Increasing soil carbon to ameliorate compaction in irrigated soils - Goulburn Broken CMA and the Australian Government's National Landcare Program
- Plan2Farm – Irrigation Business Planning Program enabling farmers to develop their business plan with support from agribusiness consultants, funded by the Australian Government's Future Drought Fund.
- Southern NSW Drought Resilience Adoption and Innovation Hub, ICC are part of the knowledge broker network, giving you a say in the direction of projects delivered locally – Funded by the Australian Government's Future Drought Fund.

- Irrigated Ag Conference – a cross-industry event bringing together leaders from the grains, rice, cotton and dairy industries.
- Heat Stress in Canola, a pure research project screening large amounts of germ plasm to see how they are impacted by heat stress, delivered in partnership with UWA and funded by GRDC
- -Smarter Irrigation for Profit - Phase 2 – Demonstrating different irrigation strategies aiming to get the best returns from water when prices are high, Funded by Rural Development Corporations (grains, rice, cotton, dairy and sugar), through funding from the Australian Government Department of Agriculture's Rural R&D for Profit program.

Become a member…

ICC Research and extension activities are designed to provide members with the latest information about profitable, sustainable irrigated cropping systems.

Memberships provide many benefits including:

- Exclusive access to local irrigated research trial results
- Industry knowledge is shared and you get the chance to speak to industry experts
- Full access to members area on our website
- Free and discounted entry to ICC events and field days
- Keep up to date with the latest innovations in the irrigated cropping industry through regular electronic updates

Memberships are exceptional value at $50 (inc. GST) per year.

Join Online

www.irrigatedcroppingcouncil.com.au

2022 Research Centre Seasonal Summary

Preparation for the 2022 winter trials started in March with judicious stubble burning and multidiscing of brown manured wheat residues.

Pre-irrigation began on April 6th for the majority of the trials. Canola trials were not pre-irrigated as we water up post sowing. Unexpected rainfall on April 18th kept the pre-irrigated bays too wet for sowing, and so the long season wheat and Murray Dairy Fodder for the Future trials were delayed. Sowing began on April 26th with the canola, cereal fodder and long season wheat trials.

With April receiving 75mm of rain, on top of 40mm in March and more rain forecast, it was decided to not water up the canola trials. This did raise the prospect of a winter drought if we did not get adequate winter rainfall before the opening of the irrigation season in mid-August, but the risk of waterlogging the trial by watering up and follow-up rain was too great.

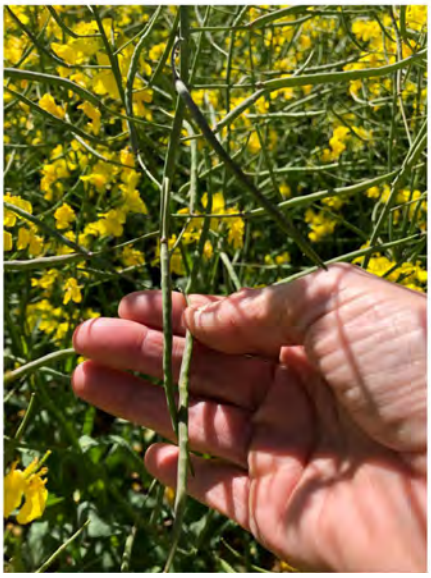
May rainfall was average (35mm), but sowing of some trials were delayed, e.g., the main wheat variety trial and the chickpea time of sowing trial. The Fodder for the Future legumes trial was sown on May 6th, followed by the wheat, barley, faba beans and a majority of the chickpea trials on May 10th and 11th.

The durum wheat trials were sown on May 23rd (on time) and sowing of the short season wheat trials was on June 14th (a little later than planned but delayed by the site being too wet).

Rain in late June enabled the first topdressings of the canola nitrogen use efficiency trials and the cereals for fodder trial.

Topdressing continued in July, but with limited opportunities as only 11.8mm was received for the month. Some events were less than forecast and barely enough to dissolve the urea.

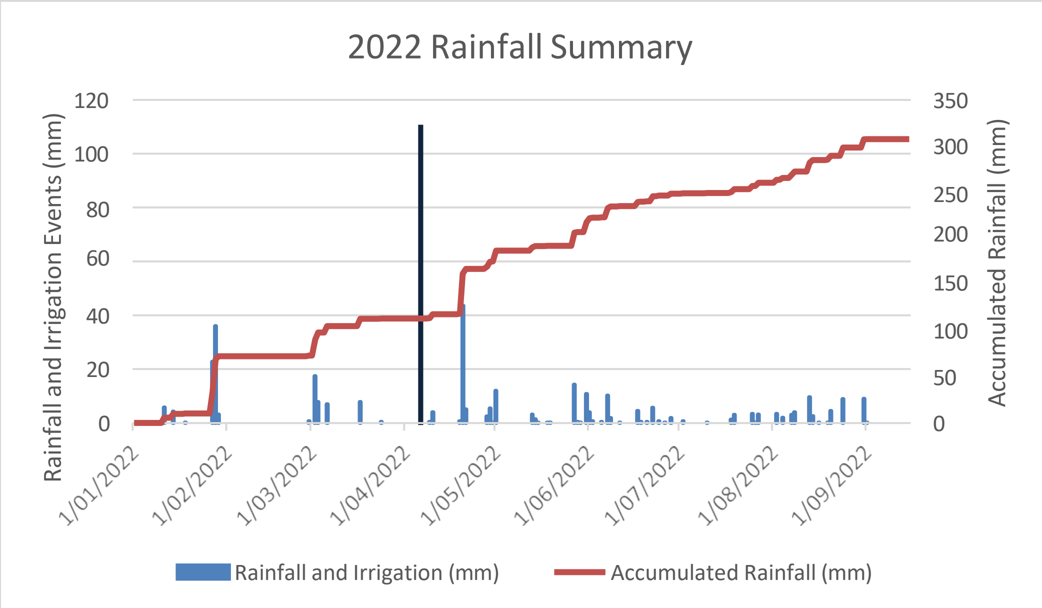
Rainfall in early August saw a flurry of N topdressings. Overall, most trials were topdressed on time and no nitrogen deficiencies were noted thanks to most trials having in excess of 100 kg N/ha present in the soil at sowing. However, there was evidence of N deficiency in the delayed N treatments in the canola N timing trial where the first topdressing was applied at the green bud stage.



August also delivered on the wet winter promised, with 48mm for the month.

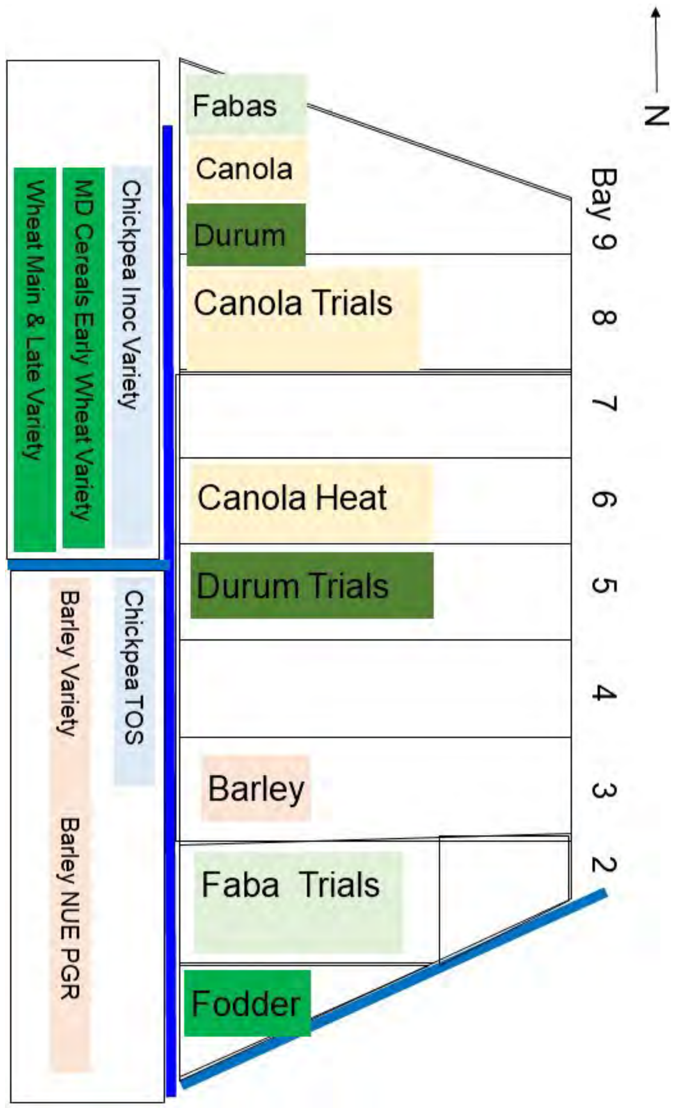
August also saw the arrival of stripe rust in the wheat trials (noted on August 10th) and Ascochyta in the chickpeas (noted on August 5th).

The canola trials had begun to show signs of wilting on the windy and sunny days in late July. Monitoring of the soil moisture showed adequate moisture in the top 150mm but drier conditions at depth. Irrigation was planned for August 15th but delayed with each rainfall event. The first spring irrigation of the canola trials occurred on September 2nd, keeping in mind that these trials were not irrigated in the autumn.



Average Growing Season Rainfall 232mm
2022 Growing Season Rainfall 194.2mm (up to September
2nd) 2022 Rainfall to date 307.4mm

Research Site Plan



ICC thanks the following partners in our independent irrigated variety trials

Pacific Seeds, Pioneer Seeds, Nuseed, SeedForce, BASF, AGT, SeedForce, Intergrain, Seednet, Longreach and University of Adelaide

VARIETY TRIALS

The variety trials are comparative crop variety testing with standardised trial management, data generation and collection to provide meaningful results for growers. Irrigation provides a unique environment that allows high yields to be targeted. However, most varieties are developed and tested under dryland conditions. To perform under irrigated conditions, a variety should the following characteristics:

- High yield potential
- Maturity that matches sowing date and the optimal grain filling period (avoiding frost at flowering but also avoiding high temperatures during grain filling)
- High tolerance to crop lodging
- Waterlogging tolerance
- Good disease tolerance/rating, although a disease management plan can address some shortfalls

In 2022 we have

- 28 Canola Varieties
- 19 Wheat Varieties (inc short, main and long season)
- 3 Barley Varieties
- 6 Faba Beans Varieties

Irrigated Cropping Council

2021 VARIETY TRIALS

Canola Variety Summary

Variety trials under irrigation provide key information on varieties in terms of yield potential, grain quality and also assess varietal characteristics such as maturity, height, disease resistance and lodging. The Kerang Research Centre is predominantly self-mulching grey clay, or a medium grey clay, with a bit of red medium clay on the western section.

Sowing Date 23rd April

Target Plant Population 40 plants/m^2

Seeding Rates 1.7 - 4.0 kg/ha based on TGW

Irrigation 1.5 Ml/ha - 24th April
0.9 Ml/ha – 30th August
1.0 Ml/ha 27th September

Total Water 3.4 Ml/ha
GSR 160.4mm decile 2

Nitrogen Total N Budget - 280kg N/ha
Wheaten hay 2020
80 kg N/ha topdressed 1st July
80 kg N/ha topdressed 29th July

Harvest 24th November

E The trial was sown into a prepared seed bed (multidisced wheaten hay stubble) at variable rates that ranged from 1.7 to 4.0 kg/ha, targeting 40 plants/m^2 . The trial was sown dry on April 23rd and watered up the following day. Average plant population achieved was 42 plants/m^2 .

F The trial was topdressed twice (July 1st 80 kg N/ha, July 29th 80 kg N/ha) to bring the total N budget to 280 kg N/ha, enough for a 4.5 t/ha crop.

W The trial was irrigated twice in spring, starting on August 30th and again on September 27th. Spring water use was approximately 1.9 Ml/ha, and 3.4 Ml/ha for the season.

F Flowering began in late July, and most varieties were flowering by August 10th.

Table 1: Yield (t/ha)

Variety	Yield (t/ha)		Oil %	Test Wt
Nuseed Raptor TF	4.52	a	44.9	66.2
AN20RR002	4.40	ab	44.3	67.2
InVigor R 5520P	4.37	ab	46.0	70.0
InVigor R 4520P	4.36	ab	44.8	68.6
InVigor R 4022P	4.26	abc	45.4	70.1
Nuseed Condor TF	4.22	abcd	47.3	67.0
Hyola Garrison XC	4.10	abcde	47.2	67.9
45Y28	4.00	bcdef	46.0	67.6
HyTTec Trifecta	3.97	bcdef	44.9	69.0
45Y95	3.96	bcdef	44.2	67.0
HyTTec Trophy	3.88	cdefg	44.4	66.4
InVigor T 4510	3.79	defgh	44.4	69.2
SF Dynatron TT	3.71	efgh	46.0	69.4
Hyola Equinox CL	3.70	efgh	46.9	69.7
44Y94	3.67	efgh	44.9	65.9
InVigor T 6010	3.64	fghi	43.3	68.4
HyTTec Trident	3.63	fghi	43.7	66.0
Hyola Blazer TT	3.57	fghi	44.4	69.5
Hyola Enforcer CT	3.49	ghi	44.7	69.0
SF Ignite TT	3.37	hi	42.0	69.9
InVigor LT 4530P	3.22	i	41.4	66.5
p	<0.001			
lsd	0.452			
cv%	8.2			
Trial Mean	3.90			

The yield results are presented in table 1 have been corrected for moisture. Nuseed Raptor TF was the highest yielding variety at 4.5 t/ha. Reminder if any variety has the same significance letter there is no difference in yield despite the differences harvested and analysed in yield values.

Results

3.9 t/ha
Average Yield

4.5 t/ha
Highest Yield

Looking at the performance of the various herbicide "groups", the best performing group was the Roundup Readies. A summary is presented in Table 2.

Table 2: Yield (t/ha) of the herbicide tolerance groups and the number of varieties in the trial.

Herbicide Group	No.	Ave Yield (t/ha)	Range
Conventional	0		
Roundup Ready	7	4.21	3.92 – 4.43
Clearfield	3	3.70	3.61 – 3.88
Triazine Tolerant	5	3.62	3.30 – 3.88
Mixed Tolerance	3	3.52	3.16 – 4.00

Note: This is only one trial in one location/environment. It is advised to consult other trial results over multiple sites and seasons before making annual variety decisions. Please note that InVigor, Hyola, HyTTec, Monola are all "registered" trademarks.

Canola Variety 2022

Trial Layout

Row	Range 1	Range 2	Range 3
9	HyTTec Trophy	45Y28	45Y28
10	Eagle TF	AN22LR008	PS-22CT107
11	44Y94CL	Hyola Blazer TT	SFR65-064TT
12	InVigor LT4530P	45Y95CL	SF Dynatron TT
13	Condor	Hyola Equinox CL	Raptor TF
14	NMH19T678	InVigor R 4520P	PS-22XC316
15	Trifecta	SFR65-059TT	XC220525
16	InVigor T 4510P	HyTTec Trident	SFR65-059TT
17	InVigor R 4022P	CHYB4372TT	HyTTec Trifecta
18	PS-22CL214	PS-21CL208	XC220525
19	44Y30RR	HyTTec Velocity	44Y30RR
20	Buffer	Buffer	Buffer

Trial Operations

April 26th	1.0l/ha Rustler plus 2.0 l/ha Gramoxone
April 26th	Sown at 1.9 – 4.0 kg/ha with 125 kg/ha DAP, targeting 40 plants/m^2.
June 7th	500 ml/ha Clethodim 240
June 21st	125 ml/ha Lontrel Advanced
June 23rd	N topdressing 90 kg N/ha
July 22nd	N topdressing 55 kg N/ha.
	Total N was 280 kg N/ha, including soil N (136 kg N/ha), starter and mineralisation through the season, enough for 4 t/ha.
Sept 5th	First spring irrigation, 0.8 Ml/ha

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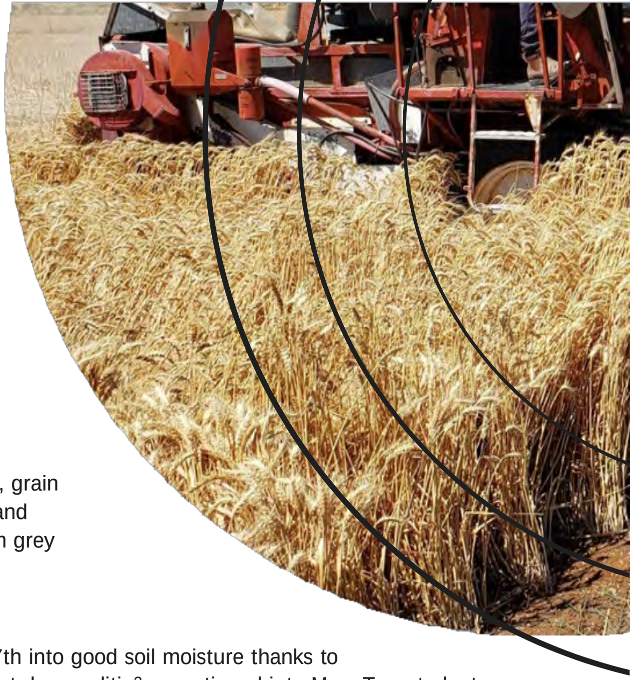

2021 VARIETY TRIALS

Barley Trial Summary

Variety trials under irrigation provide key information on varieties in terms of yield potential, grain quality and also assess varietal characteristics such as maturity, height, disease resistance and lodging. The Kerang Research Centre is predominantly self-mulching grey clay, or a medium grey clay, with a bit of red medium clay on the western section.

Sowing Date 7th May

Target Plant Population 160 plants/m^2

Seeding Rates 79 - 112 kg/ha based on TGW

Irrigation 1.5 Ml/ha - 7th April
0.9 Ml/ha – 24th August
0.9 Ml/ha – 20th September

Total Water 3.3 Ml/ha
GSR 160.4 mm Decile 2

Nitrogen Total N Budget - 240 kg N/ha
Wheat 2020
95 kg N/ha topdressed 22nd July
40 kg N/ha topdressed 10th August

Harvest 29th November

E

Sown on May 7th into good soil moisture thanks to pre-irrigation but dry conditio^{2}ns continued into May. Target plant population was 160 plants/m , or sowing rates of between 79 and 112 kg/ha. Emergence was consistent across the tria^{2}l and plant counts just met the target with an average of 158 plants/m , or 69% establishment.

F

The total N budget was 240 kg N/ha, enough for an 8 t/ha crop. Sown on a wheat stubble, soil N at sowing was a typical 63 kg N/ha. The trial was topdressed at 95 kg N/ha (205 kg urea/ha) on July 22nd and again with 40 kg N/ha (85 kg urea/ha) on August 10th.

W

The trial was received the first spring irrigation on August 24th, and again on September 20th (0.9 Ml/ha on both occasions).

L

The trial received a fungicide on August 6th (500 ml/ha Veritas). Little disease was noted at that stage.

Lodging was noted in mid-October in Commander and Sakurastar. By harvest, lodging had increased across the trial but not to the stage where it affected harvest.

Results

8.2 t/ha
Average Yield

9.2 t/ha
Highest Yield

Table 1: Yield, receival test results and lodging scores.

Variety	Yield		Protein %	Screen %	Retention %	Test Wt kg/hl	Lodging Score
Minotaur	9.22	a	9.8	1.1	94.3	67.0	1
Brewstar	8.75	ab	9.6	1.2	94.3	66.4	1
RGT Planet	8.57	b	9.5	1.4	93.2	66.6	1
Cyclops	8.57	bc	10.1	0.8	95.5	66.2	2
LaTrobe	8.44	bc	10.5	1.3	92.3	68.5	2
Spartacus CL	8.40	bc	10.9	1.2	92.2	68.2	2
Rosalind	8.30	bcd	10.2	1.5	92.7	67.6	1
Alestar	8.30	bcd	10.2	0.8	95.9	68.0	2
Laperouse	8.21	cd	10.8	0.5	97.0	70.0	1
Westminster	7.81	de	10.4	0.8	95.9	67.4	2
Commander	7.78	d	10.3	3.0	87.5	66.7	4
Sakurastar	7.62	e	10.9	1.4	93.3	66.0	5
Maximus CL	7.59	e	11.3	0.5	96.1	69.6	1
p	<0.001						
lsd	0.522						
cv%	4.4						
Trial Mean	8.28						

Lodging Score: 0= no lodging. 9 = flat on the ground

Reminder, if any variety has the same significance letter there is no difference in yield despite the differences harvested and analysed in yield values.

Note: This is only one trial in one location/environment. It is advised to consult other trial results over multiple sites and seasons before making annual variety decisions.

Seednet AGT Seed Force the power to grow

Barley Variety Trial 2022

Trial Layout ← N

Row	Range 1
1	Buffer LaTrobe
2	Rosalind
3	Black
4	Alestar
5	Maximus
6	Zena CL
7	Westminster
8	Laperouse
9	Planet
10	Cyclops
11	Fandaga
12	Minotaur
13	Spartacus CL
14	Buffer Commander

Trial Operations

April 6th	Pre-irrigation – 1. 1 Ml/ha
May 7th	2.5 l/ha Boxer Gold plus 2.0 l/ha Gramoxone
May 10th	Sown at 90 - 118 kg/ha with 125 kg/ha DAP, targeting 160 plants/m^2.
	Seed treated with Gaucho 600 (200ml/100kg)
July 22nd	N topdressing 90 kg N/ha
July 24th	Fungicide 500 ml/ha Veritas (GS <30 – 32)
Aug 9th	N topdressing 35 kg N/ha
	Total N was 260 kg N/ha, including soil N (117 kg N/ha), starter and mineralisation through the season, enough for 8 t/ha.
Sept 10th	First spring irrigation, 0.9 Ml/ha

Irrigated Cropping Council

2021 VARIETY TRIALS

Faba Beans Trial Summary

Variety trials under irrigation provide key information on varieties in terms of yield potential, grain quality and also assess varietal characteristics such as maturity, height, disease resistance and lodging. The Kerang Research Centre is predominantly self-mulching grey clay, or a medium grey clay, with a bit of red medium clay on the western section.

Sowing Date 7th May

Target Plant Population 25 plants/m^2

Seeding Rates 167 - 250 kg/ha based on TGW

Irrigation 1.5 Ml/ha - 9th April
0.9 Ml/ha – 30th August
0.9 Ml/ha – 26th September
0.8 Ml/ha – 28th October

Total Water 4.1 Ml/ha
GSR 160.4mm decile 2

Fungicide Chlorothalonil 1.5 l/ha 6th August
Chlorothalonil 1.5 l/ha 27th August
Veritas 1.0 l/ha 6th September

Harvest 15th December

E Eight faba bean varieties and lines were sown, following pre-
aiming at 25 plants/m^2. Establishment was even and
irrigation (1.5 ml/ha), on May 7th, with variable sowing rates
achieved the target population.

F The trial received three fungicide applications; August 6th, August 27th, and September 6th.

W The trial was irrigated three times in spring, beginning August 30th (0.9 Ml/ha) again on September 26th (0.9 Ml/ha) and on October 28th (0.8 Ml/ha).

Results

7.3 t/ha
Average Yield

7.8 t/ha
Highest Yield

Table 1: Yield, bean size, plant height at harvest and lodging score.

Variety	Yield		Bean Size g/100s	Plant Height cm	Lodging Score
AF14092	7.79	a	88.8	115	2.0
AF15283	7.41	ab	79.0	115	0.5
Samira	7.35	ab	76.2	105	1.5
Fiesta	7.30	b	65.4	110	1.0
Bendoc	7.28	b	65.3	110	0.0
Marne	7.19	bc	78.1	110	3.0
AF15278	6.95	bc	75.3	110	1.5
Amberley	6.79	c	73.4	115	0.5
p	0.012				
lsd	0.472				
cv%	4.4				
Trial Mean	7.26				

Reminder, if any variety has the same significance letter there is no difference in yield despite the differences harvested and analysed in yield values.

Note: This is only one trial in one location/environment. It is advised to consult other trial results over multiple sites and seasons before making annual variety decisions.

THE UNIVERSITY of ADELAIDE

Seednet

Faba Bean Variety 2022

Trial Plan

Row	Variety
10	Fiesta
11	Samira
12	Bendoc
13	Marne
14	AF14075
15	AF14092
16	AF15278
17	Amberley
18	Buffer

Trial Operations

May 11th	1.2 kg/ha Terbyne Xtreme plus 2.0l/ha Gramoxone
May 11th	Sown at 150 – 253 kg/ha with 200 kg/ha Superfect, targeting 25 plants/m^2.
June 21st	180 g/ha Factor plus 500 ml/ha Clethodim 240
August 17th	Fungicide 1.0 l/ha Veritas at early flowering

Irrigated Cropping Council

2021 VARIETY TRIALS

Long Season Wheat Trial Summary

Variety trials under irrigation provide key information on varieties in terms of yield potential, grain quality and also assess varietal characteristics such as maturity, height, disease resistance and lodging. The Kerang Research Centre is predominantly self-mulching grey clay, or a medium grey clay, with a bit of red medium clay on the western section.

Sowing Date 21st April

Target Plant Population 160 plants/m^2

Seeding Rates 77 - 117 kg/ha based on TGW

Irrigation 1.5 Ml/ha - 9th April
0.9 Ml/ha – 28th August
0.9 Ml/ha – 27th September
0.8 Ml/ha 28th October

Total Water 4.1 Ml/ha
GSR 160.4mm

Nitrogen Total N Budget - 320 kg N/ha
100 kg N/ha topdressed 13th July
70 kg N/ha topdressed 10th August

Fungicide Veritas 500 ml/ha 6th September

Harvest 14th December

E

Ten longer season (rated M-L or later, and 3 true winter type) wheat varieties and lines were sown, following pre-irrigation (1. 5 ml/ha) on April 21st with variable sowing rates aiming at 160 plants/m^2. Soil moisture was receding at sowing and so emergence was uneven across the trial. Rain in early May saw a second germination which resulted in an average of 143 plants/m^2 or 63% establishment.

F

The trial was topdressed twice: 220 kg urea/ha on July 13th and 150 kg urea/ha on August 10th, making the total N supply of 320 kg N/ha, enough for an 8 t/ha APW crop. The trial received a foliar fungicide application September 6th.

W

The trial was irrigated three times in spring, beginning August 28th (0.9 Ml/ha), again on September 27th (0.9 Ml/ha) and on October 28th (0. 8 Ml/ha). The third irrigation was probably only of any benefit to the late maturing varieties that were still green at this stage compared to the spring types that had begun to ripen.

H

Very little lodging occurred in the trial, especially when compared to the Main Season variety trial sown further down the bay. Harvested on December 14th, the trial averaged 8.9 t/ha. Anapurna was the highest yielding variety, followed by the BASF line BSWDH04-062 and a new variety from Seed Force, RGT Cesario.

Results

Table 1: Yield, receival test results, lodging score and plant height.

Variety	Yield (t/ha)		Protein %	Screen %	Test Wt kg/hl	Lodge Score	Plant Ht cm
Anapurna	10.07	a	9.2	2.2	80.8	0	85
BSWDH04-062	9.64	ab	10.3	0.7	84.2	0	95
RGT Cesario	9.24	bc	8.4	1.6	77.5	0	90
LBP16-0598	9.11	bcd	9.5	2.1	81.1	0	87.5
Sunflex	9.00	cd	11.1	1.1	83.8	0.8	90
Coota	8.98	cd	11.3	0.5	83.8	1	90
Ascot	8.80	cde	10.8	1.4	82.2	0	100
BH120020S-11	8.48	de	10.7	0.6	83.6	0	92.5
SFR86-085	8.28	ef	9.4	1.4	77.4	0.8	90
LBP16-0582	7.85	f	10.7	1.9	79.3	0.5	95
p	<0.001						
lsd	0.635						
cv%	4.9						
Trial Mean	8.94						

8.9 t/ha
Average Yield

10.0 t/ha
Highest Yield

Reminder, if any variety has the same significance letter there is no difference in yield despite the differences harvested and analysed in yield values.

Note: This is only one trial in one location/environment. It is advised to consult other trial results over multiple sites and seasons before making annual variety decisions.

AGT   Seed Force the power to grow   BASF We create chemistry   LongReach PLANT BREEDERS

Wheat Variety Trial 2022 – Long Season

Trial Plan → N

Row	Range 1
1	Buffer
2	Beaufort
3	Longsword
4	Valiant CL Plus
5	Catapult
6	Rockstar
7	RGT Cesario
8	19-14347
9	16-0598
10	Coota
11	Anapurna
12	SFR86-085
13	V12167-048
14	Buffer

Trial Operations

April 6th	Pre-irrigation – 1. 1 Ml/ha
April 26th	118 g/ha Sakura plus 2.0 l/ha Gramoxone
April 27th	Sown at 66 – 111 kg/ha with 125 kg/ha DAP, targeting 160 plants/m^2. Seed treated with Gaucho 600 (200ml/100kg)
July 22nd	N topdressing 90 kg N/ha
July 25th	1.0 l/ha Triathlon for broadleaf weed control
Aug 10th	N topdressing 90 kg N/ha. Total N was 320 kg N/ha, including soil N (118 kg N/ha), starter and mineralisation through the season, enough for 8 t/ha.
August 31th	Fungicide 125 ml/ha Soprano 500 (GS 31-53)

Irrigated Cropping Council

2021 VARIETY TRIALS

Wheat Variety Trial Summary

Variety trials under irrigation provide key information on varieties in terms of yield potential, grain quality and also assess varietal characteristics such as maturity, height, disease resistance and lodging. The Kerang Research Centre is predominantly self-mulching grey clay, or a medium grey clay, with a bit of red medium clay on the western section.

Sowing Date 6th May

Target Plant Population 160 plants/m2

Seeding Rates 79 - 123 kg/ha based on TGW

Irrigation 1.5 Ml/ha - 5th April
0.9 Ml/ha – 28th August
0.9 Ml/ha – 27th September

Total Water 3.3 Ml/ha

GSR 160.4mm

Nitrogen Total N Budget - 320 kg N/ha
100 kg N/ha topdressed on 13th July
100 kg N/ha topdressed on 10th August

Harvest 8th December

E Nineteen wheat varieties and lines were sown, following pre-irrigation (1.5 ml/ha), on May 6th with variable sowing rates aiming at 160 plants/m^2. Establishment was good, with even emergence across the trial. Establishment was close to average at 72% or 165 plants/m 2

D The trial received a foliar fungicide application on September 6th, based on when a majority of varieties had reached GS39 or full flag leaf emergence. Trojan was heavily infested with stripe rust by this date.

F The trial was topdressed twice - with 100 kg N/ha (217 kg urea/ha) on July 13th and 100 kg N/ha on August 10th, making the total N supply of 320 kg N/ha, enough for an 8 t/ha crop.

W The trial was irrigated twice in spring, beginning August 28th (0.9 Ml/ha), again on September 27th (0.9 Ml/ha).

L Lodging was quite prevalent across the trial. Lodging was first noted in mid-October, and by harvest, some plots were almost prostrate. Lodging score at harvest is presented in the yield table below – 0 = no lodging 9 = prostrate on the ground.

Table 1: Yield, receival test results and lodging score.

Variety	Yield (t/ha)		Protein %	Screen %	Test Wt kg/hl	Lodging Score
RGT Zanzibar	10.81	a	10.1	2.2	84.1	2.3
Boree	10.00	b	9.9	0.8	84.2	4.5
Sunblade CL+	9.79	bc	10.4	1.2	83.0	4.3
BSWDH04-062	9.76	bc	10.4	0.3	85.0	1.0
Sherriff CL+	9.71	bc	10.5	0.6	83.6	1.8
Rockstar	9.65	bc	10.1	1.2	82.6	4.5
Coota	9.53	bcd	11.1	0.7	83.6	3.0
Vixen	9.52	bcd	10.9	0.7	83.2	1.5
Scepter	9.51	bcd	10.9	0.7	85.3	4.3
Ballista	9.50	bcd	10.3	1.2	84.1	5.8
Catapult	9.45	bcd	9.9	1.2	82.9	5.0
Devil	9.26	cd	10.3	0.7	82.6	3.0
Illabo	9.25	cde	10.7	0.6	80.9	4.0
Scout	9.07	def	11.2	0.9	84.4	3.5
Beckom	8.75	efg	10.5	0.6	83.8	6.5
Razor CL+	8.61	fg	10.7	0.7	83.4	2.8
Coolah	8.27	g	10.1	0.9	84.9	2.5
Hammer CL+	8.19	g	11.6	0.6	84.0	5.8
Trojan	7.22	h	10.2	0.8	83.3	4.5
p	<0.001					
lsd	0.569					
cv%	4.4					
Trial Mean	9.26					

Lodging Score: 0 = no lodging, 9 = flat on the ground

Results

9.2 t/ha
Average Yield

10.8 t/ha
Highest Yield

Reminder if any variety has the same significance letter there is no difference in yield despite the differences harvested and analysed in yield values.

Note: This is only one trial in one location/environment. It is advised to consult other trial results over multiple sites and seasons before making annual variety decisions.

If you are looking to change varieties, obtain reliable information from trusted sources such as the various state based GRDC sowing guides, that include disease ratings and other important information.

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Wheat Variety Trial 2022 – Main Season

Trial Plan

→ N

Row	Range1	Range2	Range3	Range4	Range5	Range6
1	B Devil	Buffer	Buffer	Buffer	Buffer	Buffer
2	Boree	Brumby	Ballista	Beckom	Sunblade CL	Scout
3	Sunblade CL	Valiant CL	Sunmaster	Cobra	Scepter	Boree
4	Sherriff CL	Coota	Sunblade CL	Calibre	Illabo	Zanzibar
5	Scepter	Scout	Ascot	Chief CL	Zanzibar	Valiant CL
6	Ascot	Sunmaster	Brumby	Rockstar	Scout	Illabo
7	Rockstar	Calibre	Zanzibar	Sunmaster	Sherriff CL	Coota
8	Beckom	Valiant CL	Coota	Boree	Ballista	Rockstar
9	Illabo	Rockstar	Beckom	Brumby	Cobra	Sherriff CL
10	Chief CL	Cobra	Sherriff CL	Coota	Scepter	Brumby
11	Cobra	Chief CL	Scout	Ascot	Beckom	Sunmaster
12	Zanzibar	Illabo	Scepter	Ballista	Calibre	Chief CL
13	Ballista	Boree	Calibre	Valiant CL	Ascot	Sunblade CL
14	B Coolah	Buffer	Buffer	Buffer	Buffer	Buffer

Rep 4 is in yellow and has not had any fungicide applied

Trial Operations

April 6th	Pre-irrigation – 1. 1 Ml/ha
May 10th	118 g/ha Sakura plus 2.0 l/ha Gramoxone
May 10th	Sown at 79 – 123 kg/ha with 125 kg/ha DAP, targeting 160 plants/m^2.
	Seed treated with Gaucho 600 (200ml/100kg)
July 22nd	N topdressing 90 kg N/ha
July 25th	1.0 l/ha Triathlon for broadleaf weed control
Aug 10th	N topdressing 90 kg N/ha
	Total N was 320 kg N/ha, including soil N (118 kg N/ha), starter and mineralisation through the season, enough for 8 t/ha.
August 10th	Fungicide 125 ml/ha Soprano 500 Reps 1 - 3
Sept 7th	Fungicide 125 ml/ha Soprano 500 (GS32 – 53) Reps 1 - 3

Wheat Variety Trial 2022 – Short Season

Trial Plan ⟶ N

Row	Range1
1	B Barley
2	Vittaroi
3	Razor CL
4	Emu Rock
5	Calibre
6	Vixen
7	Ascot
8	Calibre
9	Razor CL
10	Ascot
11	Emu Rock
12	Aurora
13	Vixen
14	B EG Jet

Trial Operations

April 6th	Pre-irrigation – 1. 1 Ml/ha
June 13th	118 g/ha Sakura plus 2.0 l/ha Gramoxone
June 14th	Sown at 92 - 122 kg/ha with 125 kg/ha DAP, targeting 175 plants/m^2.
	Seed treated with Gaucho 600 (200ml/100kg)
August 10th	1.0 l/ha Triathlon for broadleaf weed control
Aug 29th	N topdressing 80 kg N/ha
	Total N will be 320 kg N/ha, including soil N (118 kg N/ha), starter and mineralisation through the season, enough for 8 t/ha.
August 30th	Fungicide 600 ml/ha Veritas

Optimising Irrigated Grains - Key Learnings 2020 & 2021

The following key learnings have been derived from growing crops at two irrigated research centres at Finley, NSW on a red duplex soil under surface and overhead irrigation and Kerang, VIC on a grey clay with surface and sprinkler irrigation. The research was conducted in the 2020 and 2021 seasons.

Barley under irrigation

Germplasm, Crop structure and Plant population

Key Points:

- Irrigated barley has benefited from PGR application with greater yield benefits associated with crops that are irrigated earlier in the grain fill period.
- The spring barley RGT Planet (8.13t/ha) has been significantly higher yielding than Cassiopee winter barley (7.83t/ha) when averaged over 2 years (2020 & 2021) and 4 treatments in a plant growth regulator trial at the Finley Irrigated Research Centre (IRC).
- Applying a plant growth regulator (PGR), either as a split application (GS31 & GS33) or as a single application (GS31) resulted in a significantly higher yield (8.40t/ha) compared to the untreated plots (7.79t/ha), averaged over both varieties over two years.
- The winter barley Cassiopee experienced significantly more lodging than RGT Planet and was less suitable for irrigated systems. PGR application did reduce lodging, although in Planet differences in lodging were relatively small.
- PGR application and grazing both had a similar reduction (average 7cm) in crop height compared to the untreated plots when measured over both varieties and both years.
- Defoliation of RGT Planet at GS30-31 to simulate grazing generated 722kg DM/ha RGT and 1937 kg DM/ha in Cassiopee.
- Valued at 25 cents per kg/dry matter the dry matter was valued at $180/ha and $484/ha respectively which in both cases compensated for the loss of grain yield with defoliation.
- Grazing a late April sown Planet required a minimum 4 cents/kg return on dry matter (DM) to offset the grain loss associated with 722kg DM/ha removal at GS30, whilst with Cassiopee it was 8 cents/kg DM when 1937kg DM/ha was removed at GS30. To grow Cassiopee in place of Planet in order to take advantage of the extra forage required 19 cents/kg DM to counter the loss of $359/ha in grain.

Irrigated barley at the Finley IRC has consistently shown yield benefits to the application of Plant Growth Regulators (PGRs) in the OIG project, even though responses have not always been statistically significant (Figure 1).

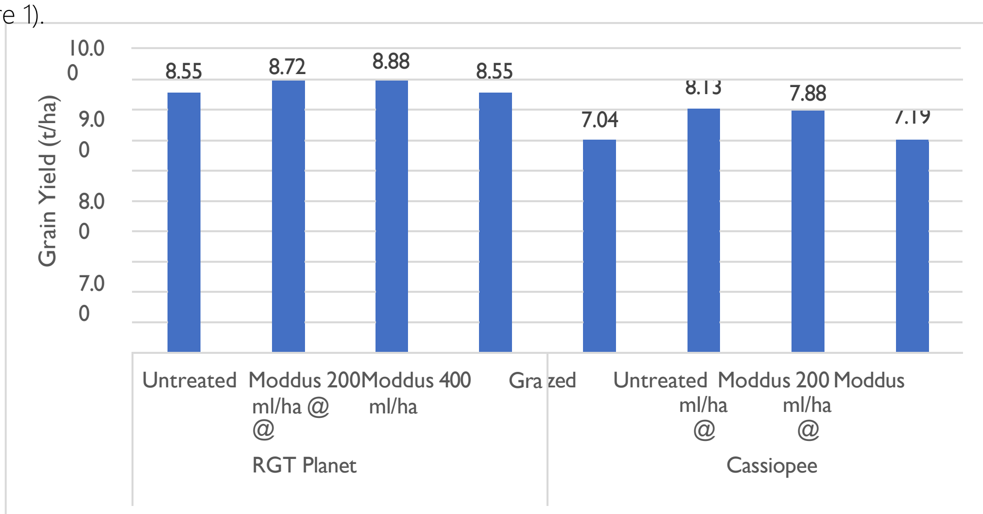

Figure 1. Influence of plant growth regulator on seed yield (t/ha) using RGT Planet spring barley and Cassiopee winter barley in 2 irrigated trials conducted at Finley – 2020 and 2021.

These PGRs, either single applications or splits of Moddus Evo (trinexapac ethyl) have been observed to reduce or delay the onset of crop lodging during grain fill. It is this reduction and delay and lodging that is thought to be related to the yield increases that have been observed (Figure 2).

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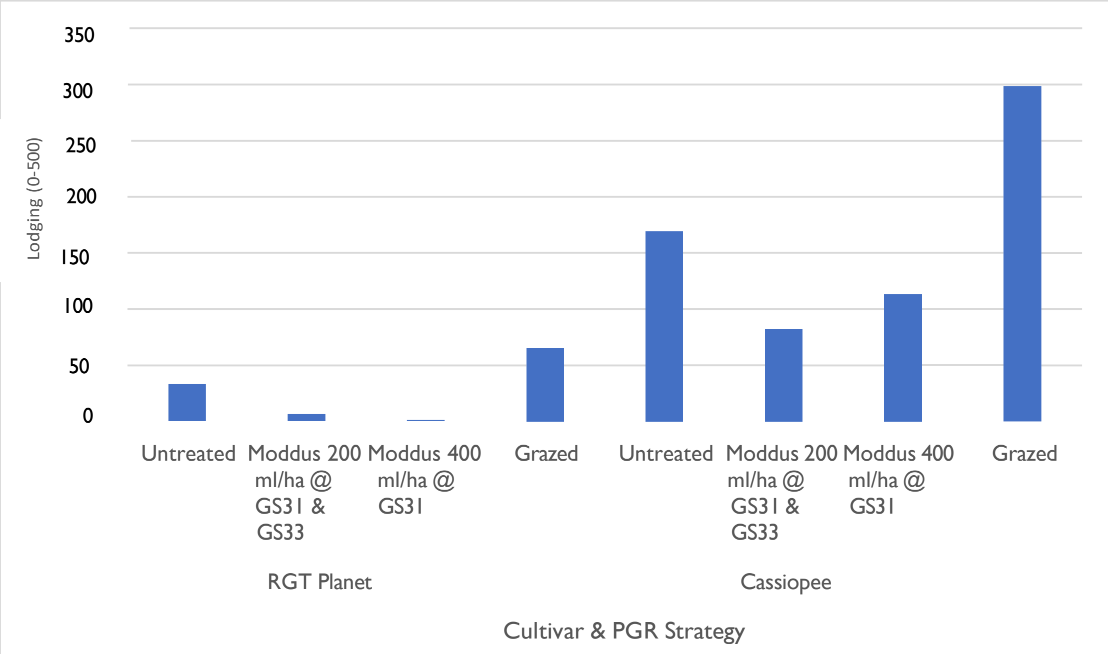

Figure 2. Influence of plant growth regulator on crop lodging using RGT Planet spring barley and Cassiopee winter barley in 2 irrigated trials conducted at Finley – 2020 and 2021.

Defoliation of the crop at GS30-31 (start of stem elongation) to mimic the effect of grazing produced significantly more dry matter with the winter barley that reached stem elongation later than the spring cultivar Planet (Figure 3).

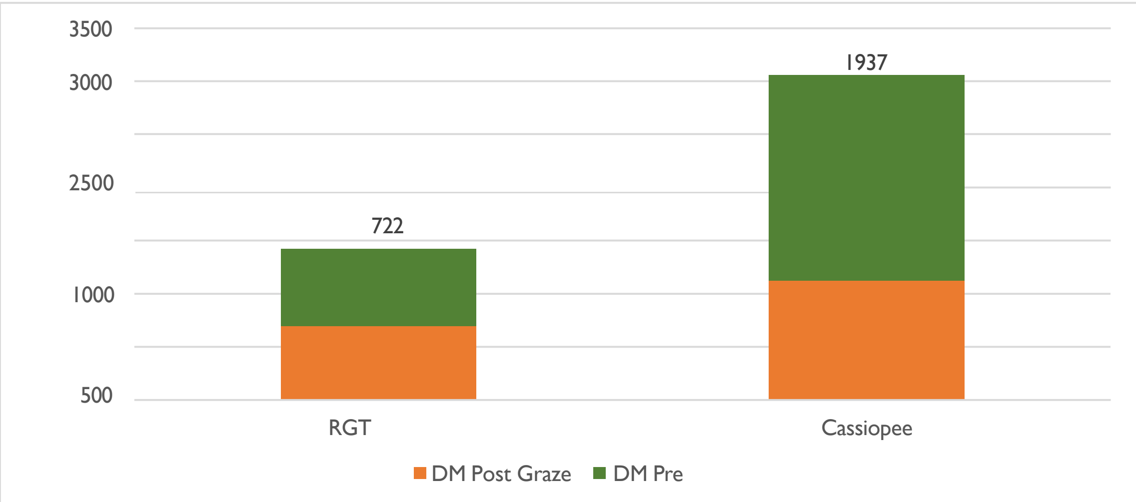

Figure 3. Influence of cultivar on dry matter (DM) kg/ha harvested by simulated grazing using a lawn mower to remove biomass at GS30-31 in two years of trials at Finley – 2020 and 2021. Figures above bars show the amount of biomass removed by simulated grazing.

The return in $/ha from PGR application with Planet was marginal, since the split application of Moddus (GS31 and GS33) was less cost effective than the untreated, whilst the single application (GS31) was slightly more cost effective. With the weaker strawed winter barley Cassiopee both single and split applications were very cost-effective applications (Table 1).

Table 1. Net income after PGR treatment, exclusive of grazing income.

Cultivar	Treatment	Yield (t/ha)	Gross Income[1] ($/ha)	PGR cost[2] ($/ha)	Net Income[3] after PGR ($/ha)
RGT Planet	Untreated	8.55	2052	-	$ 2,052
	Moddus Split GS31 & GS33	8.72	2092	61.72	$ 2,030
	Moddus @ GS31	8.88	2130	46.72	$ 2,083
	Grazed	8.55	2052	-	$ 2,052
Cassiopee	Untreated	7.04	1688	-	$ 1,688
	Moddus Split GS31 & GS33	8.13	1950	61.72	$ 1,888
	Moddus @ GS31	7.88	1890	46.72	$ 1,843
	Grazed	7.19	1724	-	$ 1,724

[1]Gross income based on $240/t for feed barley delivered Finley, (protein was above 12% for all treatments in these trials and therefore unable to achieve malt quality). [2]PGR cost based on Moddus Evo at $79.30/L and application cost of $15/ha. [3]Net income has no other costs of production included only the PGR costs and its application cost.

Table 1 does not include the value of dry matter grazed at GS30-31. In Table 2 the value of the reduction in grain yield is equated to a value for DM to justify grazing. In RGT Planet only 4 cents/kg DM was required to offset grain loss associated with removal of 722kg DM at GS30. With Cassiopee where defoliation produced nearly 2 t/ha DM the grain loss at harvest was greater (0.94t/ha compared to PGR treated) and 8 cents/kg DM was required to offset grain loss compared to the most effective PGR treatment or to warrant growing Cassiopee instead of RGT Planet 19 cents/kg DM.

Table 2. Grazing value required to ensure same income as ungrazed, PGR treated plots grain yields

			Penalty for grazing cf. highest net income ($/ha)		c/kg required from GS30 DM to offset grain loss	
Cultivar (Grazed)	Net Income ($/ha)	Grazed DM (kg/ha)	cf. Planet ($2083/ha)[1]	cf. Cassiopee ($1888/ha)[2]	$2083/ha	$1888/ha
RGT Planet	$ 2,052	722	-31		$ 0.04	
Cassiopee	$ 1,724	1937	- 359	-164	$ 0.19	$ 0.08

[1]Gross income achieved with RGT Planet and single PGR application. [2]Gross income achieved with Cassiopee and split PGR application. cf. Compared to

Canola under irrigation

Crop structure and Plant population

Key Points:

- The penalty for growing canola crops that are too thin is significant under irrigation.
- At $700/t the influence of thinner canola populations can result in productivity losses of $448-$532/ha.
- Under irrigation it's better to have hybrid canola populations that are too thick than too thin when assessing seedbed conditions and establishment.
- 80 seeds/m^2 resulting in plant populations averaging 43-45 plants/m^2 were the most profitable populations tested under surface and overhead irrigations systems.
- If autumn surface irrigation 80-100mm (0.8-1.0 Mega litre) was followed by heavy winter rainfall on poorly drained red duplex soil, canola establishment could be severely reduced (2-9 plants/m^2), and productivity reduced to yields of 1-2.5t/ha.
- Under irrigation at Finley on a red duplex soil the yield advantage of RR hybrid over TT hybrid has been 17% (0.64t/ha) resulting in a $488/ha increase in productivity at $700/t.
- In the warmer irrigation region of Kerang on grey clay the advantage of the RR hybrid has been approximately half that observed at Finley with a yield advantage valued at $231/ha.
- Higher plant populations resulted in test weights that achieved the minimum standard (62kg/hL) which was not the case with the lowest TT plant populations tested.

Crop structure and Plant population

Growing canola under irrigation with the aim of producing 5t/ha has illustrated significant penalties in yields and margins from growing crops that are too thin. With higher yield potential under irrigation small differences in plant population have a "magnifying" effect in terms of yield. With plant populations below the optimum there are significant yield penalties, whilst in the same varieties' populations that might be regarded as above the optimum have been either equal or higher yielding than the optimum. As a result, dropping to populations between 10-20 plants/m^2 can produce a significant drop in productivity compared to plant populations that are above 40 plants/m^2 when canola has been grown under irrigation. In the research looking at optimum crop canopy performance for irrigated canola the following key learnings have emerged over the last two years.

Influence of hybrid RR vs. TT

- Higher yields under irrigation magnify differences relative to dryland. Roundup Ready hybrid 45Y28 has been consistently higher yielding than the hybrid TT HyTTec. A mean 17% advantage (range 15-18% mean 0.64t/ha) advantage has been observed at Finley Irrigated Research Centre worth
$448/ha at $700/t.
- The advantage of 45Y28 over HyTTec Trophy in the warmer region of Kerang on grey clay was approximately half that observed at Finley (9%-0.33t/ha) worth $231/ha.

Influence of plant population

- Roundup ready hybrid 45Y28 has shown 15% higher productivity (mean of 0.64t/ha) from an average plant population of 45 plants/m2 (based on 80 seeds/m2) compared to populations of 14 plants/m2 (based on 20 seeds/m2) (Figure 1). Thicker canopies based on 45 plants/m2 under irrigation generated a $448/ha return for an investment of approximately $110/ha in extra hybrid seed planted (additional 3kg/ha seed). Approximately $4 return for each $ spent on additional seed.
- The differences in hybrid TT populations under irrigation produced even greater differences in productivity and again illustrated that growing crops with higher plant populations was important to secure the additional productivity offered by irrigation. Hybrid TT HyTTec Trophy has shown 23% higher productivity (mean of 0.76t/ha) from a mean population of 43 plants/m^2 with this thicker crop

generating an additional $532/ha return from a similar $110/ha investment in additional seed. Approximately $5 return for each $ spent.

Influence of irrigation system (relative to winter rainfall)

- The poorest yield results so far observed in the project resulted from autumn irrigation immediately post sowing in early May following sowing in late April. Poor drainage and flow of surface irrigation at the Finley site led to early winter water logging and very low plant establishment. Crop establishment that fell to between 2-9 plants/m^2 yielded 0.83-2.67t/ha with 45Y28 and 3-7 plants/m^2 with HyTTec Trophy yielding 1.14-1.71t/ha.

The results illustrate that under irrigation the penalty of growing crops too thinly is increased with very large losses of income if population falls to 10-15 plants/m^2. Although hybrid plant populations of 25-30 plants/m^2 removes much of this penalty, productivity and profitability has been increased further with populations at 40-50 plants/m^2, despite the additional cost of seed.

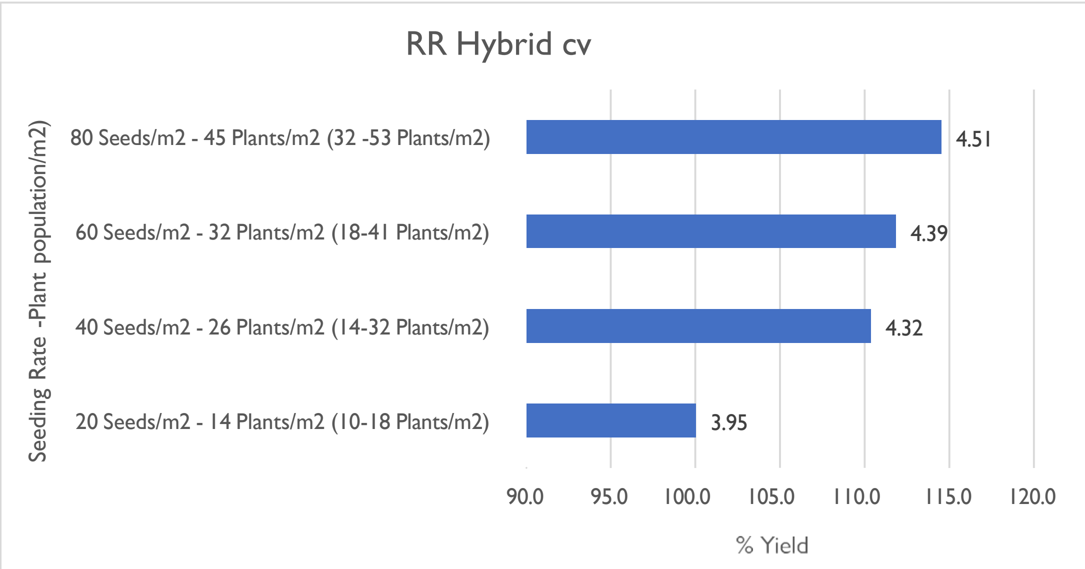

Figure 1. Influence of plant population on seed yield (t/ha) using the RR hybrid 45Y28 in 6 irrigated trials conducted at Finley and Kerang – 2020 and 2021.

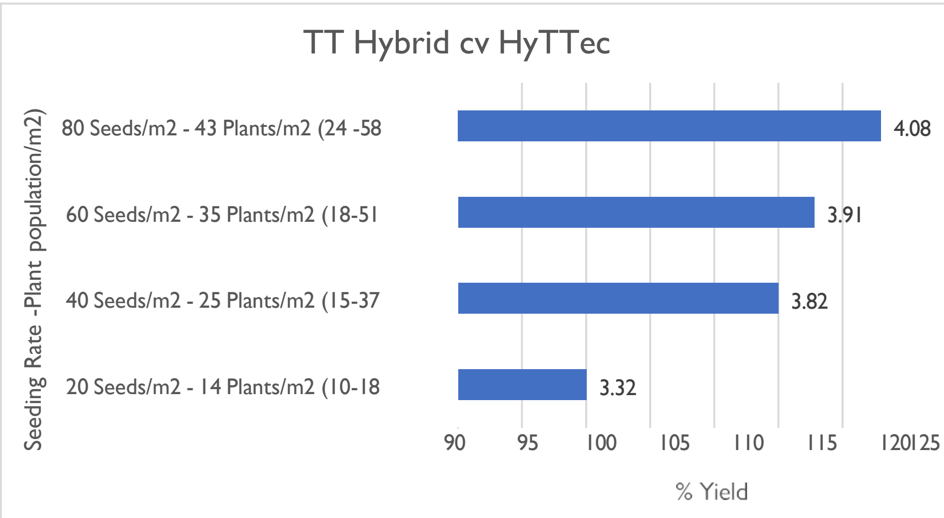

Figure 2. Influence of plant population on seed yield (t/ha) using the TT hybrid HyTTec Trophy in 6 irrigated trials conducted at Finley and Kerang – 2020 and 2021.

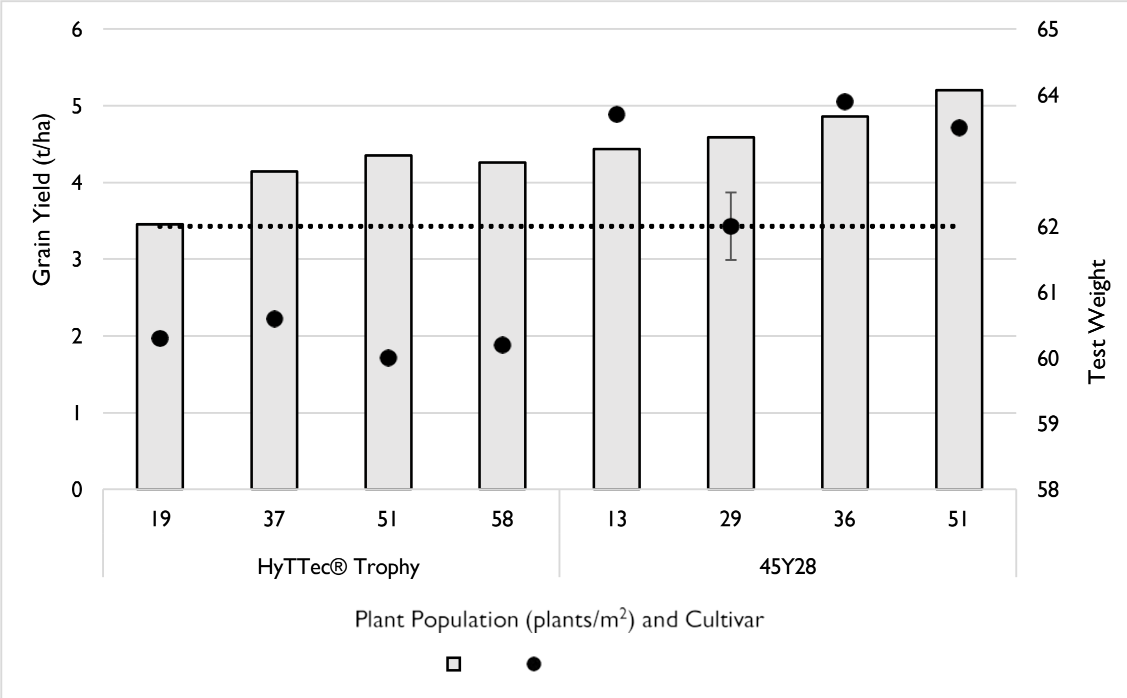

Figure 3. Influence of plant population and cultivar on seed yield (t/ha) and test weight (kg/hL) using the TT hybrid HyTTec Trophy - Finley 2021.

Nitrogen applications for 5t/ha irrigated canola

Key Points:

- Growing 5t/ha canola crops under irrigation does not require very large quantities of artificial nitrogen, it requires a fertile farming system that enables large crop canopies to draw down from a high soil N reserve in order to satisfy crop demand.
- Optimum N rates in OIG project trials required to grow 4-5t/ha canola crops have not exceeded 240kg N/ha applied as N fertiliser (urea 46% N).
- At Finley 200kg N/ha would be an appropriate target with a range of 160-240kg N/ha (upper end of range with low soil fertility or lower rate of range with high fertility).
- In trials conducted so far there have been few, if any differences in seed yield due to N timing with N rate being the most important. Timings of 6 leaf, green bud and yellow bud using split applications have had little difference to yield or oil content so far.
- When crops respond to higher levels of N input (above 240kg N/ha) it is often where crops cannot efficiently access the N fertiliser applied, a common occurrence in dryland scenarios. With irrigated crops the efficiency of N applied is improved considerably.
- The highest yielding irrigated canola crops in the project have been produced in paddocks where inherent fertility is high with applied artificial N rates typically no more than 160- 240kg N/ha at Finley and 80-120kg N/ha at Kerang.
- These fertile irrigated paddocks can often produce reasonable crops with little or no artificial N as soil N mineralisation provides a greater proportion of the N supply e.g., Finley and Kerang 2020 yields were in excess of 3t/ha achieved with only MAP at sowing.

During 2020 at Kerang on grey clay canola yields varied from 3.00-3.63 t/ha based on 0 to 320kg N/ha applied with an optimum of 80kg N/ha. In 2021 from the same N range the canola yields were 2.74-
4.36t/ha with an optimum of 120kg N/ha. In Finley during 2020 yields ranged from 3.91-4.71t/ha (Figure

4) with an optimum of 160-200kg N/ha and in 2021 from 2.21-4.22 t/ha with an optimum of 240kg N/ha from the same yield range.

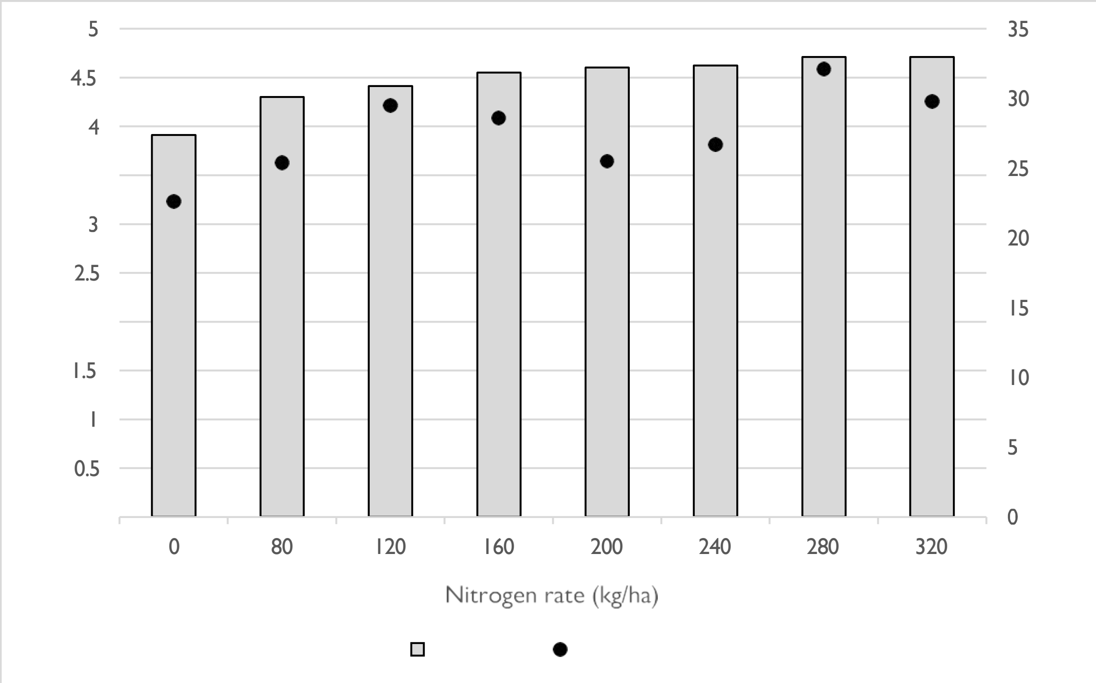

Figure 4. Influence of applied N rate on seed yield (t/ha) and harvest index (%) – cv RR Hybrid 45Y28, Finley, NSW 2020

Disease management in irrigated canola

Key Points:

- To date in the project trials at Finley in 2020 and 2021 the maximum responses to disease management strategies have been relatively small (0.13t/ha and 0.28t/ha) in irrigated canola crops of ATR Bonito.
- The research work conducted on canola has been subject to upper canopy blackleg and crown canker but not sclerotinia.
- In these cases, flutriafol in furrow followed by Miravis at 4-6 leaf has been one of the most effective treatments, although the yield increases have been small and only statistically significant in 2021.

PGR management – controlling crop height and lodging

Experimental PGR applications (based on a gibberellin inhibitors) have been successfully employed to reduce crop height in irrigated canola, however the effects of the PGR which have been manifest at flowering have largely worn off by harvest. So far, these transient reductions in crop height have not been associated with any improvement in seed yield.

Chickpeas under irrigation

Crop structure and Plant population

Key Points:

- Chickpea yields under irrigation have reached yields over 4.0t/ha.
- 35 seeds/m^2 resulting in plant populations averaging 21-25 plants/m^2 were the most profitable populations tested under surface and overhead irrigations systems from a late April sowing.
- The influence of lower chickpea populations can result in productivity losses of 1.0t/ha.
- Higher yields have come from April sowing compared to May sowing. Where sowing is delayed, populations need to be increased to 35 plants/m^2.
- Yields have not been stable between the two years of trials. Yields from the Finley site were approximately half in 2021 compared to 2020, with the overhead irrigation suffering the higher yield reduction. Kerang 2021 yields were similar between seasons.
- Lodging has been observed in higher plant populations, but this is also influenced by cultivar choice.

Crop structure and Plant population

Growing chickpeas under irrigation has demonstrated that there are yield penalties for crops that have reduced biomass. With early pod set determined by temperature (>15 degree C) and grain fill impacted by high temperatures later in spring, there is a window of opportunity for maximising yield by taking advantage of higher biomass promoted by higher seeding rates or earlier sowing (Figure 1).

Inoculation of Chickpeas

Key Points:

- As chickpeas require a specific inoculum (Group N), it is highly recommended that seed be inoculated before sowing.
- Using higher rates of Alosca granules resulted in increased nodulation in 2020 but there was no advantage to higher rates over 10kg/ha in 2021. Untreated plants had few root nodules.
- While yields were lower in the untreated plots, there was no statistically significant difference between inoculated and uninoculated crops in the trials.
- Applying artificial nitrogen (40kg N/ha) has not influenced nodulation in research conducted so far, but equally it hasn't been associated with yield increase.
- High soil N at sowing may have the effect of removing some of the reliance on nitrogen fixed by the crop.

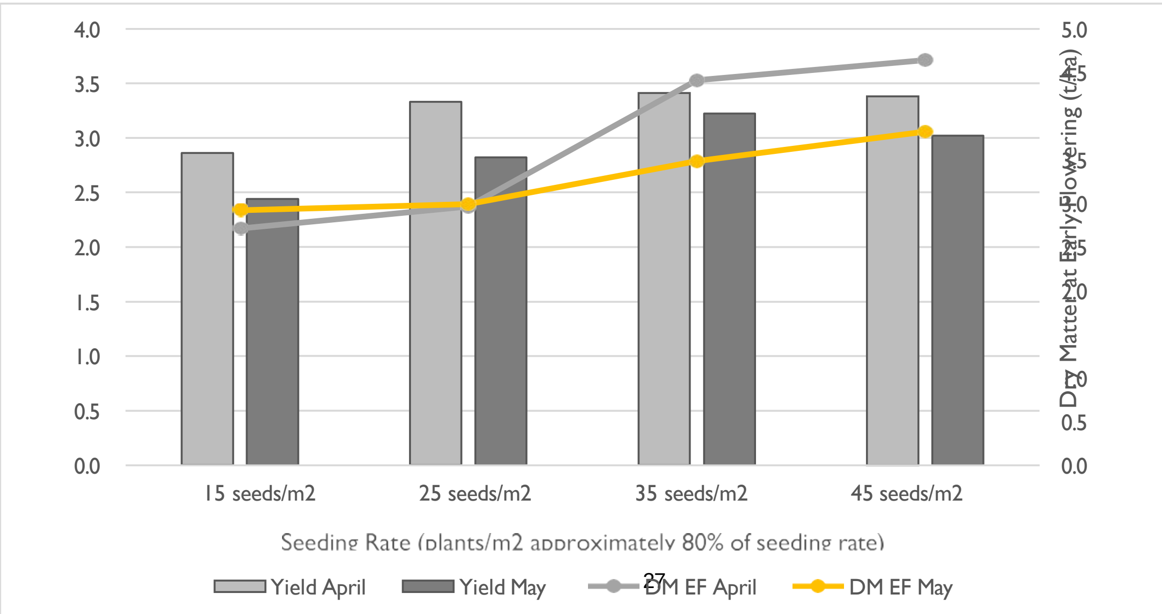

Figure 1: Chickpea yield (t/ha) and dry matter (t/ha) at early flower (EF) averaged from two cultivars – Finley, NSW cv Genesis 090 and PBA Royal.

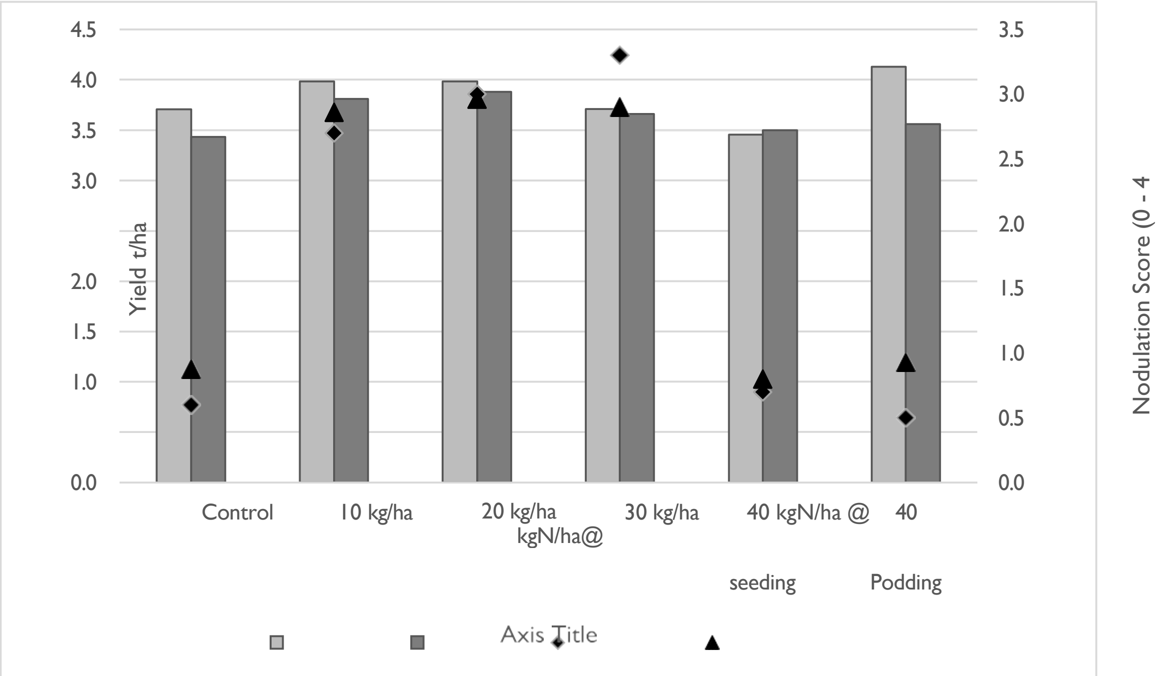

Figure 2: Influence of inoculant (ALOSCA granules) rate (kg/ha) and applied nitrogen kg N/ha on chickpea yield (t/ha) and Nodulation Score (NodSc) from the Kerang, Vic 2020 and 2021 trials – cv PBA Royal.

Inoculation has resulted in a significant improvement in nodulation scores assessed 9 weeks after sowing. However, the grain yields have not followed a similar trend, with yields regarded as statistically similar.

Disease management in irrigated chickpeas

Key Points:

- Chickpeas have been more susceptible to foliar disease, specifically ascochyta, than faba beans at both research sites.
- The disease rating of the cultivar was an important indicator of cultivar yield performance.
- The benefit of an 'Expensive' strategy using a combination of SDHI (group 7) and QoI (Group 11) chemistry gave significantly better disease control and significantly higher yields than 'Cheap' strategy based on chlorothalonil and tebuconazole, but only with PBA Monarch at both sites.
- Genesis 090 showed good response to fungicide but there was far less advantage to the more expensive fungicide strategy.
- While the untreated yields at Kerang were approximately 50% of the yields where disease was controlled, the actual grain produced in the untreated was unlikely to have any commercial value due to the number of small and discoloured chickpeas in the sample.

The OIG project has been looking at the influence of newer fungicide chemistry in chickpeas grown under either surface or overhead irrigation compared to historic standards using chlorothalonil (Table1).

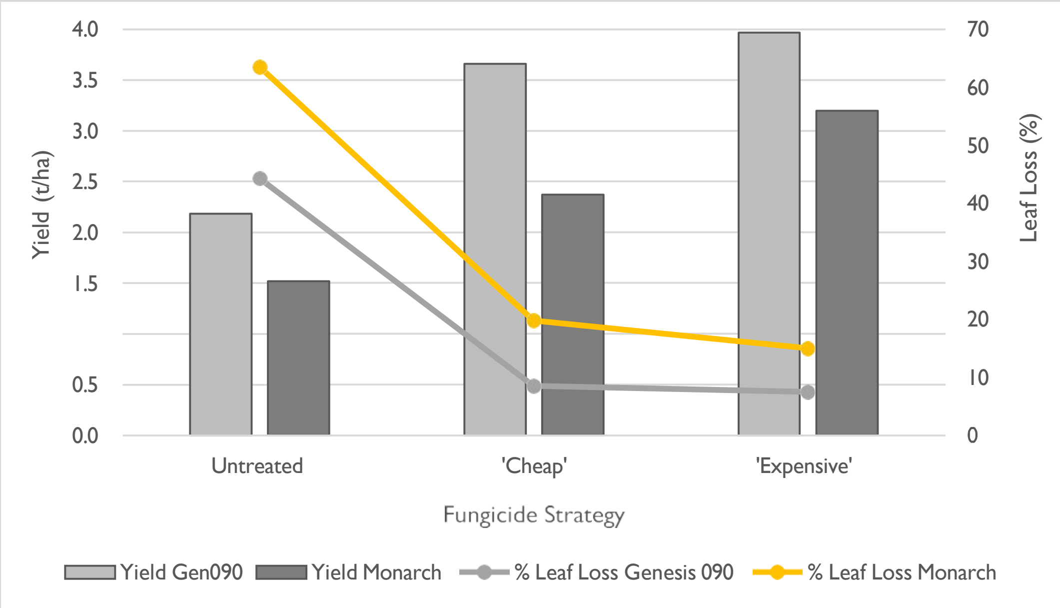

Figure 3: Influence of cultivar and fungicide strategy (based on three applications) on yield (t/ha) and % leaf loss – Kerang, VIC, cv Genesis 090 and Monarch.

Table 1. Trial treatment summary.

TRT	Variety	Management Strategy	4-5 weeks post emergence	Pre-Flower	Late Flower
1		Untreated*	-	-	-
2		Cheap	Chlorothalonil 720 1 l/ha	Chlorothalonil 720 1 l/ha	Chlorothalonil 720 1 l/ha
3		Expensive	Veritas 1l/ha	Aviator Xpro 600ml/ha	Veritas 1l/ha

Durum under irrigation

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.

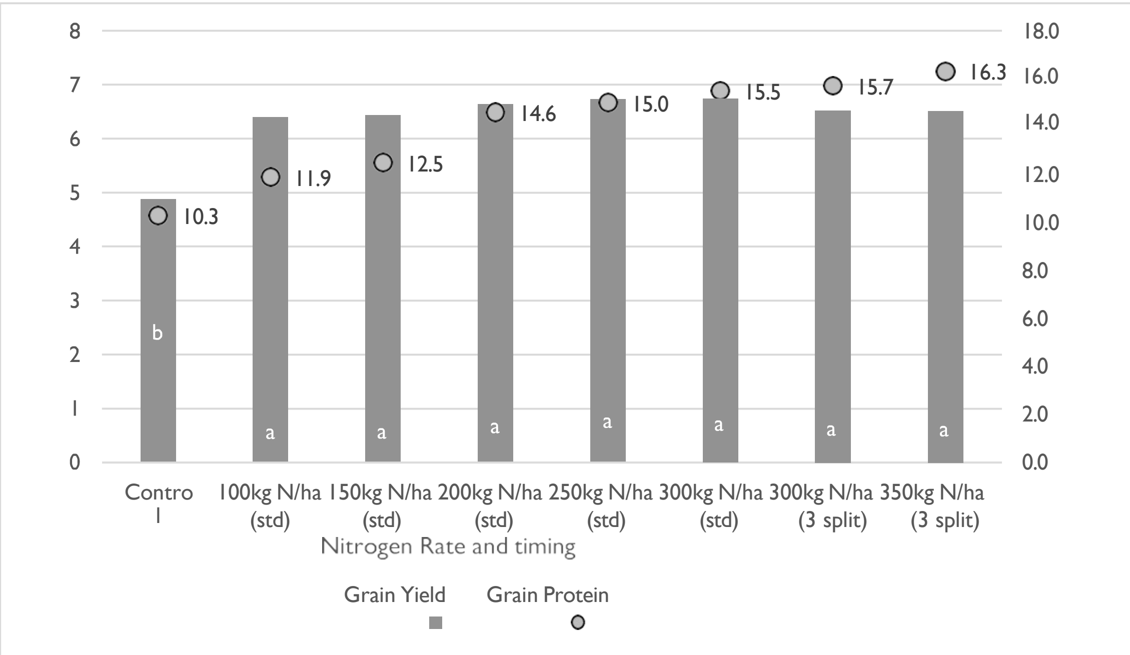

Figure 1. Influence of applied nitrogen at stem elongation on grain yield (t/ha) and protein content (%). – Finley 2021 Notes. Std – nitrogen split 50:50 between GS30 and GS32. 3 split – 100kg of nitrogen withheld until GS39 with the remainder split 50:50 between GS30 and GS32. Yield bars with different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

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	

Faba Beans under irrigation

Crop structure and Plant population

Key Points:

- High yielding faba bean crops greater than 7t/ha are achievable under both overhead and surface irrigation systems.
- The penalty for growing faba bean crops that are too thin is significant under irrigation.
- Aiming for populations above the optimum is less risky, with little to no penalty for canopies that are above optimum.
- With plot yields varying from 2.5t/ha to 8t/ha, the older variety Fiesta VF consistently out yielded the newer variety PBA Amberley by 8%.
- Surface irrigation combined with growing season rainfall at both Finley and Kerang was at least 500mm in order to achieve 7t/ha plus. Overhead irrigation systems in 2020 associated with 400mm of GSR and irrigation combined produced only 4-5t/ha with lower pod numbers/m^2 and harvest dry matter.

Cultivar and Population

Fiesta out yielded PBA Amberley by 8% across the two years of research trials under irrigation. This increased yield is consistent over plant populations that vary from low to high density, however at the high populations (plus 40 plants/m^2) PBA Amberley appears to drop in yield slightly. Irrigated grain yield plateaus at around 30 plants/m^2 and there is little gained going above 25 plants/m^2. However, when plant populations start dropping below 20 plants/m^2 the yield loss can be significant. With higher yield potentials under irrigated cropping systems, the small drops in plant populations have a "magnifying" effect on grain yield loss (loss of approx. 1.5t/ha when dropping from 20 to 10 plants/m^2). In contrast, moving from 20-30 plants/m^2 increased yield by 0.5t/ha and whilst higher populations were rarely higher yielding, the risk of poorer performance was very slight in comparison to populations dropping below the optimum.

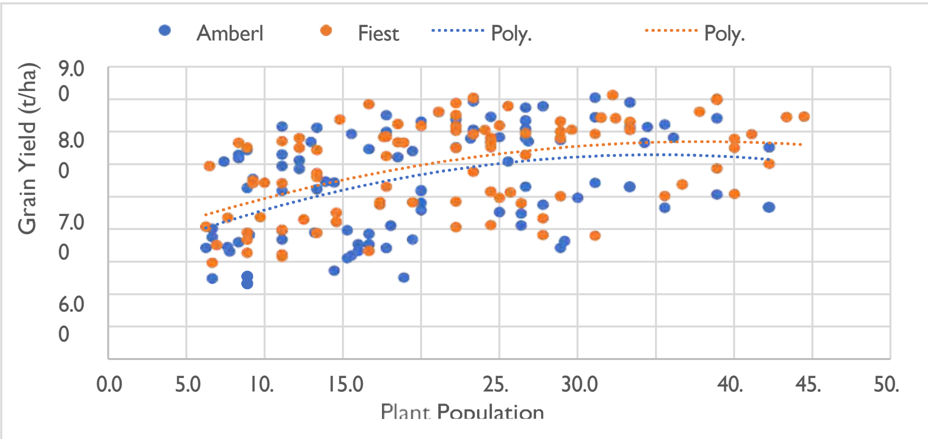

Figure 1. The influence of faba bean plant populations on grain yield (t/ha). Data points from 6 trials across 2 years and 2 sites.

If aiming for 20 plants/m^2, there are greater negative consequences if populations fall below that target than where populations are higher than the target, even up to 35-40 plants/m^2. Therefore, there is less risk of losing yield if aiming for higher populations (25-30 plants/m^2) than falling short.

What makes a 7-tonne crop?

When growing faba beans under irrigation plant populations is one of many components making up the yield achieved at the end of the season. Other yield drivers include biomass production, stem numbers, pod numbers, seeds per pod and thousand weight (TSW).

Two years of achieving high yielding irrigated faba beans has allowed us to estimate some matrix figures around what makes up a 7+ t/ha faba bean crop. When achieving 7t/ha at our Finley irrigated research site a minimum established population of 20 plants/m^2 was the establishment foundation required. From this point, at least 60 stems are required and approximately 8 pods per stem to reach the target of 7t/ha.

Table 1. Yield components of a high yielding (+7t/ha) irrigated faba bean crop.

	Population Plants/m^2	Harvest Dry Matter t/ha	Stems /m^2	Pods /m^2	Grain Yield t/ha
Amberly 2020	20	13.59	60	453	7.45
Amberley 2021	21	11.66	60	490	7.18
Fiesta 2020	27	15.15	70	557	7.06
Fiesta 2021	23	13.68	60	624	7.23
Amberley 2020	32	9.05	61	351	5.17

Despite achieving +20 plants and +60 stems/m^2 in one trial in 2020, a yield of only 5t/ha was achieved due to lower biomass and pod numbers. In this example irrigation was provided by overhead and the GSR and irrigation combined fell below 400mm, whilst in 2020 the only crops to achieve 7t/ha plus had surface irrigation of approximately 500mm at Finley (Red Duplex) and 580mm at Kerang (Grey Clay).

Nitrogen Fixation

Key Points:

- Using current estimates, high yielding faba bean crops are removing more nitrogen in the grain than they are supplying in nitrogen fixation.

Current rules of thumb (for dryland bean crops) for nitrogen fixation are 20kg of N fixed per tonne of dry matter biomass at flowering and estimates of nitrogen removal are 40kg of N per tonne of grain. Using these estimates, our irrigated faba bean crops are removing up to 300kg N/ha while only supplying 110-190kg N through fixation leaving a large N deficit.

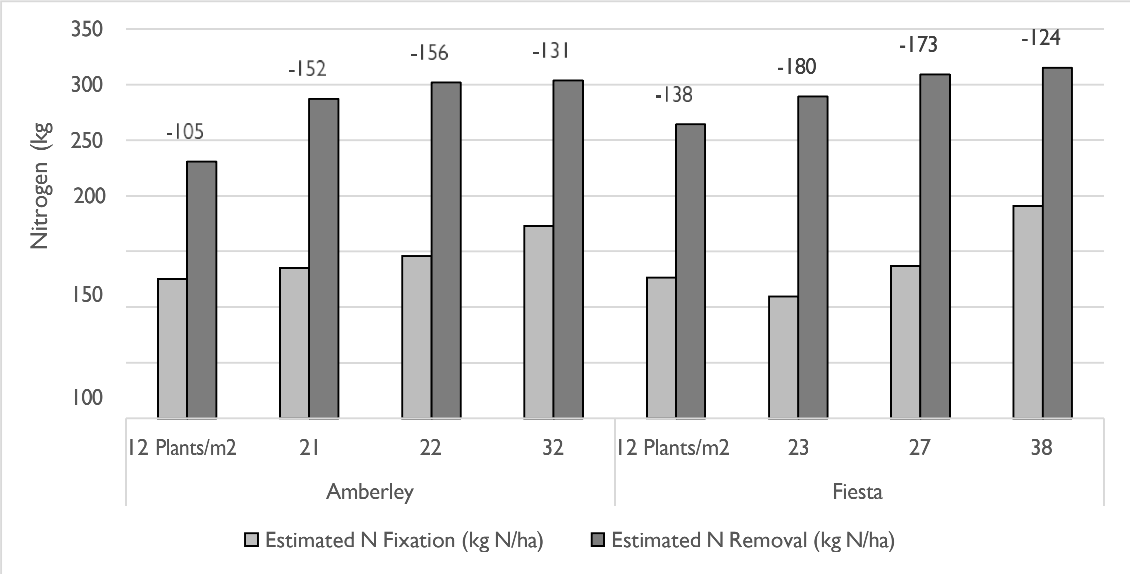

Figure 2. Estimates of nitrogen fixation and removal from high yielding irrigated faba bean crops. Data labels show the nitrogen deficit.

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.

The optimising irrigated grains projects are part of the GRDC investment in FAR1906-003RTX: Development and validation of soil amelioration and agronomic practices to realise the genetic potential of grain crops grown under a high yield potential, irrigated environment in the northern and southern regions

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Year One Yielding Results

Tatura (Agriculture Victoria)
Wheat tiller density is affected by both sowing rate and nitrogen (N) rate, with N having a greater impact. There was no effect of stem diameter on quality.

Kerang (Irrigated Cropping Council)

Winter trial: Cereal cutting time impacted yield significantly. No effect of cereal stem diameter on quality. Faba beans have potential to yield up to 20 tonnes DM/ha of high quality forage, however, there are significant challenges with ensiling/baling due to high moisture and lodging.

Mitiamo (Birchip Cropping Group)
Oaten hay yields were highest for Kingbale, Mulgara, Brusher, Yallara and Wintaroo. Sowing date had no significant impact on yield or quality between varieties. There was a yield response to N, but none to phosphorus (P) or potassium (K). There was no or minimal impact on stem diameter or quality from the application of N, P or K.

Dookie (University of Melbourne)
Significant trade-offs between cutting time, yield and quality in cereal crops. Tiller density is affected by increased sowing rate. No effect of stem diameter on quality.

Finley (Southern Growers)
Timok had better quality attributes than the woolly vetches. High sowing rates increased established plant counts but did not have an effect on yield and quality. An autumn irrigation was associated with better yields in shorter season common vetch cultivars (but no long season woolly pod vetch). There was a yield increase of two tonnes DM/ha in vetch that was irrigated versus dryland.

Rutherglen (Riverine Plains)
Vetch persistence and yield was penalised by wet conditions and subsequently out competed by the oats. Earlier sown oats significantly increase silage yield compared to the later sown stand. Cutting time, sowing date and rate have variable and inconsistent effects on quality of oat/vetch mixes.

Fodder for the Future

RiverinePlains SOUTHERN GROWERS THE UNIVERSITY OF MELBOURNE

2021 Fodder for the Future ICC Irrigated Cereals Trial

Summary

Two long season cereal varieties (an oat and a wheat) were sown at 4 sowing rates at two Time of Sowings to assess fodder production and feed quality.

Some observations:

- Sowing rates had little impact on fodder production.
- While higher sowing rates resulted in higher stems/m^2 and lower stem diameter, this failed to equate to improved feed quality.
- Oats produced higher fodder yields than wheat, but it also had higher rates of lodging due to the very tall nature of the plants.
- While appearances suggested that the oat quality would be lower than that of the wheat (higher stem diameter and taller plants), the feed quality results did not show much difference.
- Time of Sowing influence on cutting dates in RGT Cesario wheat were negated by the strong vernalisation response and so both sowing dates were cut at the same time.
- Vernalisation response in Forrester oats was not as strong and a 3-week later sowing date delayed the harvest by 11-15 days.

Objectives

To evaluate the dry matter production of irrigated oats and wheat for fodder production:

1. Optimal sowing rate
2. Optimal sowing date
3. Assess the fodder production at two cutting dates
4. The influence of crop type and time of cutting on feed quality.

Methodology

The following varieties, target populations and sowing dates were selected for the trial.

Table 1: Cereal varieties sown

Crop	Variety
Wheat	RGT Cesario
Oats	Forrester

Table 2: Crop target populations and time of sowing

Crop	Target populations	Time of sowing
Wheat	80, 120, 180 and 270 plants/m^2	31 March, 21 April
Oats	80, 120, 180 and 270 plants/m2	31 March, 21 April

The trial design was blocked by time of sowing, with the early and late sown plots grouped together within the same irrigation bay. Within each sowing block, the crop type and sowing rate treatments were randomised using a randomised complete block design generated by 'Digger' trial design software, with 4 replicates. Plot size was 12m by 1.8m.

The trial was established on a surface irrigated border check layout.

It was the intention to pre-irrigate prior to sowing and then sow into receding moisture. However, 80 mm of rainfall was recorded in late March, and so the decision was made to take this opportunity to sow the first Time of Sowing (ToS) on 31 March. Soil moisture declined quite quickly and so the decision was made to irrigate on 10 April as the plants began to emerge. This also served as a pre-irrigation for the second ToS, which occurred on 21 April.
All plots received 125 kg DAP/ha (25 kg P/ha and 22.5 kg N/ha) at sowing.

Sowing rates calculations were based on the target population, seed size and an assumed establishment rate of 70%. Nitrogen was top-dressed at tillering (90 kg N/ha) and again at early stem elongation (90 kg N/ha). This, along with the sowing N, soil N and estimated mineralisation, supplied the trial with 240 kg N/ha.
The first spring irrigation was on 28 August (1.0 Ml/ha) and again on 29 September (0.9 Ml/ha).

Table 3: Forage cutting dates

Cereal		GS49	GS71
Oats	ToS1	9 September	11 October
	ToS2	24 September	22 October
Wheat	ToS1	27 September	26 October
	ToS2	27 September	26 October

When taking the dry matter cuts, all oat samples were assessed using a cutting height of 150mm above the soil surface. Wheat GS49 assessments were cut at 75mm (due to the very short stature of the crop at the time) and the GS71 assessments at 150mm.

Two samples consisting of 3 rows by 1m were cut, weighed and a subsample of approximately 400g was selected and shredded. This was then dried at 60 degrees C to determine dry matter percentage.

Samples were taken from each plot for feed quality assessment. The number of stems in a subsample of known weight were counted and the diameter of approximately 90 tillers measured.
Statistical analysis of the data was conducted using 2-way ANOVA, with ToS and plant population as the factors. The wheat and oats were analysed separately.

Results

Table 4: Plant Establishment

Target Population	ToS1		ToS2	
	Oats	Wheat	Oats	Wheat
80 plants/m^2	89.8	76.5	83.2	85.5
120 plants/m^2	132.5	128.5	126.0	123.8
180 plants/m^2	212.2	207.0	190.5	180.0
270 plants/m^2	256.5	238.3	256.0	256.0

The mean establishment rate for the trial was 72%.

Table 5a: Oat Stem number (stems/m^2)

Target Population	ToS1	ToS2	Mean
	Stems/m^2	Stems/m^2	Stems/m^2
80 plants/m^2	279	269	274 a
120 plants/m^2	335	327	331 b
180 plants/m^2	361	362	362 c
270 plants/m^2	365	367	366 c
Mean	335 -	331 -	
LSD ToS p = 0.05	ns	P val	0.793
LSD Population p=0.05	20.29	P val	<0.001
LSD ToSxPop'n. P=0.05	29.0	P val	0.987

Table 5b: Wheat Stem number (stems/m^2)

Target Population	ToS1	ToS2	Mean
	Stems/m^2	Stems/m^2	Stems/m^2
80 plants/m^2	592	800	696 c
120 plants/m^2	676	794	735 bc
180 plants/m^2	736	867	802 ab
270 plants/m^2	692	990	841 a
Mean	674 b	863 a	
LSD ToS p = 0.05	69	P val	<0.001
LSD Population p=0.05	97.6	P val	0.024
LSD ToSxPop'n. P=0.05	138	P val	0.225

Stem counts were higher in wheat than the oats. The trend was also for higher stem counts as plant population increased.

ToS had little influence on oat stem counts, but a significant influence in wheat. Anecdotally, when plots were sampled for dry matter assessments, the first ToS samples in the wheat had much more dead material present at the bases of the plants suggesting higher tiller death.

Table 6a: Oat Stem Diameter (mm)

Target Population	ToS1		ToS2		Mean	
	mm		mm		mm	
80 plants/m^2	5.15	-	5.93	-	5.54	a
120 plants/m^2	5.15	-	5.45	-	5.30	a
180 plants/m^2	4.75	-	5.25	-	5.00	b
270 plants/m^2	4.60	-	4.88	-	4.74	c
Mean	4.91	a	5.38	b		
LSD ToS p = 0.05	0.177		P val		<0.001	
LSD Population p=0.05	0.251		P val		<0.001	
LSD ToSxPop'n. P=0.05	0.354		P val		0.170	

Table 6b: Wheat Stem Diameter (mm)

Target Population	ToS1		ToS2		Mean	
	mm		mm		mm	
80 plants/m^2	3.62	-	3.62	-	3.62	a
120 plants/m^2	3.52		3.44		3.48	b
180 plants/m^2	3.51		3.45		3.48	b
270 plants/m^2	3.35		3.09		3.22	c
Mean	3.50	b	3.40	a		
LSD ToS p = 0.05	0.074		P val		0.01	
LSD Population p=0.05	0.105		P val		<0.001	
LSD ToSxPop'n. P=0.05	0.148		P val		0.098	

The trend was for decreasing stem diameter as plant population increased. This trend occurred in both wheat and oats and at both times of sowing. Wheat had thinner stems than oats, averaging 3.45mm compared to 5.15mm.

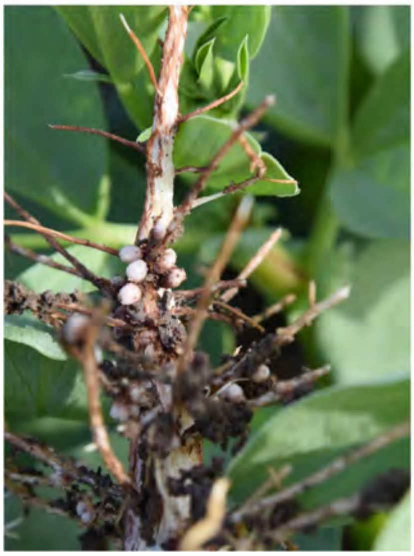


Table 7a: Oat Dry matter (t/ha) at GS 49 and GS71

	Dry Matter (t/ha) GS49 (booting) and GS71 (watery ripe)											
Target Population	GS49						GS71					
	ToS1		*ToS2*		*Mean*		*ToS1*		*ToS2*		*Mean*	
80 plants/m²	9.34	-	10.30	-	*9.82-*		16.99		20.94	-	*18.97*	-
120 plants/m²	8.64	-	10.89	-	*9.77-*		16.03		18.03	-	*17.03*	-
180 plants/m²	8.74	-	11.23	-	9.98-		15.64		18.66	-	17.15	-
270 plants/m²	8.57	-	11.33	-	9.95-		15.10		17.94	-	16.52	-
Mean	8.82	b	10.94	a			15.94	b	18.89	a		

LSD ToS GS49 p = 0.05	0.597	P val	<0.001
LSD Pop'n GS49 p=0.05	ns	P val	0.942
LSD N TxP GS49 p=0.05	1.194	P val	0.154

LSD ToS GS71 p = 0.05	1.770	P val	0.002
LSD Pop'n GS71 p=0.05	Ns	P val	0.224
LSD N TxP GS71 p=0.05	3.541	P val	0.882

Plant population made no difference to yield of oats at either ToS. There appears to be no dry matter/fodder advantage for earlier sowing. In fact, there were higher yields from the second ToS at both the early (1.9 t DM/ha) and late (3.0 t DM/ha) harvests. Another aspect to note is the approximate doubling of dry matter produced between the GS49 and GS71 stages.

Table 7b: Wheat Dry matter (t/ha) at GS 49 and GS71

	Dry Matter (t/ha) GS49 (booting) and GS71 (watery ripe)											
Target Population	GS49						GS71					
	ToS1		*ToS2*		*Mean*		*ToS1*		*ToS2*		*Mean*	
80 plants/m²	8.32	-	8.56	-	*8.44*	-	14.35		15.23		*14.79*	-
120 plants/m²	8.77	-	8.63	-	*8.70*	-	12.94		14.35		*13.64*	-
180 plants/m²	8.37	-	8.19	-	8.28	-	15.90		15.55		15.73	-
270 plants/m²	8.75	-	7.64	-	8.20	-	13.36		14.88		14.12	-
Mean	8.55	-	8.23	-			14.14	-	15.00	-		

LSD ToS GS49 p = 0.05	ns	P val	0.143
LSD Pop'n GS49 p=0.05	ns	P val	0.256
LSD N TxP GS49 p=0.05	4.783	P val	0.227

LSD ToS GS71 p = 0.05	ns	P val	0.113
LSD Pop'n GS71 p=0.05	ns	P val	0.056
LSD N TxP GS71 p=0.05	2.185	P val	0.584

Similar to the oats, plant population did not have any influence on the yield at either cutting stage. In contrast to the oats, the ToS did not influence the yield of wheat at either cutting stage.

Another similarity with the oats was the doubling of the yield of wheat between GS49 and GS71.
Overall, oats had higher yields than wheat at both the early (1.49 t DM/ha) and late (2.85 t DM/ha) harvests. Average plant height at GS72 was 150cm for oats compared to 87cm for the wheat. This translated to lodging in the oats and none in the wheat.

Part 2: Feed quality

Table 1: Effect of time of sowing and growth stage on the ME, CP, NDF and ADF contents of wheat and oats.

Cereal	Cut Stage	Sowing	ME	CP	ADF	NDF
Oats	GS49	ToS1	9.2	12.6	35.9	61.1
Oats	GS49	ToS2	8.8	12.8	39.2	63.6
Oats	GS71	ToS1	8.9	9.1	38.6	62.4
Oats	GS71	ToS2	8.9	10.4	39.9	64.4
Wheat	GS49	ToS1	9.6	14.4	33.4	58.8
Wheat	GS49	ToS2	9.4	17.3	33.9	60.9
Wheat	GS71	ToS1	9.6	10	34.1	57.4
Wheat	GS71	ToS2	9.6	11.4	35.1	59.6

Overall, wheat had a slight quality advantage over the oats. Trial average ME for wheat was 9.6 MJ/kg compared to 8.9 MJ/kg for oats. Crude protein was generally higher in wheat than in oats (15.9 Vs 12.7 %DM at GS49 and 10.7 Vs 9.7 %DM at GS72) while the ADF (38.4 Vs 34.1) and NDF (62.9 Vs 59.2) were lower when averaged across all treatments.

The ME, ADF and NDF contents remained reasonably consistent between GS49 and GS71 in both cereals. The CP content declined between GS49 and GS71 in both oats (12.7 Vs 9.7 %DM) and wheat (15.9 vs 10.7 %DM).

Plant population had no influence ($p<0.05$) on any of the feed quality variables that were analysed. The second ToS did see an increase in CP in wheat when compared to ToS1 but this may be due to differing nitrate levels related to the time of N application.

Conclusions

- Plant populations had little influence on yield or feed quality.
- The fodder yields in wheat were not affected by the sowing date but in oats sowing in late March compared to 21 April resulted in higher yields at both the early and late harvests.
- Oats had higher yields than wheat at both the early and late harvests but at a small quality penalty.
- Wheat would have been an easier crop to harvest due to no lodging and smaller stature.

2021 Fodder for the Future ICC Irrigated Faba Bean Fodder Trial

Summary

The faba bean variety PBS Bendoc was sown at two rates at two Time of Sowings to assess fodder production and feed quality at 3 maturity stages.

Some observations:

- Sowing rates had little impact on fodder production.
- The first time of sowing (23 April) produced higher fodder (dry matter) totals than the later sowing (17 May).
- Dry matter production exceeded 20 t/ha for some treatments.
- The last sampling for quality occurred at physiological maturity, where the plants were only 22% dry matter.
- Quality did not decline during pod filling. The highest crude protein and metabolisable energy contents were at physiological maturity.

Objectives

To evaluate the dry matter production of irrigated faba beans for fodder production:

1. Optimal sowing rate
2. Optimal sowing date
3. Assess the fodder production at three cutting dates
4. The influence of the time of cutting on feed quality.

Methodology

The following varieties, target populations and sowing dates were selected for the trial.

Table 1: Crop target populations and time of sowing

Crop	Target populations	Time of sowing
Faba Beans	15 and 25 plants/m^2	2 April, 17 May

The trial design was blocked by time of sowing (ToS) with the early and late sown plots grouped together within the same irrigation bay. Within each sowing block, the sowing rate treatments were randomised using a randomised complete block design generated by 'Digger' trial design software, with 4 replicates. Plot size was 12m by 1.8m.

The trial was established on a surface irrigated border check layout. Soil type was a grey vertisol. Pre-irrigation (1.2 Ml/ha) occurred on 10 April. Sowing of the first ToS occurred on 23 April followed by the second ToS on 17 May. All plots received 200 kg Superfect/ha (18 Kg P/ha, 22 kg S/ha) at sowing. Sowing rates calculations were based on the target population, seed size and an assumed establishment rate of 90%. The first spring irrigation was on 28 August (1.0 Ml/ha) and again on 29 September (0.9 Ml/ha).

Table 2: Fodder cutting dates

		End of Flowering	Mid pod fill	Physiological maturity*
Faba Beans	ToS1	27 September	18 October	5 November
	ToS2	11 October	25 October	9 November

*: Due to lodging issues, accurate quadrat cuts were unable to be taken and so the plots were sampled for dry matter percentage and feed quality assessment only.

When taking the dry matter cuts, samples were cut at a height of 50mm above the soil surface.
Two samples consisting of 3 rows by 1m were cut, weighed and a subsample of approximately 400g was randomly selected and shredded. This was then dried at 60 degrees C to determine dry matter percentage.

Physiological maturity was determined by the change in colour of the bean hilum to a dark silver colour. At this stage, the plants had begun to lose their lower leaves while the stems and upper canopy remained green. Samples were taken from each plot for feed quality assessment.

Statistical analysis of the data was conducted using 2 way ANOVA, with ToS and plant population as the factors.

Results

Plant establishment was higher for ToS2 than for ToS1 (Table 3).

Table 3: Plant Establishment

Target Population	ToS1		ToS2	
	Plants/m^2	Establishment %	Plants/m^2	Establishment %
15 plants/m^2	11.8	71	15.4	92
25 plants/m^2	21.9	78	27.8	100

Table 4: Faba Bean stem number (stems/m^2) and stems/plant assessed at end of flowering

Target Population	Stems/m^2						Stems/plant					
	ToS1		*ToS2*		*Mean*		*ToS1*		*ToS2*		*Mean*	
15 plants/m^2	74.0	-	77.1	-	75.5	-	6.5	-	5.0	-	5.7	a
25 plants/m^2	85.1	-	92.0	-	88.5	-	3.9	-	3.3	-	3.6	b
Mean	79.5	-	84.5	-			5.2	-	4.2	-		
LSD ToS St/m^2 p = 0.05			ns				P val				0.471	
LSD Pop'n St/m^2 p=0.05			ns				P val				0.055	
LSD N TxP St/m^2 p=0.05			ns				P val				0.754	
LSD ToS St/pl p = 0.05			ns				P val				0.072	
LSD Pop'n St/pl p=0.05			1.11				P val				0.002	
LSD N TxP St/pl p=0.05			1.57				P val				0.383	

Although there were higher stem numbers in the high sowing rate treatment, they were not statistically different (P=0.055) to those of the lower population.

The data in Table 4 shows a that there were fewer stems per plant as population increased, and lower stem numbers from the later sowing date. Only the population effect was statistically significant and the data should be viewed with caution due the high variability (cv%=21).

Table 5a: Faba bean dry matter (t/ha) at the end of flowering

Target Population	ToS1		ToS2		Mean	
	t/ha		t/ha		t/ha	
15 plants/m^2	13.3	-	11.0	-	12.1	-
25 plants/m^2	14.7	-	11.5	-	13.1	-
Mean	14.0	a	11.2	b		
LSD ToS p = 0.05	2.058		P val		0.015	
LSD Population p=0.05	ns		P val		0.321	
LSD ToSxPop'n. P=0.05	2.911		P val		0.649	

At this first cutting stage, the average dry matter content was 13.8%. Population had no influence on dry matter yield but the earlier sowing had a higher yield than the later sowing (14.0 vs. 11.2 t DM/ha).

Table 5b: Faba bean dry matter (t/ha) at mid-pod fill

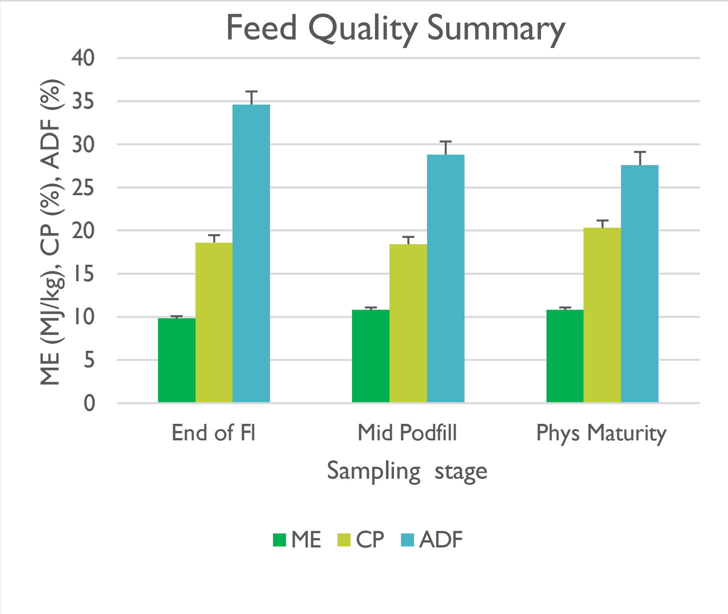
Target Population	ToS1		ToS2		Mean	
	t/ha		t/ha		t/ha	
15 plants/m^2	19.51	-	13.21	-	16.2	-
25 plants/m^2	21.12	-	13.62	-	17.8	-
Mean	20.32	a	13.42	b		
LSD ToS p = 0.05	3.808		P val		0.003	
LSD Population p=0.05	ns		P val		0.561	
LSD ToSxPop'n. P=0.05	5.386		P val		0.728	

At the mid-pod fill harvest the sowing rate did not affect the DM yield but the first time of sowing resulted in a higher DM yield than the later sowing (20.3 vs 13.4 t DM/ha) (Table 5b).

At mid-pod fill, the dry matter content averaged 17.0%. The intended third cut at physiological maturity was not possible as most plots had lodged badly and accurate quadrat cuts were not possible. Samples were collected for dry matter content which averaged 22%.

Part 2: Feed quality

Figure 1: Effect of growth stage on the ME, CP and ADF contents of Faba beans at 3 stages of maturity.



The plant population did not influence the quality parameters of ME, CP or ADF (Figure 1). Time of sowing did not influence ME or CP contents but did have an effect on ADF content with a slightly lower ADF content at the second ToS (31.2 Vs 29.5 %DM).

The quality parameters measured were affected by the maturity at the time of harvest, with ME ($p<0.001$, 10.8 Vs 9.8) and CP ($p<0.001$, 20.3 vs 18.6 %DM) higher at the last than at the first harvest. Later sampling saw a decline in ADF ($p<0.001$) compared to the first harvest (27.6 vs 34.6 %DM).

Conclusions

- Fodder yields exceeded 20 t DM/ha for some treatments at the middle harvest. (Were unable to do DM assessments at the final harvest).
- The plant populations used in this trial had little influence on yield or feed quality.
- Fodder yields saw a benefit from sowing in late April compared to mid-May.
- The Faba beans had some logistical problems for forage conservation. Lodging was an issue late in the season and the water content at physiological maturity was still too high to ensile it immediately.
- Feed quality parameters improved from the first (end of flowering) to the final (physiological maturity) harvest with both ME (10.8 vs 9.8 MJ/kg DM) and CP (20.3 Vs 18.6 %DM) contents increasing and the ADF content decreasing (27.6 vs 34.6 %DM).

Appendix 1: Soil Test Results

Paddock Name		Bay 1		
Sampling Date		4/6/2021		
Sample Depth		0-10 cm	10-30 cm	30-60 cm
Soil Colour		Grey		
Soil Texture		Clay		Clay
Nitrate Nitrogen	mg/kg	11	5	3
Ammonium Nitrogen	mg/kg	11	10	6
Total Nitrate N	kg/ha			45.5
Phosphorus (Colwell)	mg/kg	69		
Phosphorus Buffer Index (PBI-Col)		98		
Available Potassium	mg/kg	639		
Sulphur (KCl40)	mg/kg	14.8		
Organic Carbon (W&B)	%	1.45		
pH (1:5 Water)		6.4		
pH (1:5 CaCl2)		7.7		
Electrical Conductivity (1:5 water)	dS/m	0.140		
Elec. Cond. (Sat. Ext.)	dS/m	0.896		
Chloride	mg/kg			
Calcium (Amm-acet.)	cmol(+)/kg	14.66		
Potassium (Amm-acet.)	cmol(+)/kg	1.77		
Magnesium (Amm-acet.)	cmol(+)/kg	10.90		
Sodium (Amm-acet.)	cmol(+)/kg	1.48		
Aluminium (KCl)	cmol(+)/kg	0.06		
Cation Exch. Cap.	cmol(+)/kg	28.87		
Calcium/Magnesium Ratio		1.34		
Sodium % of Cations (ESP)	%	5.1		
Aluminium Saturation	%	0.2		
Copper (DTPA)	mg/kg	3.02		
Iron (DTPA)	mg/kg	48.4		
Manganese (DTPA)	mg/kg	17.72		
Zinc (DTPA)	mg/kg	0.64		
Boron (Hot CaCl2)	mg/kg	2.95		

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Key learnings from the Optimising Irrigated Grains Economics Team

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Impacts of climate change on flowering times and optimal flowering windows

Optimal flowering times are affected by the risk of frost (if flowering happens too early) and the risk of heat stress (if flowering occurs too late). Tables 1 and 2 show optimal flowering windows for durum wheat across southern Australia range from early-September to early-November in dryland conditions and late-September to mid-November under irrigation, depending on the region.

Over the long-term, we showed that early sowing dates for durum wheat produce higher yields than late sowing. The optimal sowing dates vary across southern Australia:

- In New South Wales and Victoria, optimal sowing ranges from early-May to mid-June for rainfed durum and from late-May to early-July for irrigated crops.
- In South Australia, optimal sowing varies from mid-May to early-June for rainfed durum wheat and from mid-June to early-July for the irrigated.
- In Tasmania, optimal sowing times for rainfed durum wheat starts in early-June to early-July, while for irrigated sowing ranges from late-June to early-July.

Modelling of irrigated durum wheat in comparison to dryland durum over a 110-year simulation showed improved long-term average yields of well irrigated durum wheat compared with dryland crops. For regions in southern Australia, irrigation improved durum yield by: -

- 146% in Griffith, 57% in Finley and 58% in Coleambally regions of New South Wales.
- 83% in Kerang and 90% in Yarrawonga regions of Victoria.
- 62% in Keith and 26% Frances regions of South Australia.
- 27% in Hagley, Tasmania.

Using the recorded weather data for the last 110 years, we saw a shortening of crop lifecycles resulting in earlier flowering of winter crops. We saw that irrigation extended the duration of crop lifecycles (growing season) in comparison to dryland crops by reducing water stress. The model demonstrated the impact of climate change has already had, when all other factors (cultivar, technology, agronomy etc) are kept constant over the last 110 years: long-term average yield of durum wheat would decline by 11% for irrigated crops and by 29% for rainfed crops. We have not seen these declines in yield manifest in paddocks as a result of improved breeding, efficiencies in inputs and farming practice changes mitigating climate impacts over 110 year timeframe. This indicates that adoption of new practices, genotypes and technologies has outweighed the nagative impacts climate change has already had on yields of crops in Australia.

Read the full scientific paper here: https://iopscience.iop.org/article/10.1088/1748-9326/ac5a66

Table 1 Optimal sowing and flowering periods for dryland durum wheat for regions across the southern Australia cropping zone.

State	Region	Optimal range of flowering		Optimal range of sowing	
		Start	End	Earliest	Latest
New South Wales	Griffith	7-Sep	21-Sep	3-May	17-May
	Finley	16-Sep	3-Oct	10-May	24-May
	Coleambally	27-Sep	7-Oct	17-May	14-Jun
Victoria	Kerang	23-Sep	8-Oct	3-May	24-May
	Yarrawonga	8-Oct	22-Oct	24-May	21-Jun
South Australia	Keith	18-Oct	30-Oct	17-May	7-Jun
	Frances	17-Oct	31-Oct	7-Jun	5-Jul
Tasmania	Hagley	1-Nov	11-Nov	7-Jun	5-Jul

Table 2 Optimal sowing and flowering periods for irrigated durum wheat for regions across the southern Australia cropping zone.

State	Region	Optimal range of flowering		Optimal range of sowing	
		Start	End	Earliest	Latest
New South Wales	Griffith	26-Sep	11-Oct	24-May	21-Jun
	Finley	11-Oct	26-Oct	31-May	5-Jul
	Coleambally	19-Oct	30-Oct	7-Jun	5-Jul
Victoria	Kerang	3-Oct	23-Oct	24-May	5-Jul
	Yarrawonga	25-Oct	4-Nov	7-Jun	5-Jul
South Australia	Keith	16-Oct	23-Oct	21-Jun	5-Jul
	Frances	21-Oct	31-Oct	14-Jun	5-Jul
Tasmania	Hagley	6-Nov	17-Nov	21-Jun	5-Jul

The optimising irrigated grains projects are part of the GRDC investment UOT1906-002RTX: Optimising farm scale returns from irrigated grains: maximising dollar return per megalitre of water.

Agronomic and irrigation infrastructure adaptations for improving farm profit

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What difference does changing irrigation infrastructure and cropping systems have on whole-farm profitability and risk? On a case study farm near Finley in NSW we saw a profit gap of ~$10 M for the irrigated farm area over 30 years between the least profitable and most profitable scenario. The most profitable scenario was whole-farm intensification (described further below).

To understand the trade-offs between risk and reward in the face of high climate variability and market volatility, we conducted a 30-year modelling study using real climate data and market prices for a farm near Finley, NSW. We tested 16 whole-farm adaption scenarios by changing irrigation method (surface by gravity or Flood, Pipe & Riser, Pivot and Drip systems) and agronomic system (Current practice; Diversified, which increased diversity of crops in the system; Intensified, which increased crops and inputs in the existing system including summer crops, irrigation and nitrogen fertilisers and Simplified, which reduced crops and inputs used).

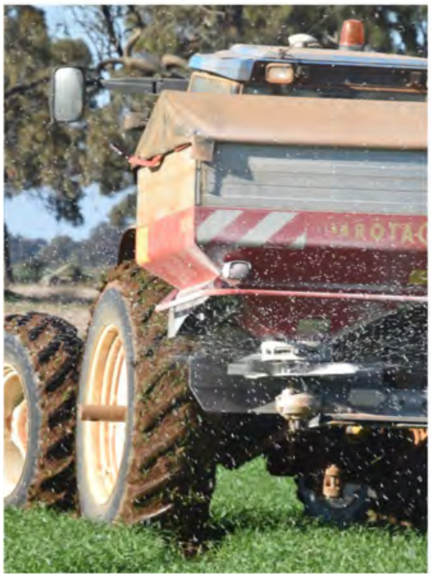
We found that whole-farm agronomic changes had greater relative influence on financial performance than irrigation infrastructure. Relative to the Baseline (the current system implemented on the case study farm with flood-irrigated wheat-canola) significant long-term profit gain opportunities were identified for the Intensified (+273%) and Diversified (+80%) scenarios. Staying with the current baseline system for the next 30 years or moving to the Simplified scenario significantly reduced profitability (-16% and -37%, respectively).

On a per ML basis, the Diversified and Simplified crop rotations were more profitable (e.g., up to $160/ML for Diversified systems with Drip irrigation). However, on a per hectare basis, Intensified systems were more profitable (e.g., up to $491/ha for Intensified systems with Pipe & Riser irrigation infrastructure), thus more suited to farmers targeting area-based rather than water-based returns.

Diversified scenarios with surface (flood, pipe & riser and pivot irrigation) and all Simplified scenarios reduced downside risk relative to the current system. For example risk reduced for Diversified scenarios from 1% (Diversified system with Pivot irrigation) to 19% (Diversified system with Flood irrigation). Drip irrigation increased risk by 12%. Taking infrastructure investment into account, the investment rate of return was lowest for Current farm system with Pivot irrigation (4.9% return on investment, 14 years to pay it back), whereas the Intensified system with Flood irrigation had the highest rate of return (27%) and the lowest payback period (3 years). In terms of benefit: cost ratio, for each $1 of cost in the adaptation, the expected dollar benefits generated were up to $1.63 for Intensified system with Pipe & Riser irrigation.

This study highlights the complexity of decisions on infrastructure and agronomic systems as a result of the interactions between potential risks and rewards. The study demonstrates that Intensified systems are more profitable per hectare, while Diversified systems are more profitable per unit irrigation water applied.

Read the full scientific paper here: https://www.sciencedirect.com/science/article/pii/S0378377422002876



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