Optimising high rainfall zone cropping for profit in the Western and Southern Regions (DAW1903-008RMX)

A Grains Research & Development Corporation (GRDC) investment

2021 FINAL CEREAL RESULTS

Research hosted by:

WA CROP TECHNOLOGY CENTRE (ESPERANCE)

WA CROP TECHNOLOGY CENTRE (ALBANY)

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Provisional Report – 25th February 2022

Contents

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2021 WA Crop Technology Centre (Esperance)

Sown: 16 April 2021, (Trials 1 and 2 sown 15 May, Trial 6 sown 14 May)
Harvested: 11 November (barley), 15 December (wheat)
Rotation position: 1st Cereal after Canola
Soil type & Management: Sand Plain duplex, Sand over Clay.

Notes on Yields and Statistics:

Yield figures followed by the same letter are not considered to be statistically different (p=0.05), for example a yield of 7.45bc is considered statistically different to 6.6d but not to a yield of 7.7abc.

Plot yields: To compensate for edge effect a full row width (22.5cm) has been added to either side of the plot area (equal to plot centre to plot centre measurement in this case). All results have been analysed through ARM software or GenStat.

Trial 1. Wheat nutrition Management on ameliorated soils

Trial Code: FAR WAE W21-01

cv. Catapult (spring wheat) sown 15 May

Objectives: To examine the influence of different soil amelioration and establishment methods on the performance of a mid-May sown spring wheat.

Key Messages:

- Spatial analysis of the yield results revealed a significant interaction between amelioration/crop establishment method and subsequent nutrition on a deep sandplain duplex.
- Deep ripping to a depth of 800mm in autumn 2021 (following deep ripping to 600mm in 2019) significantly increased yield (0.47t/ha) under standard nutrition (farm practice) and increased N input strategy.
- There was no significant difference in yield due to establishment if PKS was increased as well as N input.
- Spade seeding following deep ripping to a depth of 800mm conferred a further significant (p=0.009) yield advantage of 0.69t/ha over tine DBS seeding wheat into the same ameliorated soil under standard nutrition.
- When the nutritional status of the crop was increased there was no significant benefit to spade seeding in this trial.
- Increased yield with spade seeding under standard nutrition was associated with more even establishment and greater dry matter production (2.5t/ha) at flowering (GS65).
- Costed at $80/ha deep ripping has given just under a $2 return for each $ spent over the last two seasons, assuming the benefit observed was for a single season.

The whole trial area (deep sandplain duplex) was deep ripped commercially to a depth of 600mm in autumn 2019. On 17 March 2021 the trial area was marked out based on three treatments replicated four times i) deep ripped to 800mm – tine DBS seeded on 15th May, ii) deep ripped to 800mm - spade seeded 15th May and iii) non-ameliorated – tine DBS sown 15th May (i.e. deep ripped in 2019 but not 2021). Superimposed on these main plots (18m x 50m) were smaller nutrition sub plots (2.5m x 18m) where three nutrition treatments were evaluated: i) standard nutrition (farm practice) (see Table 7), ii) standard plus extra NPKS (N: 40kg P: 5.6kg, K: 23.7kg, S: 42kg/ha) and iii) standard plus extra N (40kg N/ha). Both seeding techniques (tine DBS and spade seeding) were completed on the same day, sown into good moisture.

Influence of soil amelioration, method of establishment and nutrition on dry matter production, grain yield and quality

There was a significant interaction (p=0.003) between amelioration/establishment method and nutrition applied (Table 1). Under standard nutrition (farm practice) deep ripping and superimposed spade seeding significantly increased yield, however as nutrition was increased the benefit of the ripping and spade seeding was reduced, indicating that these establishment techniques were implicated in better access to soil nutrients at the levels of nutrition in the farm standard treatment.

Table 1. Influence of amelioration/establishment and nutrition on Yield (t/ha).

	Nutrition superimposed establishment method					
	Standard		Standard + N		Standard + NPKS	
Amelioration & Establishment						
2019 Ripped, Tine DBS	3.30	d	3.66	cd	4.72	a
2019 + 2021 Ripped (800mm), Tine DBS	3.77	c	4.31	b	4.59	a
2019 + 2021 Ripped (800mm), Spade Seeder	4.46	a	4.62	ab	4.46	a

LSD – Rip x nutrient interaction 0.39t/ha
P value – 0.003

When nutrition treatments were meaned there was evidence that the spade seeded blocks produced significantly more dry matter at the mid flowering stage GS65 (see Table 2). When soil amelioration/establishment treatments were meaned there was evidence that the additional NPKS treatment had significantly increased grain yield over the standard nutrition (see Table 3), but there was no statistical interaction between soil amelioration/establishment and nutrition (p=0.09).

Table 2. Influence of soil management on dry matter at the start of head emergence (GS51) (standard nutrition only) and mid flowering (GS65), Yield (t/ha) (mean of nutrition treatments).

	Nutrition		**GS65 DM**		**Yield**
	Standard trt. only		Mean of nutrition trt.		t/ha
2019 Ripped, Tine DBS	4.3	b	8.6	b	3.89
2019 + 2020 Ripped, Tine DBS	4.0	b	10.7	b	4.22
2019 + 2020 Ripped, Spade Seeder	5.8	a	13.2	a	4.76
Mean	4.7		10.83		---
LSD	1.1		2.2		---
P Value	0.01		0.007		---

Table 3. Influence of nutrition on dry matter at mid flowering (GS65), Yield (t/ha, %) (mean of amelioration).

	GS65 Dry matter		**Yield**	**% Mean Yield**
	t/ha		t/ha	%
Standard nutrition 164kg N/ha	9.90	b	3.84	91
Standard nutrition plus extra NPKS: 204kg N/ha + PKS (P: 5.6kg, K: 23.7kg, S: 42kg/ha)	12.02	a	4.59	109
Standard plus extra N only 204kg N/ha	10.59	ab	4.20	100
Mean	11.7		---	---
LSD	1.43		---	---
P Value	0.019		---	---

Grain protein was significantly increased when additional NPKS input was added (mean of amelioration treatments) but test weight and screenings were unaffected by treatment (Table 4).

Table 4. Influence of soil management (amelioration) and nutrition on grain yield (t/ha) and quality (%, kg/hL).

	Yield		Protein		Test weight		Screenings	
	t/ha		%		Kg/hL		%	
2019 Ripped, Tine DBS								
Standard nutrition	3.30	d	10.2	-	78.2	-	1.0	-
Standard plus 25% extra NPKS	4.72	b	10.7	-	76.3	-	1.2	-
Standard plus 25% extra N only	3.66	cd	10.2	-	75.9	-	1.4	-
Mean	3.89		10.4		76.8		1.2	
2019 + 2020 Ripped, Tine DBS								
Standard nutrition	3.77	c	10.1	-	77.8	-	1.1	-
Standard plus 25% extra NPKS	4.59	a	10.6	-	74.9	-	1.2	-
Standard plus 25% extra N only	4.31	b	10.1	-	74.2	-	1.4	-
Mean	4.22		10.3		75.6		1.2	
2019 + 2020 Ripped, Spade Seeder								
Standard nutrition	4.46	b	10.0	-	77.2	-	1.7	-
Standard plus 25% extra NPKS	4.46	a	11.1	-	74.2	-	2.0	-
Standard plus 25% extra N only	4.62	ab	10.5	-	76.3	-	1.7	-
Mean	4.51		10.5		75.9		1.8	
Mean	4.21		10.4		76.1		1.4	
LSD	0.39		0.58		4.30		0.56	
P Value	0.003		0.388		0.826		0.581	

In terms of gross margin (with an assumed grade of APW cv Catapult) spade seeding increased margins under the standard nutrition package, however as nutritional inputs were increased, the economic benefits of amelioration and spade seeding dissipated (Table 5). The implication of these results will be further evaluated in 2022.

Table 5. Influence of amelioration/establishment and nutrition on gross margin ($/ha).

	Nutrition superimposed establishment method		
	Standard	Standard + N	Standard + NPKS
Amelioration & Establishment			
2019 Ripped, Tine DBS	622	748	1,119
2019 + 2021 Ripped (800mm), Tine DBS	696	885	983
2019 + 2021 Ripped (800mm), Spade Seeder	810	866	810

Assumed grain price all made APW - $350/t, Deep ripping costed at $80/ha, Spade seeding at $140/ha & Tine DBS seeding at $43/ha

Table 6. Details of trial management (kg, g, L, ml/ha).

Sowing date:	**15 May**
Sowing rate:	200 seeds/m2
Sowing Fertiliser:	130kg/ha Summit Vigour Compound
	(13 Kg N; 15.6 Kg P; 15.6 Kg K; 6.5 Kg S)

Nutrition:		
Standard N applied: (10 June, 11 Jul, 18 August)	164 kg N (not including sowing N)	
Standard N + PKS applied:	204 kg N; 5.6kg P; 23.7kg K; 42 kg S	
Standard N + extra N applied	204 Kg N	
PGR:	---	
Fungicide:	15 May	Flutriafol 500 – 200 mL
	22 September	Elatus Ace – 500 mL
	7 October	Amistar Xtra – 400 mL
Herbicide:		
Summer knockdown:	16 March	LV Ester 680 – 600 mL
		Glyphosate 450 – 2.5 L
		Metsulfuron 600 WG – 4 g
		Ammonium Sulphate – 1 %
		Li700 Surfactant – 120 mL
Pre sowing:	11 May	Glyphosate 540 – 1.8 L
		2,4-D Ester 680 – 500 mL
		Ammonium Sulphate – 2 %
		Li700 Surfactant – 0.2 %
IBS/PSPE:	14 May	Overwatch – 1.2 L
		Paraquat 360 – 1 L
In crop:	10 August	Tigrex – 750 mL
		Lontrel 750 SG – 40 g
	20 September	Sharpen – 34 g
		Hasten 1 %

All other inputs of insecticides and herbicides were standard across the trial.

Trial 2. Wheat disease management on ameliorated soils

Trial Code: FAR WAE W21-02

cv. Catapult (Spring wheat)

Objectives: To examine the influence of different soil amelioration techniques and establishment methods on the performance of an early-May sown spring wheat with different levels of fungicide input.

Key Messages:

- Disease pressure was low in this field trial and there were no obvious differences in foliar disease observed.
- There was no interaction between amelioration/establishment and disease management, with all fungicide treatments giving small differences.
- Amelioration/establishment strategy (meaned over fungicide treatments) had a significant effect on yield with spade seeding increasing yield following deep ripping compared to tine DBS seeding.
- Both ripping and spade seeding increased grain yield relative to crops grown following tine DBS seeding on ground that had not been ameliorated.

- Margin increases paid for amelioration and establishment costs but in general increased expenditure on fungicides was more difficult to justify.
- Note that in this trial there was no additional nutrition applied to the blocks over and above the farm standard.

The trial was laid out in an identical way to Trial 1 but in this case instead of nutrition, four different disease management sub plots were superimposed on the three amelioration/establishment sub plots. The fungicide strategies were based on three fungicide timings (GS31, GS39 and GS59) (Table 1). Nutrition in this trial was standard farm practice.

Table 1. Disease management treatments (mL/ha).

	GS31 Fungicide	GS39 Fungicide	GS59 Head wash
Untreated			
Standard Disease Management	Prosaro – 300 mL	Tilt – 500 mL	---
High Input – GS39 onwards	Aviator Xpro – 416 mL	Tilt – 500 mL	---
High Input – GS31	Aviator Xpro – 416 mL	Radial – 840 mL	Prosaro – 300 mL

i) Influence of amelioration/establishment and fungicide strategy on grain yield (t/ha)

There was no interaction between amelioration/establishment method and disease management in this trial (Table 2). Deep ripping gave a 0.76t/ha yield improvement on non-ameliorated ground with spade seeding increasing yield by a further 0.7t/ha over tine DBS when it was superimposed on deep ripped soil. The land that was deep ripped and spade seeded combined gave a 1.46t/ha benefit over the ground that was un ripped and DBS tine seeded.

Table 2. Influence of soil amelioration/establishment and disease management strategy on grain yield (t/ha).

	Fungicide Strategy								
	Untreated		Standard 2F		High input 2F		High input 3F		**Mean**
Establishment	t/ha		t/ha		t/ha		t/ha		
2019 Ripped, Tine DBS	3.62	-	3.50	-	3.66	-	3.64	-	**3.60 c**
2019 + 2021 Rip, Tine DBS	4.49	-	3.95	-	4.58	-	4.42	-	**4.36 b**
2019 + 2021 Rip, Spade Seeder	4.78	-	4.94	-	5.27	-	5.25	-	**5.06 a**
Mean	**4.29 bc**		**4.13 c**		**4.50 a**		**4.43 ab**		
LSD – Establishment	0.2								
P Value	<0.001								
LSD – Fungicide	0.2								
P Value	0.002								
LSD – Est x Fungicide interaction	0.34								
P Value	ns								

At an assumed grain price of $350/t (APW) spade speeding produced the highest margins, but none of the additional expenditure on fungicide proved more cost effective than the untreated crop (Table 3).

Table 3. Influence of soil management (amelioration) and disease management strategy (product & application) on net margin after additional input cost of soil management, establishment and fungicide ($/ha).

	Fungicide Strategy				
	Untreated	Standard 2F	High input 2F	High input 3F	Mean
Establishment	$/ha	$/ha	$/ha	$/ha	
2019 Ripped, Tine DBS	793	682	770	738	**746**
2019 + 2021 Rip, Tine DBS	1,069	730	969	931	**925**
2019 + 2021 Rip, Spade Seeder	1,138	1,008	1,114	1,125	**1,096**
Mean	**1,000**	**807**	**951**	**931**	

Deep ripping costed at $80/ha, Spade seeding at $140/ha & Tine DBS seeding at $43/ha
Assumed grain price based on APW at $350/t
Standard fungicide - $28/ha, High input 2F $32/ha, High input 3F $50/ha
Fungicide application cost - $7.50/ha per pass

Table 4. Details of trial management (kg, g, L, ml/ha).

Sowing date:	**15 May**
Sowing rate:	200 seeds/m2
Sowing Fertiliser:	130kg/ha Summit Vigour Compound
	(13 Kg N; 15.6 Kg P; 15.6 Kg K; 6.5 Kg S)
Nutrition:	
10 June (150kg Urea/MOP – 80:20%)	55 Kg N; 15 Kg K; 0.35 Kg S
11 July	46 Kg N
18 August	28 Kg N
Total N (including 13N at sowing)	**142 Kg N**
PGR:	N/A
Fungicide:	As per treatment list

Trial 3. Early sown germplasm (winter vs spring) x management interaction trial

Trial Code: FAR WAE W21-03

Objectives: To assess a comparison of early sown winter and spring wheat germplasm managed under different levels of management (16 April sown).

Key Messages:

- There was no statistical difference in yield between winter and spring wheat sown early in mid-April with the highest yielding winter and spring wheats achieving 6 - 6.50t/ha.
- The earlier development of the spring varieties Rockstar and Denison resulting in flowering in August was unaffected by frost in this trial and produced the highest yields of 6.57t/ha and 6.50t/ha respectively when all management strategies were averaged.

- High Input which incorporated greater N input (223kg N/ha), fungicide and PGR produced significantly higher yields than standard management, which in turn was significantly better than where crops were subject to simulated grazing (mechanical defoliation) prior to stem elongation.
- The superior performance of the high input strategy was linked to higher harvest dry matter and head number.
- Rockstar and Denison crops were later developing (phenology) and significantly higher yielding than Scepter with Denison being slightly longer season than Rockstar at this sowing date.
- High input produced grain proteins that averaged 11.8% which were significantly higher than standard (11.2%) and grazed (10.6%) managements.
- Management had no significant effect on test weights as all test weights were below 76kg/hL.

i) Influence of cultivar and management on yield

Both cultivar and management had significant effects on yield and there was a significant interaction indicating that cultivars performed to the different management approaches (Table 1 & Figure 1).

Table 1. Influence of cultivar on grain yield (t/ha) under different canopy management regimes.

	Canopy Management (Grain Yield t/ha)						
	Standard Input		**"Grazed" Standard***		**High Input**		**Mean**
Cultivar (Type)	t/ha		t/ha		t/ha		t/ha
Illabo (Winter)	5.63	fgh	5.95	efg	6.47	b-e	**6.02**
Rockstar (Spring)	6.24	c-g	6.04	efg	7.44	a	**6.57**
LRP19-14347 (Winter)	6.22	c-g	6.09	efg	6.93	abc	**6.41**
Cutlass (Spring)	5.91	efg	4.98	hi	6.49	b-e	**5.79**
Denison (Spring)	6.36	b-f	6.14	d-g	7.00	ab	**6.50**
RGT Accroc (Winter)	5.67	fgh	5.58	gh	5.78	efg	**5.67**
Scepter (Spring)	5.02	hi	4.56	i	6.85	a-d	**5.47**
Mean	**5.86**	**b**	**5.62**	**b**	**6.70**	**a**	
LSD Cultivar p = 0.05 b		0.43		P Value	0.026		
LSD Management p = 0.05 a		0.28		P Value	<0.001		
LSD Cultivar x Management p = 0.05		0.74		P Value	<0.001		

"Grazed standard" – simulated grazing using mechanical defoliation

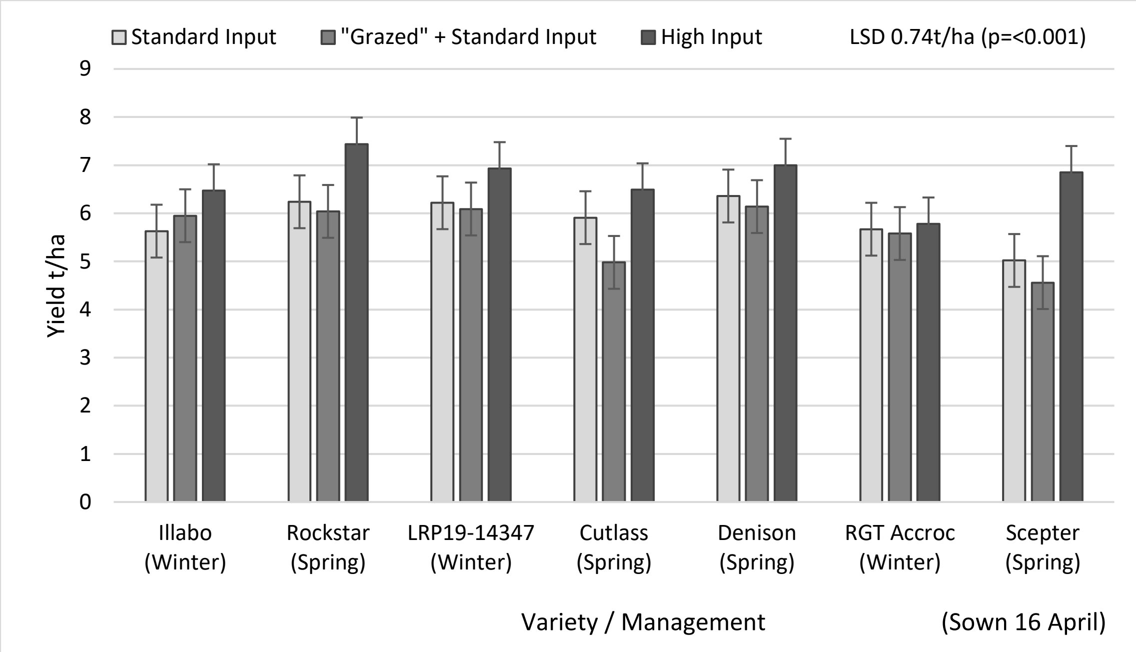

Figure 1. Influence of management and cultivar on grain yield (t/ha).
Note: Interaction between management and cultivar was not statistically significant, signifying that all cultivars responded similarly to the three management strategies

Influence of cultivar and management on harvest index and grain quality

Denison's yield performance was backed up with significantly higher protein and the highest harvest index in the trial (Table 2).

Table 2. Influence of cultivar on harvest index (%) and grain quality (%, kg/hL) (mean of three management strategies).

	Harvest index	Protein		Test weight		Screenings (<2mm)	
Cultivar (Type)	%	%		Kg/hL		%	
Illabo (Winter)	40	11.3	ab	73.5	-	1.7	cd
Rockstar (Spring)	39	10.7	cd	74.8	-	1.9	bcd
LRP19-14347 (Winter)	41	11.4	ab	75.5	-	1.4	d
Cutlass (Spring)	37	11.1	bc	74	-	2.0	bc
Denison (Spring)	40	11.7	a	75.2	-	2.4	ab
RGT Accroc (Winter)	31	10.5	d	75.8	-	2.5	a
Scepter (Spring)	40	11.7	a	74.3	-	2.4	ab
Mean	38	11.2		74.7		2.0	
LSD	.05	0.45		1.66		0.54	
P Value	0.039	<0.001		0.106		0.006	

Higher nutrition input associated with the high input strategy significantly increased grain protein as well as yield (Table 3).

Table 3. Influence of management level on grain yield (t/ha) and quality (%, kg/hL) (mean of cultivar).

	Yield		Protein		Test weight		Screenings (<2mm)	
	t/ha		%		Kg/hL		%	
Standard Management	5.86	b	11.2	b	74.8	-	1.9	-
Standard Grazed Management	5.62	b	10.6	c	74.5	-	2.2	-
High Input Management	6.70	a	11.8	a	74.9	-	2	-
Mean	5.99		11.2		74.7		2.0	
LSD	0.41		0.29		1.09		0.35	
P Value	0.007		0.009		0.779		0.542	

Influence of cultivar on Phenology

For the Esperance region mid-September is generally regarded as the ideal flowering window for wheat. Mid-April sowing with traditional spring cultivars such as Scepter resulted in flowering dates six weeks in advance of this target window. Phenology assessments in the trial revealed that Rockstar and Denison were later to reach GS30 and flower than Scepter which was the fastest developer in the trial (Table 4).

Table 4. Calendar date that each cultivar reached stem elongation (GS30) and the beginning of flowering (GS61).

Cultivar (type)	Date GS30	Date GS61
Illabo (Winter)	30 July	15 September
Rockstar (Spring)	22 July	5 August
LRP19-14347 (Winter)	22 July	10 September
Denison (Spring)	16 July	24 August
RGT Accroc (Winter)	1 August	14 October
Scepter (Spring)	5 June	1 August

Influence of cultivar and management on canopy structure and dry matter

Longer tillering phases with later developing cultivars were reflected in significantly higher head numbers and final crop maturity dry matters with the longer season winter wheat RGT Accroc (which flowered in mid-October), giving the highest recordings of both parameters (Table 5). Unfortunately, whilst the cultivar had the highest harvest dry matter it had the lowest harvest index (proportion of the biomass converted to grain - data not shown).

Table 5. Influence of cultivar on plants, heads/m2 and dry matter production at maturity (t/ha) under standard management.

	Canopy Structure					
Cultivar (Type)	Plants		Heads		Maturity Dry Matter	
	/m^2		/m^2		t/ha	
Illabo (Winter)	148	-	350	cd	13.9	b
Rockstar (Spring)	123	-	382	bc	15.1	ab
LRP19-14347 (Winter)	136	-	403	b	14.0	b
Cutlass (Spring)	151	-	308	d	13.9	b
Denison (Spring)	150	-	413	b	14.2	b
RGT Accroc (Winter)	124	-	479	a	16.3	a
Scepter (Spring)	169	-	321	d	12.1	c

Mean	143	379	14.2
LSD	36.1	44.4	1.50
P Value	0.155	<0.001	0.016

Note: Plants and Heads/m2 is a subset of data as all treatments were assessed

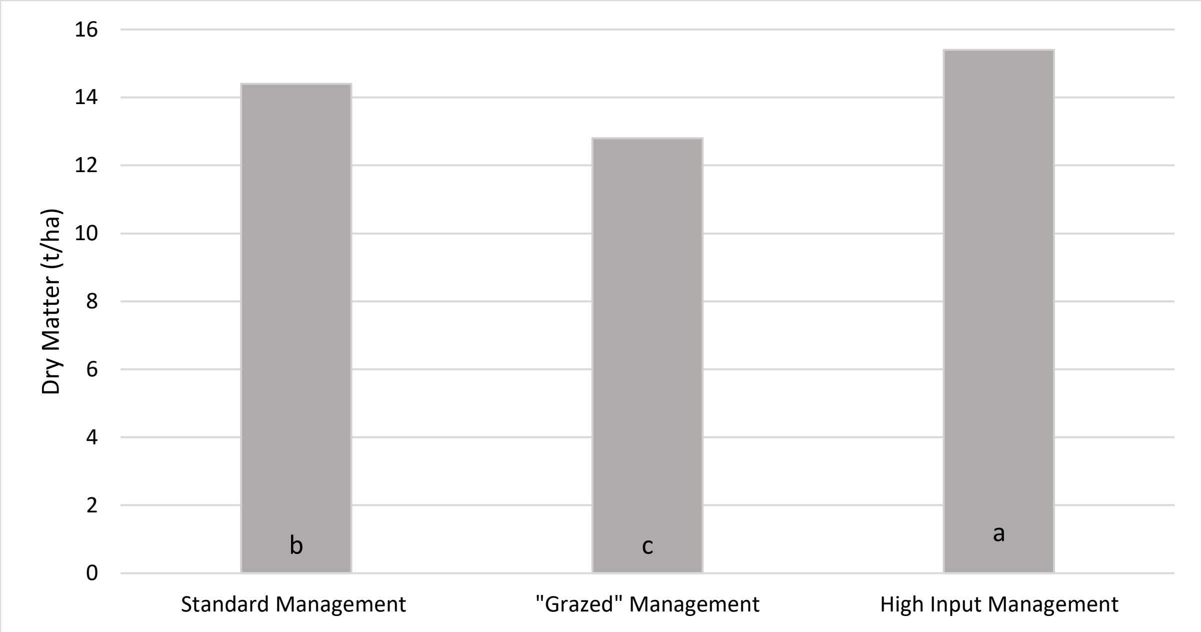

Figure 2. Influence of management level on dry matter production (t/ha) at harvest – mean of seven cultivars (LSD 1.0, P Value 0.019).

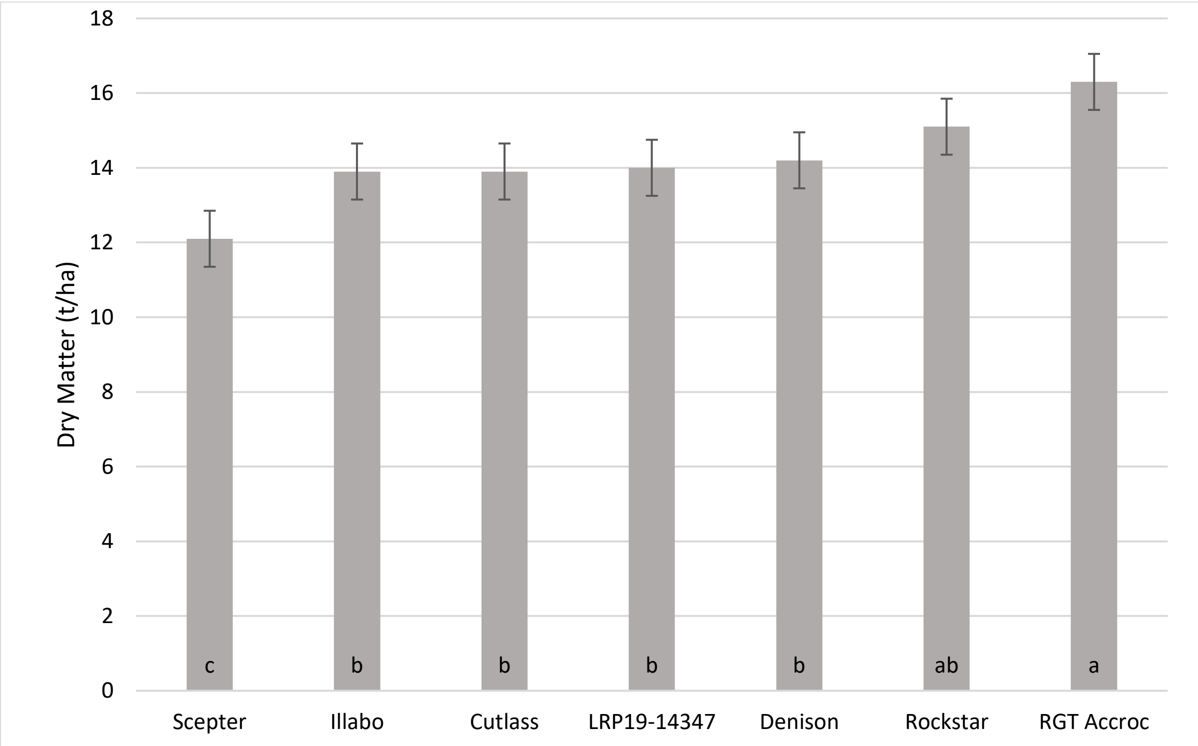

Figure 3. Influence of cultivar on dry matter (t/ha) production – mean of management levels (LSD 1.5, P Value 0.016).

There was a low level of lodging in the trial that had little influence on yield, however the spring variety Denison lodged significantly more than all other cultivars, irrespective of management technique (see Figure. 5).

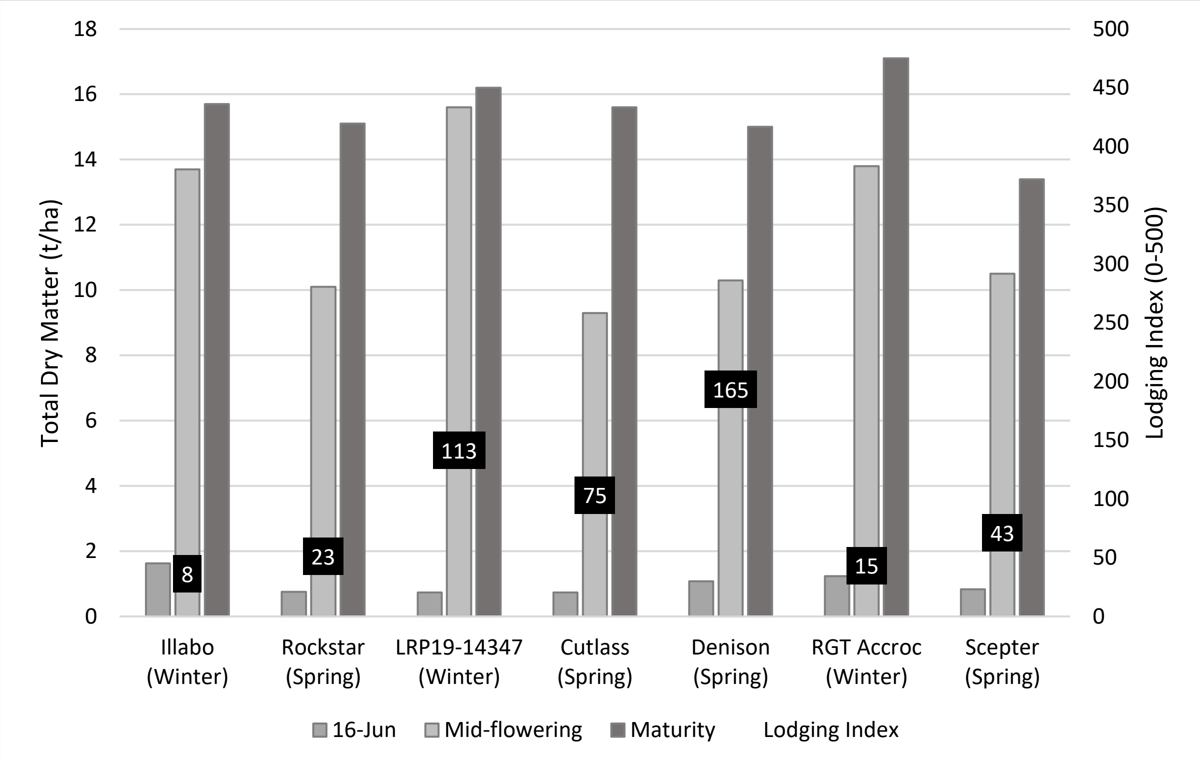

Figure 5. Influence of cultivar on dry matter (t/ha) production at three timings (tillering/stem elongation, mid flower, maturity) and Lodging Index (0-500 scale) at maturity – standard management.

Table 6. Influence of cultivar and management on gross margin ($/ha).

	Canopy Management (Gross Margin $/ha)				
	Standard Input	**"Grazed" Standard***		**High Input**	**Mean**
Cultivar (Type)	$/ha	$/ha		$/ha	$/ha
Illabo (Winter)	1,368	1,886	(316)	1,650	1,585
Rockstar (Spring)	1,581	1,712	(110)	1,990	1,778
LRP19-14347 (Winter)	1,574	1,682	(63)	1,811	1,689
Cutlass (Spring)	1,466	1,294	(63)	1,657	1,505
Denison (Spring)	1,731	1,873	(132)	1,955	1,864
RGT Accroc (Winter)*	1,041	1,224	(118)	1,062	1,123
Scepter (Spring)	1,154	1,243	(160)	1,783	1,393
Mean	**1,416**	**1,559**		**1,701**	

**Red Grained Feed wheat assumed grain price as feed*
Grain priced assumptions APW – $350/t, H2 – $367/t, FED – $290/t
Figure in brackets (Dry Matter value at $.0.27/kg DM included in Gross Margin)

Table 7. Details of the three management levels (kg, g, ml/ha).

Plant pop'n:		200 seeds/m^2 (150 plants/m^2 target)		
		Standard	**"Grazed" Standard**	**High Input**
Grazed:		----	✓	----
Seed treatment:		Vibrance/ Gaucho		
Basal Fertiliser:		130kg/ha Summit Vigour compound		
Nitrogen:	10 June	55 kg N/ha (15K)	55 kg N/ha(15K)	55 kg N/ha (15K)
	18 June	----	----	41 kg N/ha
	7 July	40 kg N/ha	40 kg N/ha	40 kg N/ha
	11 July	46 kg N/ha	46 kg N/ha	50 kg N/ha
	18 August	28 kg N/ha	28 kg N/ha	28 kg N/ha
PGR:	GS31	----	----	200mL Moddus Evo
				1.3L Errex
Fungicide:	GS00	----	----	Systiva
	GS31	150mL Prosaro	150mL Prosaro	300mL Prosaro
	GS39	500mL Opus	500mL Opus	840mL Radial

**Timings of PGRs and fungicides were adjusted to take account of the differences in spring and winter wheat phenology (development).*

Trial 4. Wheat early sown germplasm screening trial – winter and spring (unyielded).

Trial Code: FAR WAE W21-04

Objectives: 20 commercial and coded lines (winter and spring cultivars) were sown 16 April in small plots (5m) (standard nitrogen management but no fungicide or PGR input) to examine their phenology (speed of development), disease susceptibility and standing power. Plots were not taken to yield.

Key Messages:

- Following 16th April sowing, eight cultivars/lines flowered in the "target sweet spot" of mid-September (10-20th September); this included the commercial winter wheat Illabo.
- The majority of winter wheats sourced from Europe e.g. Anapurna and RGT Accroc flowered too late (early – mid October).
- The high yielding cultivars in Trial 3 had flowered in August illustrating that at this site in the absence of frost there were no constraints to yield from flowering so early.
- Given these early flowering spring wheats mature very early out of synchrony with the majority of wheats in the region (potentially harvesting early – mid November) erosion of grain quality at harvest (e.g. Haberg falling number) could be more problematic.

Table 1. Zadoks growth Stages (GS00-99) of each cultivar/breeding line on 5 July, 20 July, 30 August, , 4 October, 21 October and 15 November.

Variety	5 July	20 July	30 Aug	4 Oct	21 Oct	15 Nov
Illabo (winter)	VE	30	41-43	½ grain	71-73	83
Scepter (spring)	33	41-43	73	83-85	87	89
Anapurna (winter)	VE	VE	32	55	65	73
LPB16-0598	VE	VE	39	63	65	79-83
V12167-048	30	37	59	½ grain	77-83	89
Rockstar (spring)	31	39-41	67	77	87	89
Catapult (spring)	32	41-43	69-71	77	87	89
SFR86-092 (winter)	VE	VE	31	51	61-65	73
Valiant CL Plus	31	37	68	77	87	89
21GXE-014 (winter)	30	32	37	69	71	77-79
21GXE-010 (winter)	30	32	37	65	71	83
Sun10871	32	39	68	77-83	87	89
RGT Accroc (winter)	VE	VE	32	55-57	69	75-77
RGT Cesario (winter)	VE	VE	32	51-55	69	75
Denison (spring)	31	37	67	75	87	89
LPB17-5691	31	37	61	77	85	89
LPB16-0582	30	31	37	65	71	79-83
SFR86-085 (winter)	VE	VE	31	39-41	65	71-73
21GXE-012 (winter)	30	32	37	65-69	71-73	83
21GXE-008 (winter)	30	32	37	69	71	83

*VE = Vegetative/Tillering – pre GS30.

Assessment in mid-September revealed six coded lines that were likely to flower in the ideal window of September 10^{th}-20^{th} (Figure 1).

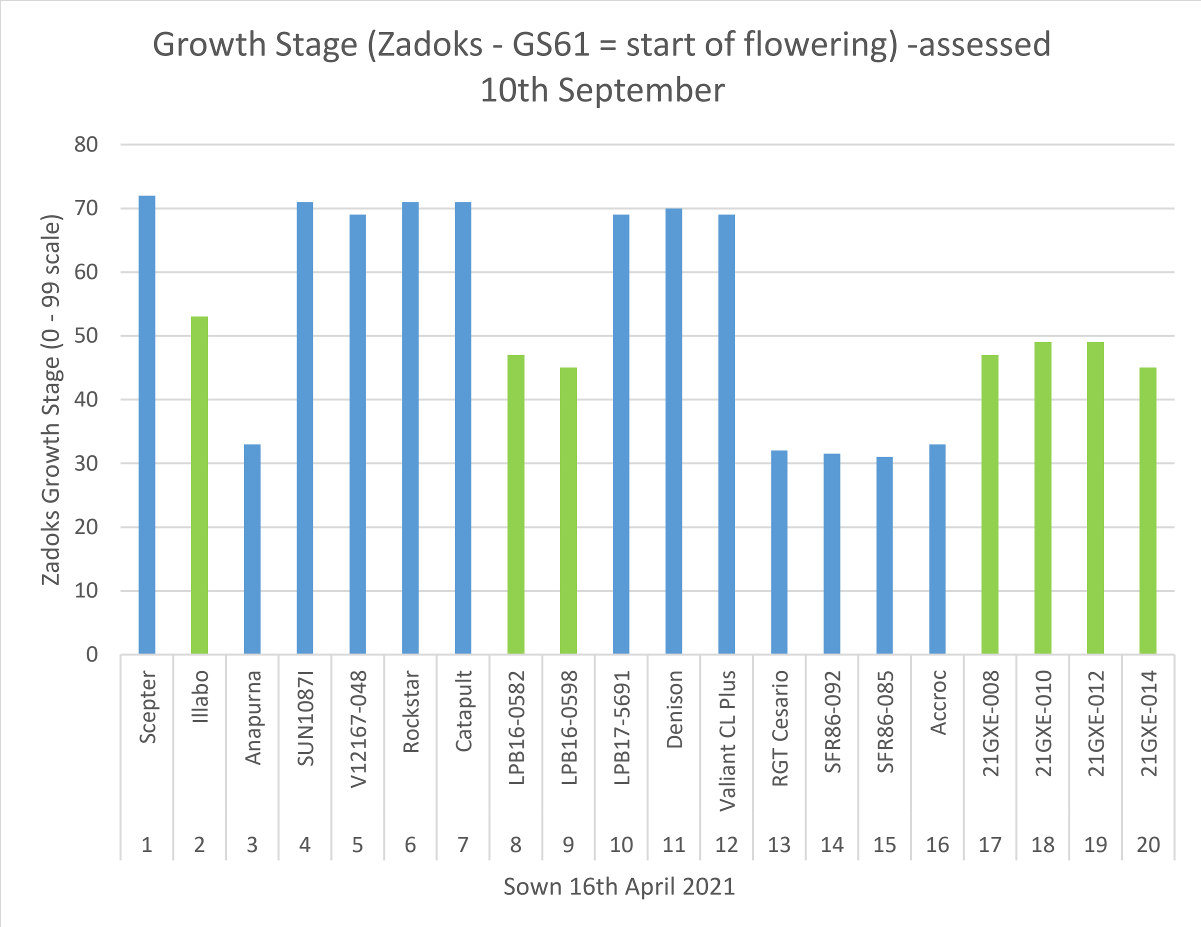

Figure 1. Zadoks growth stages assessed 10th September – *(lines in green those likely to flower in the ideal window).*

Table 2. Details of the management levels (kg, g, mL/ha).

Sowing date:		**16 April**
Seed Rate:		200 Seeds/m^2
Sowing Fertiliser:		130kg/ha Summit Vigour Compound
Seed Treatment:		Nil
Grazing:		Nil
Nitrogen:	10 June	55 kg N/ha (15K)
	11 July	46 kg N/ha
	18 August	28 kg N/ha
PGR:		Nil
Fungicide:		Nil

Trial 5. Early sown germplasm evaluation

Trial Code: FAR WAE W21-05

Objectives: To assess the performance of wheat (winter and spring germplasm) sown in the early sowing window (sown 16th April) under a single high management approach (as described in Trial 3).

Note this is a frost-free environment

Key Messages:

- Rockstar, Denison (spring wheats) and Illabo (winter wheat) significantly outyielded all cultivars tested in this early sowing trial except Catapult.
- In general winter wheat cultivars were associated with higher harvest dry matters, but in the case of the later developing European types such as Anapurna, it resulted in lower harvest indices.
- Rockstar produced significantly lower proteins than Denison, but both achieved test weight over 76kg/hL (a result consistent with Trial 3).
- All screenings were 2.1% or lower with Rockstar producing lower screenings than Denison (0.5 v 1.4%).

Table 1. Influence of cultivar on Yield (t/ha), dry matter at harvest (GS89) (t/ha) and Harvest Index (%).

	Yield		Dry matter		Harvest Index	
Cultivar (Type)	t/ha		t/ha		%	
Scepter (Spring)	6.71	cd	12.6	ef	47%	ab
Illabo (Winter)	7.46	ab	16.5	abc	41%	c
Rockstar (Spring)	7.50	a	15.3	bcd	43%	abc
Magenta (Spring)	6.41	cd	11.5	f	49%	a
Trojan (Spring)	6.48	cd	13.7	de	42%	bc
Catapult (Spring)	7.35	ab	14.4	cde	45%	abc
Denison (Spring)	7.67	a	14.9	bcd	45%	abc
DS Bennett (Winter)	6.64	cd	18.5	a	32%	d
Anapurna (Winter)	6.27	d	16.6	ab	33%	d
Valiant CL Plus (Spring)	6.92	bc	15.6	bcd	40%	c
Mean	6.94		15.0		42%	
LSD	0.57		2.2		0.06	
P Value	<0.001		<0.001		<0.001	
CV	5.62					

Plot yields: To compensate for edge effect a full row width (22.5cm) has been added to either side of the plot area (equal to plot centre to plot centre measurement in this case).

Table 2. Influence of cultivar on grain yield (t/ha, % site mean) and quality (%, kg/hL, grams) (mean of canopy management strategies).

	Yield		% Yield		Protein		Test weight		Screenings (<2mm)	
Cultivar (Type)	t/ha		%		%		Kg/hL		%	
Scepter (Spring)	6.71	cd	97	cd	12.0	a	78.4	bc	0.7	de
Illabo (Winter)	7.46	ab	107	ab	11.1	bc	77.5	cd	0.5	e
Rockstar (Spring)	7.50	a	108	a	10.3	c	78.6	bc	0.9	de
Magenta (Spring)	6.41	cd	92	cd	11.4	ab	76.4	d	2.1	a

Trojan (Spring)	6.48	cd	93	cd	11.4	ab	78.8	b	0.7	e
Catapult (Spring)	7.35	ab	106	ab	11.4	ab	77.8	bc	1.2	cd
Denison (Spring)	7.67	a	111	a	11.2	ab	77.5	cd	1.4	bc
DS Bennett (Winter)	6.64	cd	96	cd	9.1	d	81.0	a	1.6	b
Anapurna (Winter)	6.27	d	90	d	10.7	bc	78.3	bc	1.5	bc
Valiant CL Plus (Spring)	6.92	bc	100	bc	10.7	bc	80.0	a	0.6	e
Mean	6.94		100		10.9		78.4		1.1	
LSD	0.57		8.2		0.8		1.2		0.5	
P Value	<0.001		<0.001		<0.001		<0.001		<0.001	
CV	5.62									

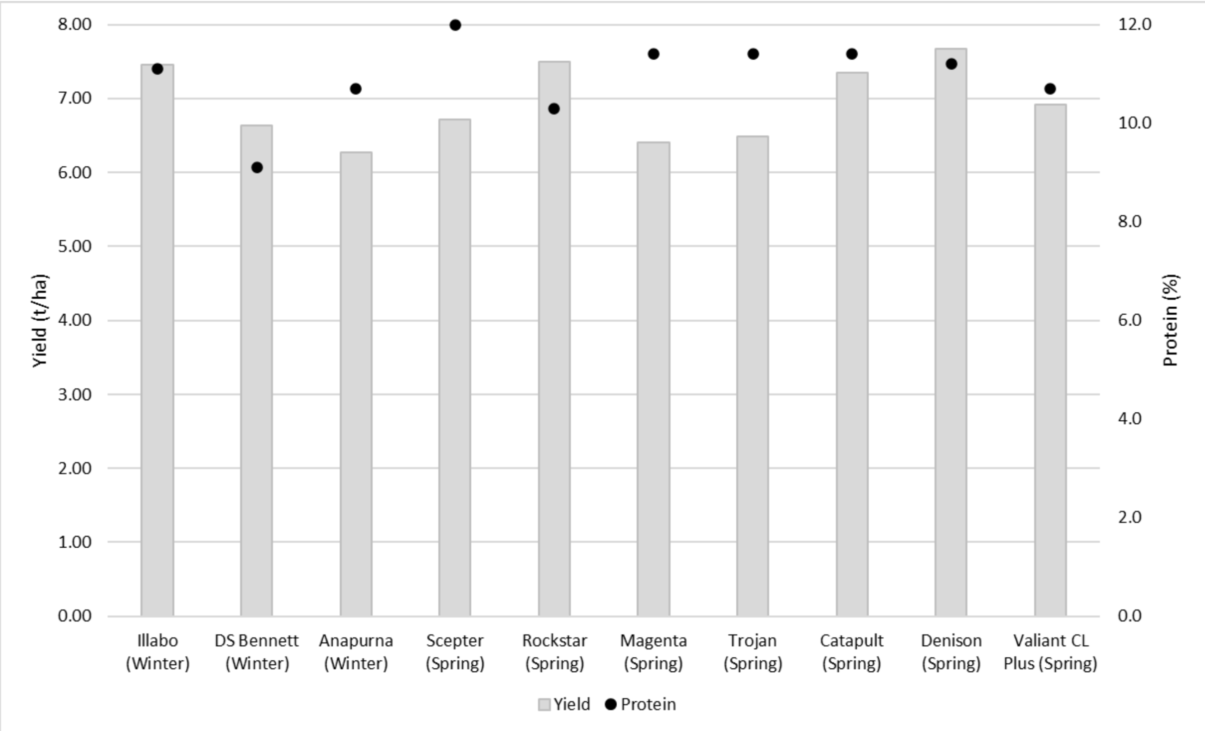

Figure 1. Influence of cultivar on Yield (t/ha) and Protein (%) – sown 16 April.

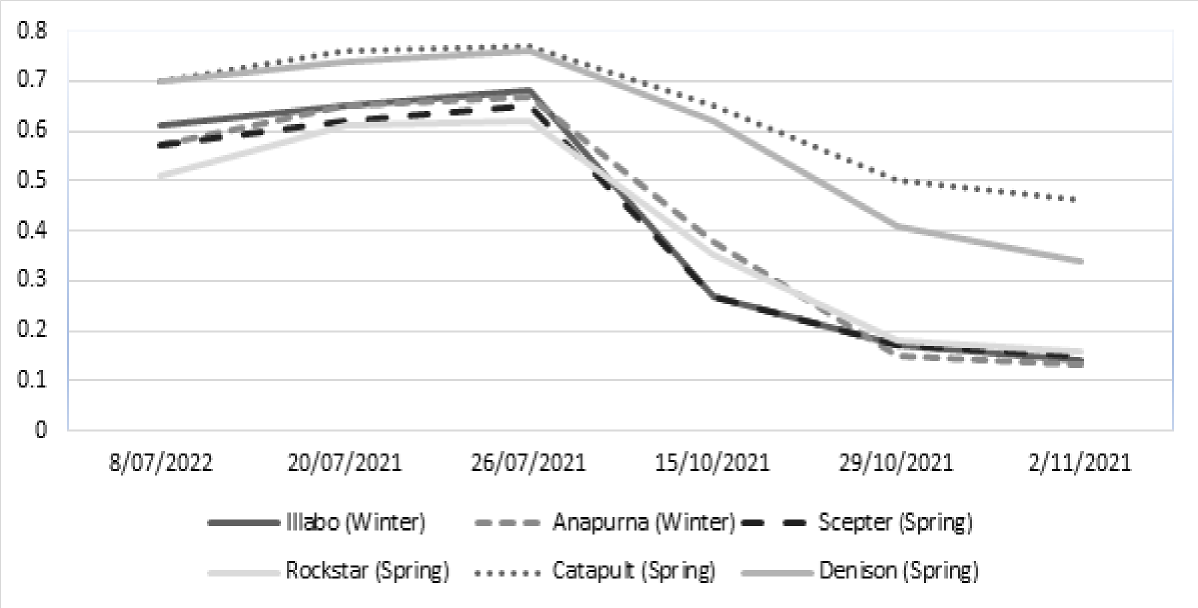

Figure 2. NDVI (scale 0-1) taken at eight points throughout the growing season.

Table 2. Details of the management levels (kg, g, ml/ha).

Sowing date:		**16 April**
Seed Rate:		200 Seeds/m^2
Sowing Fertiliser:		130kg/ha Summit Vigour Compound
Seed Treatment:		Vibrance / Gaucho
Grazing:		Nil
Nitrogen:	10 June	55 kg N/ha (15K)
	7 July	40 kg N/ha
	11 July	50 kg N/ha
	18 August	28 kg N/ha
PGR:	GS31	200mL Moddus Evo + 1.3L Errex
Fungicide:	GS31	300mL Prosaro
	GS39	840mL Radial

Trial 6. Main season wheat germplasm evaluation

Trial Code: FAR WAE W21-06

Objectives: To assess the performance of wheat sown in the traditional mid-May sowing window (sown 14th May).

Key Messages:

- Mid May sowing resulted in all spring wheat cultivars significantly out yielding the milling winter wheat (cv Illabo).
- Though not statistically comparable spring wheat yields were higher than an equivalent trial sown on 16th April (Trial 4) with the spring variety Denison (8.06t/ha) significantly out yielding all other wheats including Rockstar (7.72t/ha).
- In contrast winter wheat cultivars Illabo and Anapurna were significantly lower yielding than the spring wheat germplasm at this May sowing date.
- Flowering in the highest yielding spring wheats in the trial coincided with mid – late September and was 6-8 weeks later than when the same spring cultivars were sown on 16 April.

Influence of cultivar on grain yield and quality

The sowing date of 14 May was too late for the winter wheats to express their inherent yield potential and both Illabo and Anapurna were significantly lower yielding than all spring wheats, except Trojan which also performed poorly (Table 2). The later sowing resulted in Scepter flowering in the mid – late September window as compared to 1 August when it was sown on the same site on 16th April. All of the spring wheats flowered in the mid – late September window. Denison produced significantly higher yields (8.06t/ha) than all other cultivars, although test weight and screenings were significantly inferior to those of Rockstar that produced the second highest yields in the trial (7.5t/ha). Overall in the trial, screenings were low, less than 2%, and test weights were high at 78kg/hL and above.

Table 1. Zadoks growth Stages (GS00-99) of each cultivar on 5 July, 20 July, 24 August, 14 October, 27 October and 15 November.

Variety	5 July	20 July	24 Aug	14 Oct	27 Oct	15 Nov
Scepter (Spring)	VE	30	41	71/73	77	83/85
Illabo (Winter)	VE	VE	31	65	73	77
Anapurna (Winter)	VE	VE	30	55/57	69	71/73
Rockstar (Spring)	VE	VE	33	71/73	77	83
Vixen (Spring)	VE	30	41	77/83	85	89
Trojan (Spring)	VE	30	32	71	81	83
Catapult (Spring)	VE	VE	32/33	69/71	83	85/87
Denison (Spring)	VE	VE	33	71	77	79/83
Sting (Spring)	VE	VE	33/37	71	75	81
Devil (Spring)	VE	VE	33	73	77	83

VE = Vegetative / Tillering prior to GS30

Table 2. Influence of cultivar on grain yield (t/ha) and quality (%, kg/hL, grams) (mean of canopy management strategies).

	Yield		% of Mean Yield		Protein		Test weight		Screenings (<2mm)	
Cultivar (Type)	t/ha		%		%		Kg/hL		%	
Scepter (Spring)	7.29	cd	102	cd	10.8	ab	80.5	ab	1.1	bcd
Illabo (Winter)	6.51	f	91	f	10.4	bc	77.9	d	0.8	cd
Anapurna (Winter)	6.80	ef	95	ef	9.7	e	79.3	bcd	2.5	a
Rockstar (Spring)	7.72	b	108	ab	9.7	e	80.4	ab	1.0	bcd
Vixen (Spring)	7.41	bc	103	bc	11.2	a	80.0	abc	0.8	bcd
Trojan (Spring)	6.75	ef	94	ef	9.8	de	81.6	a	0.6	d
Catapult (Spring)	7.16	cd	100	cd	10.4	bc	80.6	ab	1.1	bc
Denison (Spring)	8.06	a	112	a	10.2	cd	78.6	cd	2.1	a
Sting (Spring)	6.97	de	97	de	10.9	ab	81.0	a	1.3	b
Devil (Spring)	6.97	de	97	de	9.8	de	79.9	abc	1.0	bcd
Mean	7.16		100		10.3		80.0		1.2	
LSD	0.339		5		0.5		1.7		0.5	
P Value	<0.001		<0.001		<0.001		<0.001		<0.001	
CV	3.26									

Table 2. Details of the management levels (kg, g, mL/ha).

Sowing date:		**14 May**
Seed Rate:		200 Seeds/m^2
Sowing Fertiliser:		130kg/ha Summit Vigour Compound
Seed Treatment:		Vibrance / Gaucho
Grazing:		Nil
Nitrogen:	10 June	55 kg N (15K)
	7 July	40 kg N
	11 July	50 kg N
	18 August	28 kg N
PGR:		Nil
Fungicide:	GS31	300mL Prosaro
	GS39	840mL Radial

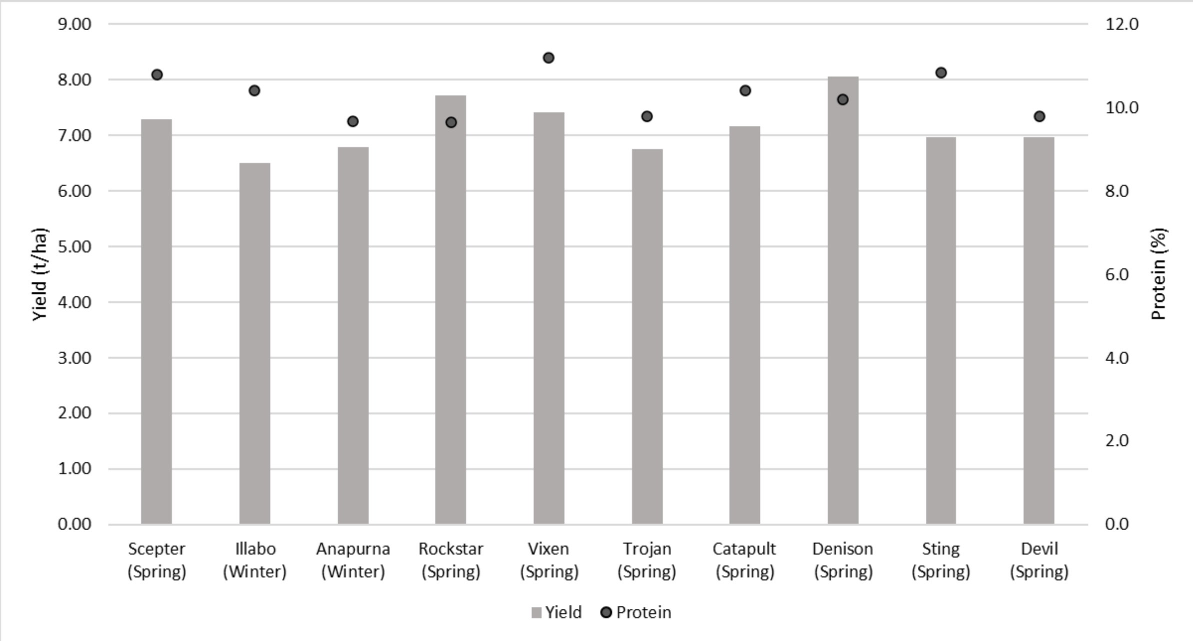

Figure 1. Influence of cultivar on Yield (t/ha) and Protein (%) – sown 14 May.

Trial 7. Early sown barley germplasm (winter vs spring) x management interaction trial

Trial Code: FAR WAE B21-07

Objectives: To assess a comparison of early sown winter and spring barley germplasm under different levels of management (16 April sown).

Key Learnings:

- Aspirational grain yield goals of 8t/ha were achieved with spring barley varieties Laperouse and RGT Planet grown under a higher input management system.
- Treatments that achieved 8t/ha had final dry matters greater than 15t/ha and were achieved with higher input management - more nitrogen and a robust fungicide strategy.
- Management that increased biomass production was more important than the conversion of dry matter to yield (Harvest Index) in this experiment. Standard grazed and un grazed had less final biomass than high input strategies, but with a similar harvest index meaning yields were lower.
- Harvest Index (HI) ranged from 37% to 47%, and management had little impact on HI (results not significant). These HIs are lower than the theoretical maximum of 55% for spring barley. This means there is potential for yields as high as 9 – 10t/ha available at Esperance. The reasons for this will be investigated.
- The winter cultivar Urambie was the equal highest yielding when defoliated/grazed (6.5t/ha), and achieved similar yields under both standard and high inputs.
- The more robust fungicide strategy associated with high input was evident in terms of SFNB control and increased green leaf retention, particularly with RGT Planet and HV8 Nitro.

Influence of cultivar and management on grain yield

There was a significant interaction between cultivar and management meaning that the five cultivars tested responded significantly different to the various management levels imposed in the trial (Table 1 & Figure 1). The winter barley Urambie showed no significant response to the different levels of management input, whilst all four spring barleys showed yield depression from simulated grazing and yield increases from higher input (N, fungicide and PGR).

Table 1. Influence of cultivar on grain yield (t/ha) under different canopy management regimes.

	Canopy Management (Grain Yield t/ha)					
Cultivar (Type)	**Standard Input**		**"Grazed" Standard***		**High Input**	
Laperouse (Spring)	7.16	c	6.31	de	8.00	a
Urambie (Winter)	6.31	de	6.48	d	6.60	d
RGT Planet (Spring)	6.59	d	5.59	f	8.00	a
HV8 Nitro (Spring)	5.80	ef	5.56	f	7.45	bc
Rosalind (Spring)	5.74	f	5.32	f	7.70	abc
Mean	**6.32**		**5.87**		**7.55**	
LSD Cultivar p = 0.05		0.32			**P Value**	<0.001
LSD Management p=0.05		0.60			**P Value**	<0.01
LSD Cultivar x Management P=0.05		0.55			**P Value**	<0.01

Although all spring cultivars gave a significant response to the high input it was apparent that the return on investment was smaller with Laperouse (0.84t/ha) compared to 1.41t/ha with RGT Planet, 1.65t/ha with Nitro and 1.96t/ha with Rosalind. In 2020 a similar positive response to higher input was observed with spring cultivars tested, in that case it was principally associated with higher N input. In 2021 the N levels applied were increased overall to 182kg N/ha in the standard and grazed managements with 223kg N/ha applied in the high input. With proteins at 11.5% or above in the standard management it was observed that disease control (SFNB) and green leaf retention related to disease control was much more influential in the success of the high input strategy (Photos 1-6). Planet and Laperouse suffered a yield penalty from defoliation and may have indicated that these cultivars required more N to achieve their yield potential given the removal of the dry matter.

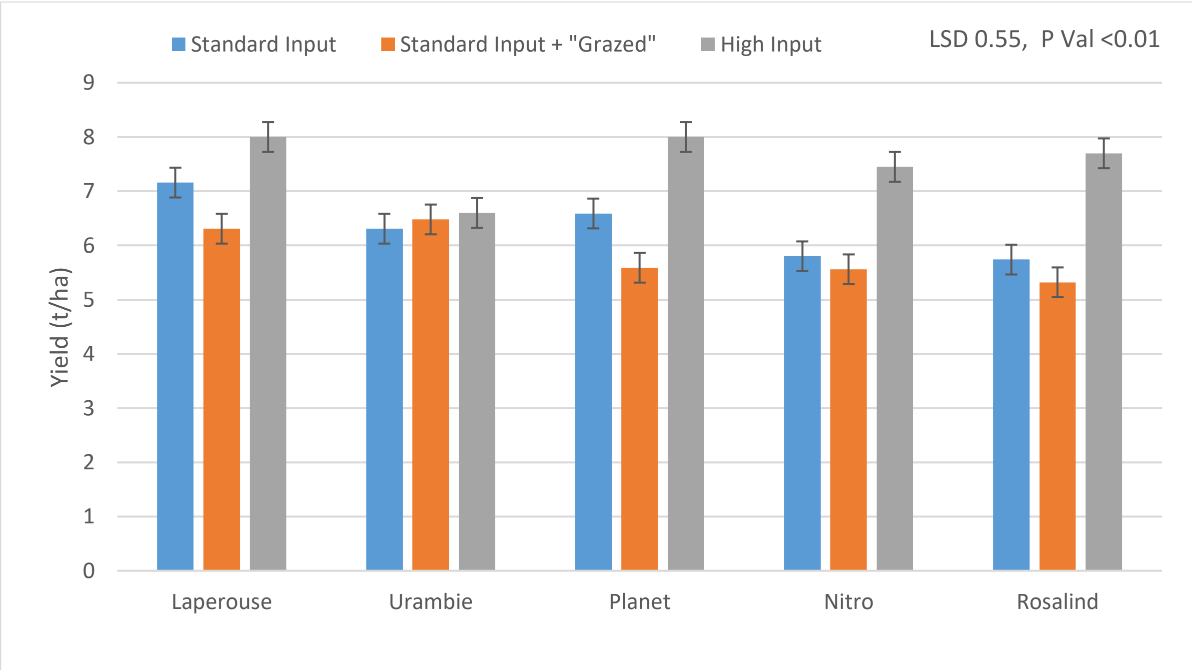

Figure 1. Influence of cultivar and management regime on grain yield (t/ha).

Laperouse – standard input	RGT Planet – standard input	HV8 Nitro – standard input

Laperouse – High input	RGT Planet – High input	HV8 Nitro – High Input

Photos 1-6. Influence of cultivar and management regime on SFNB infection and green leaf retention (10 September).

Table 2. Influence of cultivar on grain protein (%) under different canopy management regimes.

	Canopy Management (protein %)					
	Standard Input		"Grazed" Standard*		High Input	
Cultivar (Type)	%		%		%	
Laperouse (Spring)	11.7	-	10.5	-	12.4	-
Urambie (Winter)	11.2	-	10.8	-	12.5	-
RGT Planet (Spring)	11.5	-	11.5	-	12.6	-
HV8 Nitro (Spring)	12.8	-	11.7	-	13.6	-
Rosalind (Spring)	12.1	-	10.7	-	12.9	-
Mean	**11.9**	**b**	**11.0**	**c**	**12.8**	**a**
LSD Cultivar p = 0.05		0.4			**P Value**	<0.001
LSD Management p=0.05		0.7			**P Value**	0.002
LSD Cultivar x Management P=0.05		0.8			**P Value**	0.283

Table 3. Influence of cultivar on grain yield (t/ha) and quality (%, kg/hL) (mean of canopy management strategies).

	Yield		Protein		Test weight		Screenings (<2.2mm)		Retention (>2.5mm)	
Cultivar (Type)	t/ha		%		Kg/hL		%		%	
Laperouse (Spring)	7.15	a	11.5	b	66.2	a	2.8	c	88.9	a
Urambie (Winter)	6.46	bc	11.5	b	63.1	bc	10.2	a	50.2	d
RGT Planet (Spring)	6.76	b	11.9	b	62.0	c	7.4	b	74.4	bc
HV8 Nitro (Spring)	6.27	c	12.7	a	64.3	b	6.9	b	76.9	b
Rosalind (Spring)	6.25	c	11.9	b	64.3	b	8.4	ab	70.5	c
Mean	6.58		11.9		64.0		7.1		72.2	
LSD	0.32		0.4		1.4		1.9		5.8	
P Value	<0.001		<0.001		<0.001		<0.001		<0.001	
CV	5.8									

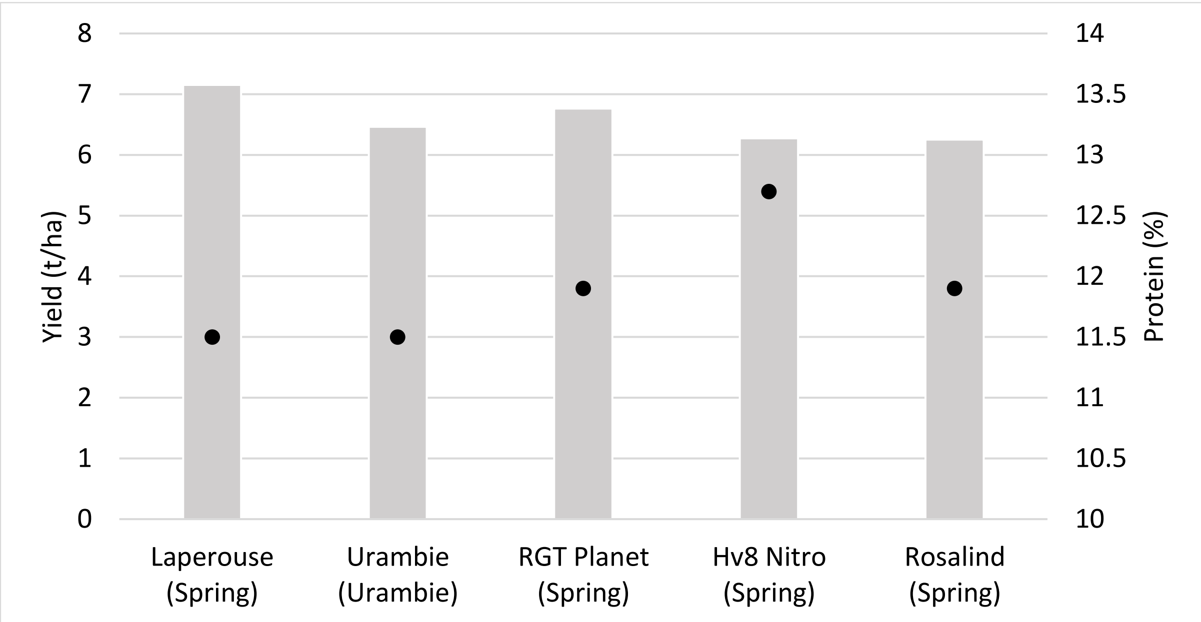

Figure 1. Influence of Cultivar on Grain Yield (t/ha) and Protein (%) (mean of canopy management strategies).

The increased inputs associated with a higher input strategy were cost effective with RGT Planet, HV8 Nitro and Rosalind, but less cost effective with Laperouse. This was mainly associated with disease management as there was no lodging in the trial indicating PGR would have had little impact and all grain proteins for the standard management averaged 11.9%, indicating N input was not sub optimal. Additional N in the high N input approach increased protein to 12.8%

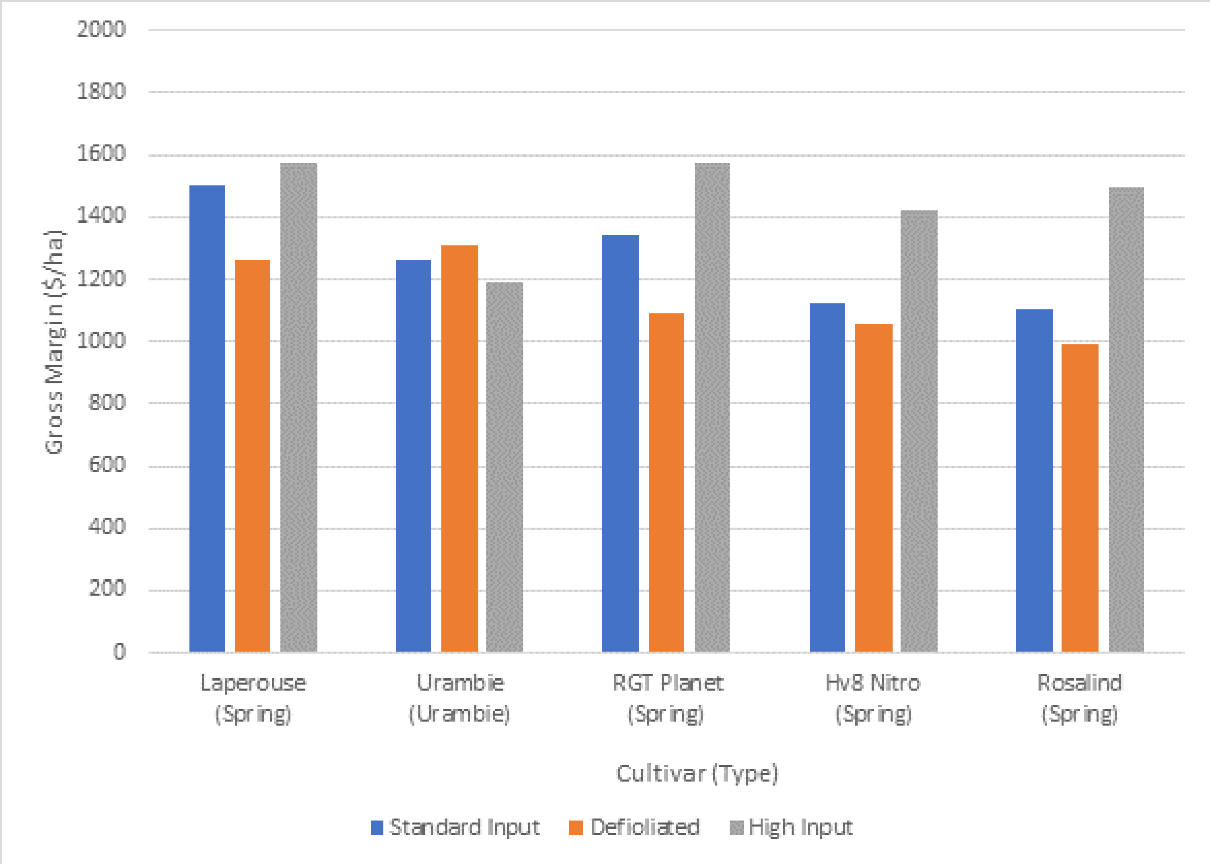

Table 2. Influence of cultivar and different canopy management regimes on gross margin ($/ha).

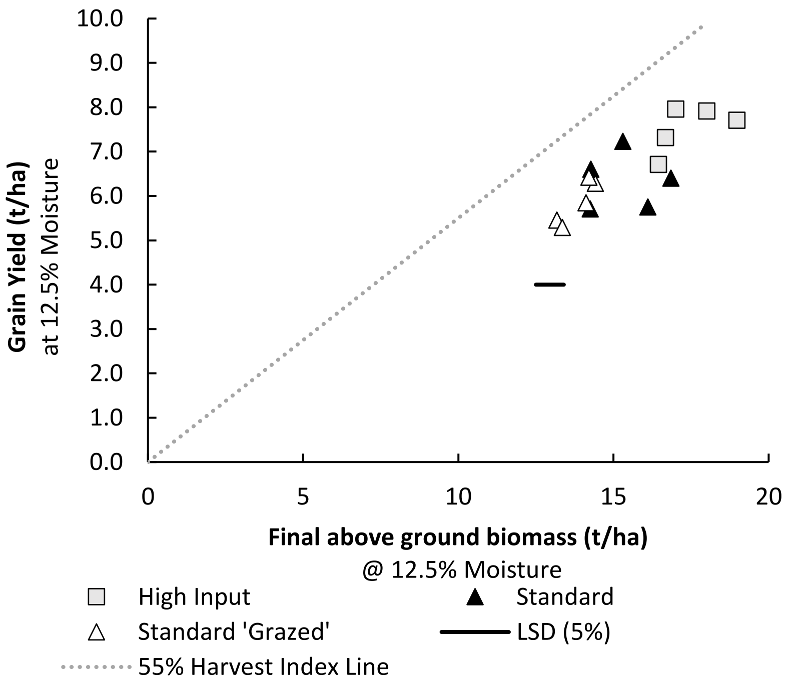

Figure 3. Relationship between final biomass and grain yield (12.5% Moisture) across different management groups at Esperance in 2021. The dashed line represents a theoretical maximum yield for each level of biomass.

Table 2. Details of the three management levels (kg, g, ml/ha).

Plant pop'n:	200 seeds/m^2 (150 plants/m2 target)			
		Standard	**"Grazed" Standard**	**High Input**
Grazed:		----	18 June	----
Basal Fertiliser:	16 April	130kg Summit Vigour	130kg Summit Vigour	130kg Summit Vigour
Nitrogen:	10 June	55 kg N (15K)	55 kg N (15K)	55 kg N (15K)
	18 June	---	---	41 kg N
	7 July	40 kg N	40 kg N	40 kg N
	11 July	46 kg N	46 kg N	46 kg N
	18 August	28 kg N	28 kg N	28 kg N
Total N (13 N at sow)		**182 kg N**	**182 kg N**	**223 kg N**
PGR:	GS31	----	----	Mod. 200mL
Fungicide:	GS00			Systiva
	GS31-32	Prosaro 150ml	Prosaro 150ml	Prosaro 300ml
	GS49	Opus 500ml	Opus 500ml	Radial 840ml

*All other inputs of insecticides and herbicides were standard across the trial. All seed was treated with Rancona Dimension and Gaucho. Mod. – Moddus Evo, *Timings of PGRs and fungicides were adjusted to take account of the differences in spring and winter barley phenology (development). Available Soil Nitrogen, 22 February 71 kg N/ha (0 – 80cm) "Grazed standard" – simulated grazing using mechanical defoliation*

Trial 8. Early sown barley germplasm evaluation

Trial Code: FAR WAE B21-10

Objectives: To assess a comparison of early sown winter and spring barley germplasm managed under different levels of management (16 April sown).

Key Messages

- Mid-April sown barley following canola achieved yields between 7 – 8t/ha under a full fungicide regime and 227kg N/ha.
- In an equivalent wheat trial sown on the same day with the same level of applied N, the highest yielding wheat cultivars Dennison and Rockstar produced similar yields to barley 7.5 – 7.7t/ha.
- Maximus CL and RGT Planet produced the highest grain yields (7.8 and 7.7t/ha respectively), although Maximus CL produced the better grain quality in terms of test weight and screenings.
- Head number did not relate strongly to yield since RGT Planet had significantly less heads/m^2 than Maximus (860 v 1161 heads/m^2), however higher harvest indices were more closely aligned with yield.
- For the N applied RGT Planet had the lowest grain proteins and showed significantly less grain protein than four of the seven cultivars tested.

- The winter cultivar Cassiopee performed poorly with low grain yields and significantly lower harvest indices (30%) than all other cultivars.

Influence of cultivar on grain yield (t/ha)

Of eight cultivars evaluated from a 16 April sowing date under high input, Maximus CL and RGT Planet produced the highest grain yields, although Maximus produced the best grain quality in terms of test weight and screenings. For the same level of N input RGT Planet produced significantly lower protein than Maximus (Table 1). The statistical yield advantage of these two cultivars was not statistically superior to IGB1844, Bottler or AGTB-0244. All spring barleys achieved over 7t/ha in this trial and were significantly better than the winter cultivar Cassiopee which had high final harvest biomass and low grain yields indicative of a poor harvest index (30%) (Table 2). In contrast, Maximus CL had a harvest index of over 50% which is exceptional since the theoretical maximum typically considered is 55%. The robust fungicide programme (Table 3) ensured that only low levels of SFNB were observed so it is unlikely that disease reduced yield potential in this trial.

Table 1. Influence of cultivar on grain yield (t/ha) and quality (%, kg/hL, grams) (mean of canopy management strategies).

	Yield		Protein		Test weight		Screenings (<2mm)		Retention	
Cultivar (Type)	t/ha		%		Kg/hL		%		%	
RGT Planet (spring)	7.70	ab	12.2	e	65.2	cd	2.5	d	87.7	b
Cassiopee (winter)	5.60	d	12.4	b-e	64.0	d	5.6	b	65.5	d
Alestar (spring)	7.36	bc	12.7	abc	63.3	d	4.2	c	81.2	c
Bottler (spring)	7.63	abc	12.4	cde	66.4	bc	2.3	d	89.0	ab
AGTB-0244 (spring)	7.44	abc	12.3	de	61.2	e	9.1	a	69.6	d
Westminster (spring)	7.29	c	12.8	ab	66.7	bc	2.9	d	84.0	bc
Maximus CL (spring)	7.80	a	13.1	a	68.8	a	1.1	e	93.4	a
IGB1844 (spring)	7.62	abc	12.7	bcd	67.4	ab	2.6	d	84.6	bc
Mean	7.30		12.6		65.4		3.8		81.9	
LSD	0.37		0.4		2.1		1.0		5.3	
P Value	<0.001		0.002		<0.001		<0.001		<0.001	
CV	3.46									

There was a poor relationship between absolute head number and final yield since RGT Planet produced similar yields and dry matters to Maximus CL and IGB1844 but with significantly less heads (860 heads/m^2 v 1100+ heads/m^2) (Table 2).

Table 2. Influence of cultivar on Heads/m^2, final biomass at maturity (t/ha), Yield (t/ha) and harvest index (%).

	Heads		Biomass		Yield		Harvest Index	
Cultivar (Type)	/m^2		t/ha		t/ha		%	
RGT Planet	860	c	14.8	-	7.70	ab	0.46	ab
Cassiopee	758	c	16.6	-	5.60	d	0.30	c
Alestar	908	c	14	-	7.36	bc	0.46	ab
Bottler	886	c	14.9	-	7.63	abc	0.45	ab
AGTB-0244	885	c	13.3	-	7.44	abc	0.50	ab
Westminster	782	c	14.1	-	7.29	c	0.45	ab
Maximus CL	1161	b	13.4	-	7.80	a	0.52	a

IGB1844	1433	a	15.5	-	7.62	abc	0.44	b
Mean	959		14.6		7.30		0.45	
LSD	218		2.1		0.37		0.07	
P Value	<0.001		0.054		<0.001		<0.001	

Table 3. Details of the management levels (kg, g, ml/ha).

Sowing date:		**16 April**
Seed Rate:		200 Seeds/m^2
Sowing Fertiliser:		130kg/ha Summit Vigour Compound
Seed Treatment:		Vibrance / Gaucho
Grazing:		Nil
Nitrogen:	10 June	55 kg N (15K)
	7 July	40 kg N
	11 July	50 kg N
	18 August	28 kg N
PGR:	GS31	200mL Moddus Evo
Fungicide:	GS00	Systiva
	GS31	300mL Prosaro
	GS39	840mL Radial

2021 WA Crop Technology Centre (Albany)

The trial site was established on a forest gravel loam into canola stubble. The research programme at this site aims to repeat some of the research proposed for Esperance but with a focus on late April sowing. Three trials were pursued that allowed the research team to compare the economics of wheat and barley, winter and spring germplasm sown in the traditional ANZAC day sowing window.

Sown: 29, 30 April, 1 May 2021
Harvested: 10 December 2021
Rotation position: 1st Cereal after canola, 2019 Hay oats, 2018 canola, 2017 wheat
Soil type: Forest gravel loam

Trial 1. April sown germplasm (winter vs spring) x management interaction trial

Trial code: FAR WAA W21-01

Objectives: To assess a comparison of winter and spring wheat germplasm under different levels of management sown on 29 April.

Key Messages:

- Planted in late April both winter wheats and spring wheats achieved similar 8-9t/ha under both standard and higher input management systems.
- Plots yielding 9t/ha were based on harvest dry matters of 16.5 – 19.4t/ha and harvest indices of 40%.
- Higher dry matter at harvest was correlated to higher yields but the relationship was not as strong as the relationship between harvest indices and yield.
- Responses in grain protein under higher N fertiliser input would indicate that nutrition was a key element as to why higher inputs generated more yield.
- Higher inputs associated with the high input strategy gave cost effective returns with all cultivars except the red feed wheat RGT Accroc which performed best with a standard input package.
- All wheats in the trial flowered in September with the exception of RGT Accroc which flowered a month later.
- In 2021, wheats flowering from 5 September to 25 October yielded similarly in this field trial.

Influence of cultivar and management on yield

There was a significant interaction (p=0.006) between cultivar and management at the Frankland River site with cultivars responding differently to the three different management levels. The high yielding wheats RGT Accroc (winter red feed wheat) and Rockstar (spring white milling wheat) which produced yields between 8-9t/ha showed no statistical difference in yield when grown under a standard and high input management strategy (Table 1). In contrast cultivars such as spring wheats Vixen, Scepter, and winter wheats Illabo and LRPB19-14347 produced significant yield increases when higher input was applied (extra N, fungicide and PGR). Cutlass showed a similar trend, but the difference was not statistically significant. Grazing management which was identical to standard except plots were mechanically defoliated at during spring (same time). With all wheats this mechanical defoliation reduced yield although with some wheats the differences were not statistically significant.

Table 1. Influence of cultivar on grain yield (t/ha) under different canopy management regimes.

	Canopy Management (Grain Yield t/ha)						
	Standard Input		**"Grazed" Standard***		**High Input**		**Mean**
Cultivar (Type)	t/ha		t/ha		t/ha		t/ha
Scepter (Spring)	6.97	gh	5.83	i	8.10	bcd	6.97
Illabo (Winter)	8.04	cde	6.96	gh	8.82	a	7.94
LRPB19-14347 (Winter)	7.11	fgh	6.79	h	8.47	abc	7.46
Rockstar (Spring)	8.12	bcd	6.72	h	8.93	a	7.92
Vixen (Spring)	6.80	h	5.79	i	7.73	def	6.77
Cutlass (Spring)	7.36	e-h	6.91	gh	8.02	cde	7.43
RGT Accroc (Winter)	8.79	ab	7.57	d-g	8.12	bcd	8.16
Mean	**7.60**	**ab**	**6.65**	**b**	**8.31**	**a**	

LSD Cultivar p = 0.05	0.40	**P Value**	<0.001
LSD Management p=0.05	0.95	**P Value**	0.015
LSD Cultivar x Management P=0.05	0.70	**P Value**	0.006

Plot yields: To compensate for edge effect a full row width (22.5cm) has been added to either side of the plot area (equal to plot centre to plot centre measurement in this case).
**"Grazed standard" – simulated grazing using mechanical defoliation*

Higher harvest dry matters were in general associated with high yields (Table 2 & Figure 1). This is apparent with comparisons of Scepter and Vixen to Rockstar where the latter was associated with higher DM irrespective of management, and significantly higher yields at all levels of management. In contrast Scepter and Vixen produced the lowest dry matters at harvest. Assessment also showed that there were significant increases in dry matter in the post flower development period with cultivars increasing overall dry matter by between 4.1 – 7.5t/ha (Figure 2). At yields over 9t/ha at least 40% of the dry matter had been partitioned as grain (Figure 3). Harvest index showed a reasonable strong relationship with yield.

Table 2. Influence of cultivar on Dry matter at maturity (t/ha) under different canopy management regimes.

	Canopy Management (Dry matter t/ha)							
	Standard Input		**"Grazed" Standard***		**High Input**		**Mean**	
Cultivar (Type)	t/ha		t/ha		t/ha		t/ha	
Scepter (Spring)	15	-	14.2	-	16.3	-	15.1	d
Illabo (Winter)	17.1	-	16.6	-	18.5	-	17.4	b
LRPB19-14347 (Winter)	17.1	-	16.8	-	16.4	-	16.8	bc
Rockstar (Spring)	17.2	-	16.4	-	17.4	-	17.0	bc
Vixen (Spring)	15.1	-	14.2	-	15.9	-	15.1	d
Cutlass (Spring)	15.5	-	15.4	-	17.3	-	16.0	cd
RGT Accroc (Winter)	18.7	-	18.9	-	18.7	-	18.8	a
Mean	**16.5**	**b**	**16.1**	**b**	**17.2**	**a**		
LSD Cultivar p = 0.05	1.2				**P Value**	<0.001		
LSD Management p=0.05	0.6				**P Value**	0.008		
LSD Cultivar x Management P=0.05	2.0				**P Value**	ns		

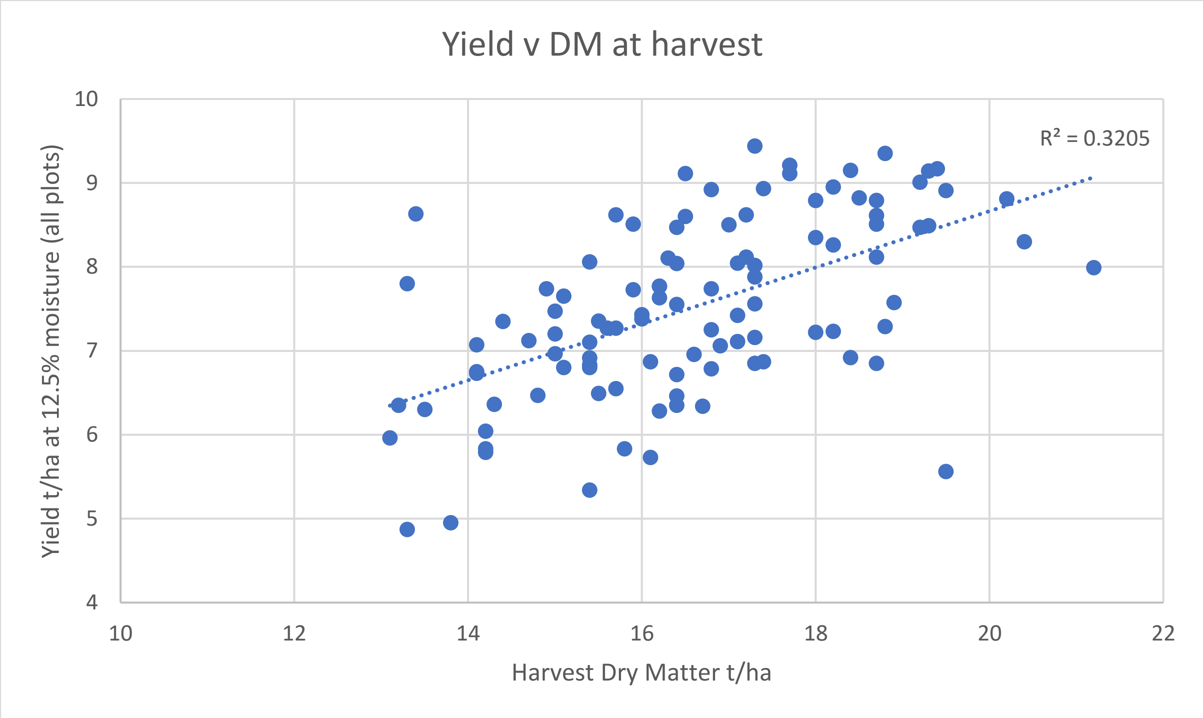

Figure 1. Correlation of grain yield (t/ha reported at 12.5% moisture) with harvest dry matter (t/ha reported at 0%) at maturity under different canopy management regimes (using all treatment plots).

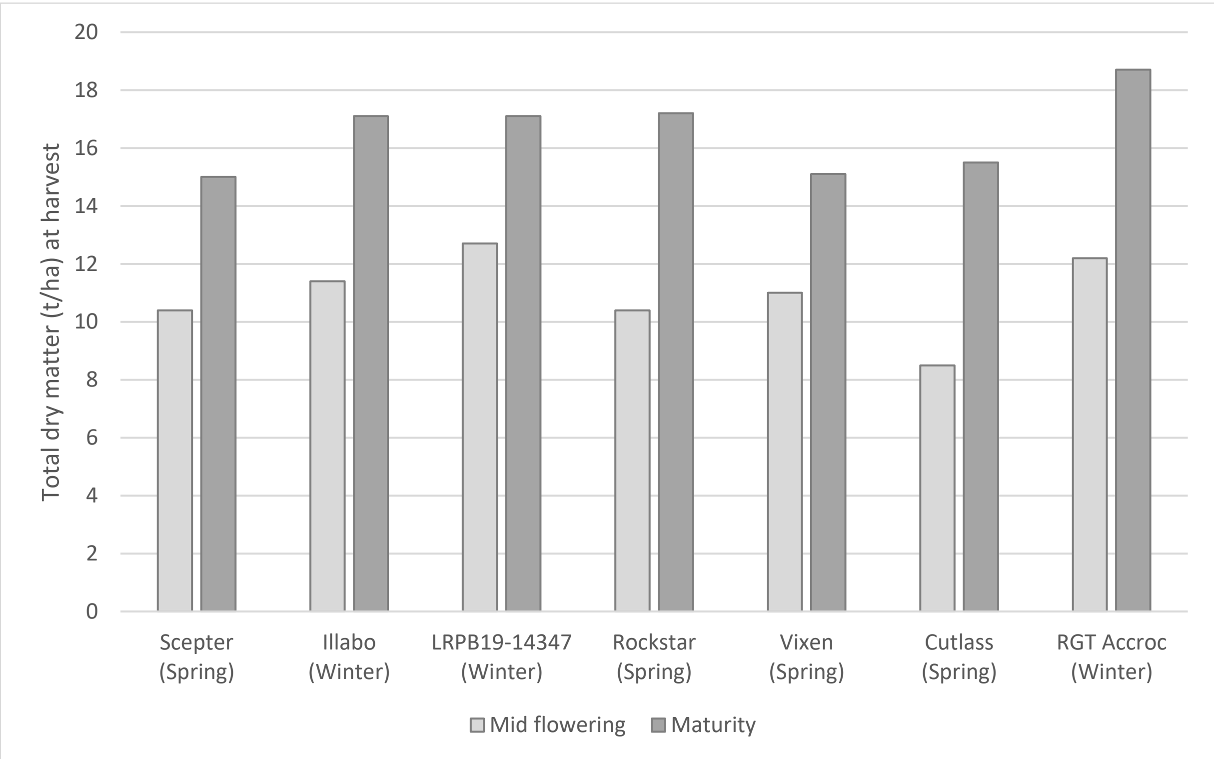

Figure 2. Influence of cultivar on total biomass production at approximately mid flowering (GS65) and final maturity (GS89). GS65 dry matters taken 15 Sept (spring germplasm), 6 Oct (Illabo, LRPB19) & 14 Oct (RGT Accroc).

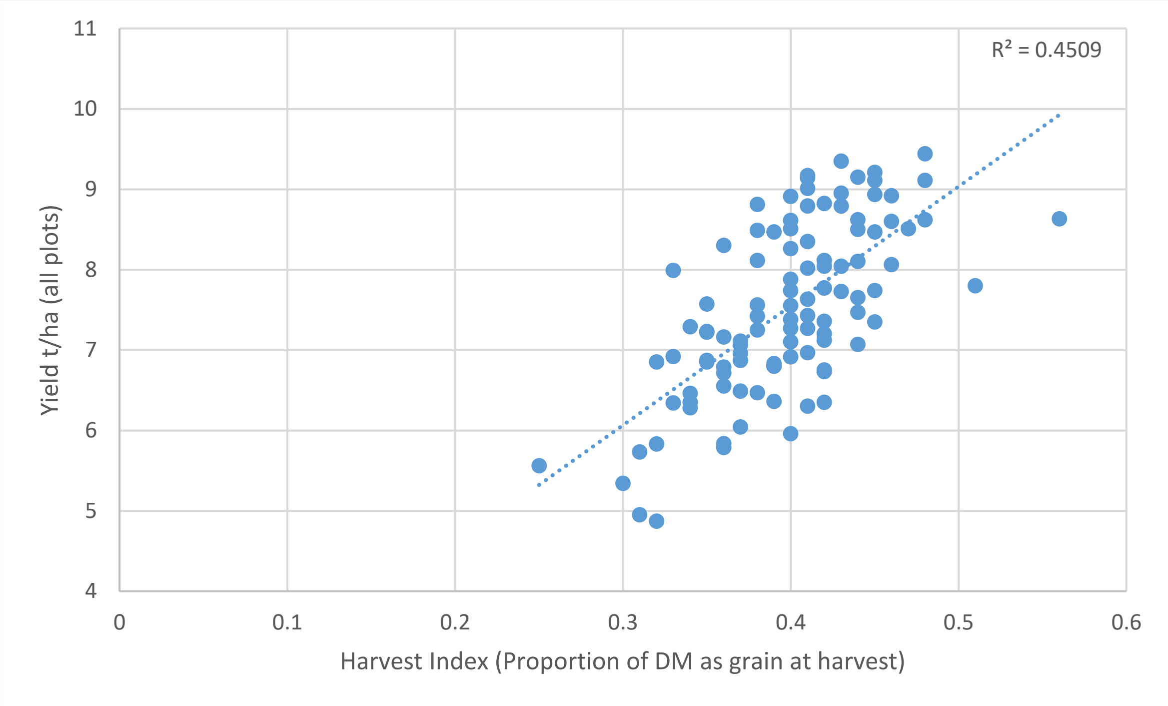

Figure 3. Correlation of grain yield (t/ha reported at 12.5% moisture) with harvest index (proportion of dry matter harvested as grain reported at 0% moisture) at maturity under different canopy management regimes (using all treatment plots).

Influence of cultivar and management strategy on crop structure and phenology

Later development (Figure 4) resulted in higher head numbers, for example Rockstar was later developing than Scepter reaching GS30 (mid-July) and as a result produced significantly more heads (Table 3). Although later developing cultivars (e.g., winter wheats) had more time to tiller and therefore generate potentially more heads, the correlation between final head number at harvest and final yield is relatively weak (R^2 0.11 – data not shown) compared to correlation with harvest index.

Table 3. Influence of cultivar on head numbers (/m^2) and final biomass at maturity (t/ha) at mean of management levels.

Cultivar (Type)	**Heads/m^2**		**Biomass (t/ha)**	
Scepter (Spring)	338	d	15.1	d
Illabo (Winter)	405	c	17.4	b
LRPB19-14347 (Winter)	475	b	16.8	bc
Rockstar (Spring)	422	c	17.0	bc
Vixen (Spring)	421	c	15.1	d
Cutlass (Spring)	343	d	16.0	cd
RGT Accroc (Winter)	561	a	18.8	a
Mean	424		16.6	
LSD	45		1.2	
P Value	<0.001		<0.001	

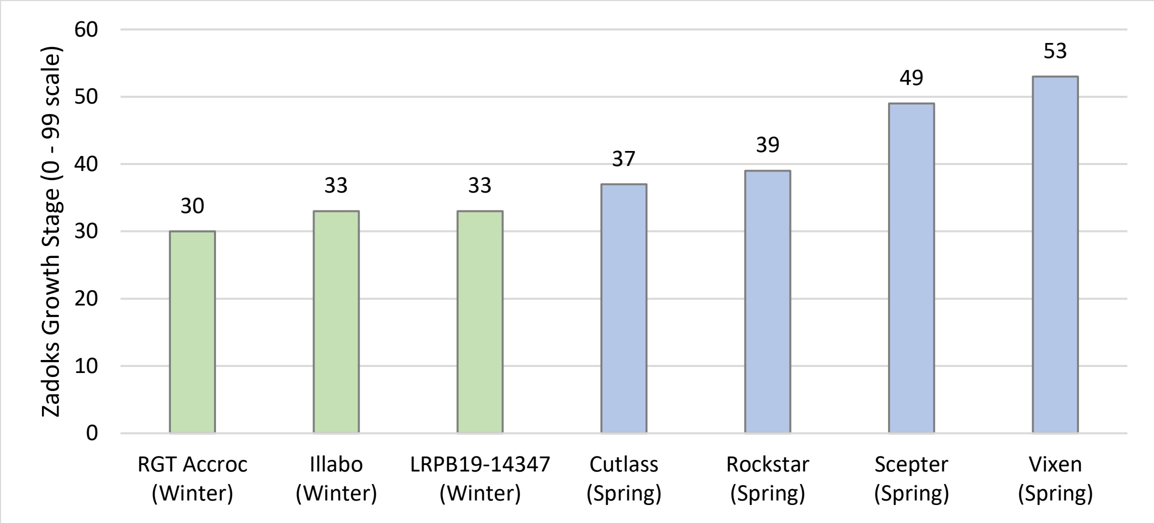

Figure 4. Zadoks growth Stage (GS) that each cultivar was at on 19 August.

Table 4. Approximate calendar date that each cultivar reached stem elongation (GS30) and the beginning of flowering (GS61) – 28th April sown.

Cultivar (type)	Date GS30	Date GS61
Illabo (Winter)	30 July	15 September
Rockstar (Spring)	22 July	20 September
LRP19-14347 (Winter)	22 July	10 September
Cutlass (Spring)	16 July	20 September
RGT Accroc (Winter)	16 August	25 October
Scepter (Spring)	23 June	5 September

Influence of cultivar & management strategy on grain quality

All wheat cultivars in this trial averaged over 80kg/hL test weight and had screenings less than 1.5%. Whilst there were significant differences in grain quality for these parameters the differences were small, however the differences in grain protein were larger. Higher yields have invariably diluted grain protein and in all cases the addition N input associated with the high input strategy has increased grain protein (Table 5).

Table 5. Influence of cultivar and management on grain protein (%)

	Canopy Management (Grain Protein %)						
	Standard Input		**"Grazed" Standard***		**High Input**		**Mean**
Cultivar (Type)	%		%		%		
Scepter (Spring)	10.7	ef	10.3	fg	11.5	bc	**10.8**
Illabo (Winter)	9.1	jk	9.0	k	10.6	efg	**9.6**
LRPB19-14347 (Winter)	9.7	hi	9.2	ijk	11.3	bcd	**10.1**
Rockstar (Spring)	9.5	ijk	9.2	ijk	10.9	de	**9.9**
Vixen (Spring)	11.7	b	11.3	bcd	12.5	a	**11.8**
Cutlass (Spring)	9.6	ij	9.3	ijk	11.0	cde	**10.0**
RGT Accroc (Winter)	7.6	l	8.0	l	10.2	gh	**8.6**
Mean	**9.7**		**9.5**		**11.1**		
LSD Cultivar p = 0.05		0.7			**P Value**	0.003	

LSD Management p = 0.05	0.3	**P Value**	<0.001
LSD Cultivar x Management P = 0.05	0.6	**P Value**	<0.005

Influence of cultivar & management strategy on gross margin ($/ha)

Using typical grain prices for the region the results were translated into gross margins where the yields, grades obtained, and input costs were used to generate gross margins for the trial (Table 6).

Table 6. Influence of cultivar and management on gross margin ($/ha) – (*grain price of grade obtained minus cost of inputs).*

	Canopy Management (Gross Margin $/ha)			
	Standard Input	**"Grazed" Standard***	**High Input**	**Mean**
Cultivar (Type)	$/ha	$/ha	$/ha	$/ha
Scepter (Spring)	2,033	1,684 (47)	2,330	2,194
Illabo (Winter)	1,928	1,704 (90)	2,053	2,058
LRPB19-14347 (Winter)	2,013	1,991 (89)	2,374	2,290
Rockstar (Spring)	1,949	1,659 (116)	2,084	2,053
Vixen (Spring)	2,091	1,794 (75)	2,330	2,241
Cutlass (Spring)	2,096	2,042 (96)	2,220	2,281
RGT Accroc (Winter)*	2,145	2,155 (363)	1,847	2,122
Mean	**2,036**	**2,861**	**2,177**	

*FED1
(Dry Matter value at $.027/kg DM included in Gross Margin)

Stats have not been applied to individual plot yields for this analysis, it is based on the mean yield

Table 7. Details of the three management levels (kg, g, L, mL/ha).

Plant pop'n:		200 seeds/m^2 (150 plants/m^2 target)		
		Standard	**Standard Grazed**	**High Input**
Grazed:		----	✓	----
Seed treatment:		Vibrance/ Gaucho		
Basal Fertiliser:		139kg MAP / MOP		
Nitrogen:	1 June	52 kg N/ha	52 kg N/ha	93 kg N/ha
	3 July	32 kg N/ha	32 kg N/ha	84 kg N/ha
	17 August	32 kg N/ha	32 kg N/ha	32 kg N/ha
Total N (With 9 N at sowing)		**116 kg N/ha**	**116 kg N/ha**	**209 kg N/ha**
PGR:	GS31	----	----	Moddus Evo 200mL
				Errex 1.3L
Fungicide:	GS00	----	----	Systiva
	GS31	150mL Prosaro	150mL Prosaro	300mL Prosaro
	GS39	500mL Opus	500mL Opus	840mL Radial

All other inputs of insecticides and herbicides were standard across the trial.
**Timings of PGRs and fungicides were adjusted to take account of the differences in spring and winter wheat phenology (development).*

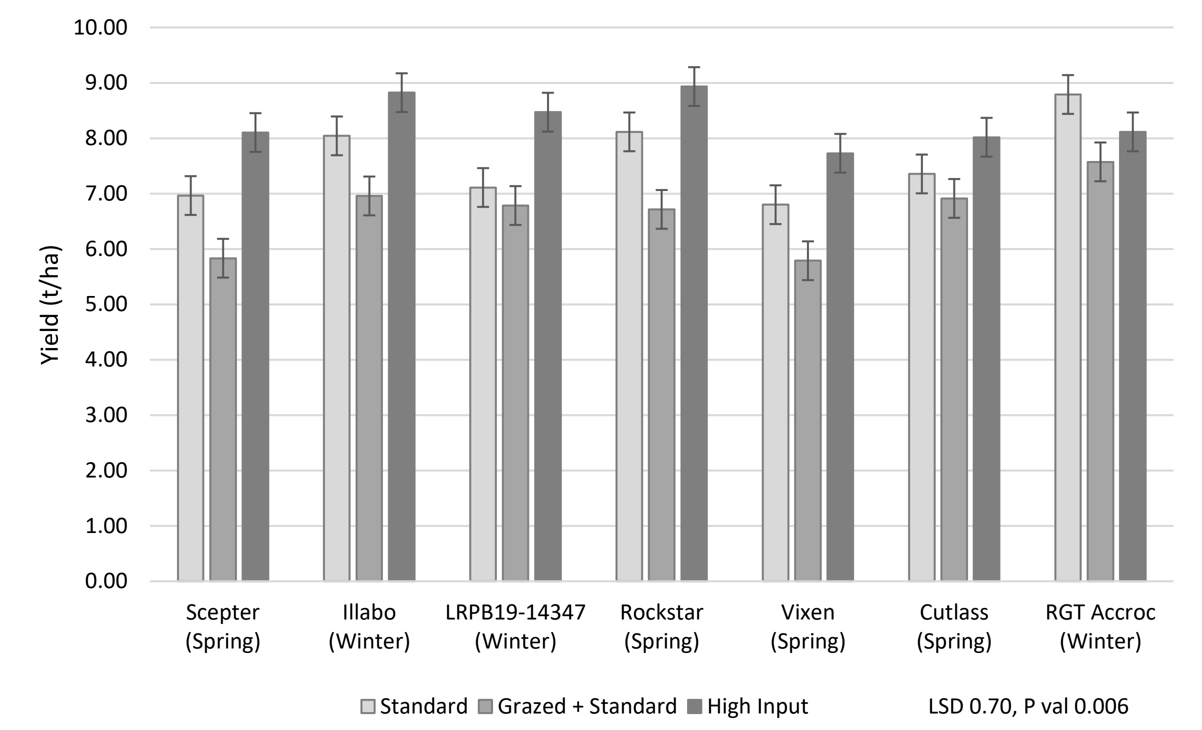

Figure 4. Management influence on Cultivar to grain yield (t/ha).

Trial 2. Wheat April sown germplasm screening trial – winter and spring (not taken to yield)

Trial code: FAR WAA W21-02

Objective: To examine the phenology, disease resistance and standing power of new wheat germplasm established in the traditional late April/early May sowing window relative to current commercial cultivars; sown April 30.

Treatments: 24 commercial and coded lines (winter and spring cultivars) were sown 30 April in small plots (5m) with standard nitrogen management but no fungicide or PGR input, to examine their phenology (speed of development) relative to a winter and spring wheat control (Illabo (winter) and Scepter (spring)), disease susceptibility and standing power. Plots were not taken to yield.

Key Messages

- Little ability to separate cultivars based on disease incidence, although all winter types appeared disease free throughout the year.
- The late September window for flowering was associated with the highest yields in spring wheats (Trial 1), Rockstar flowering in the second half of September and both Scepter and Vixen flowering early in September from this sowing date.

- Many winter wheats were at early head emergence in early October indicating that even mid-October flowering dates were able to finish the season since RGT Accroc still produced yields of almost 9t/ha (Trial 1) sown in the same time period.
- Winter wheats showed similar yields from a wide range flowering date.

Disease incidence was low throughout most of the start of the season. Coded Longreach Plant Breeding variety LPB17-5691 had the highest levels of lodging than any other cultivar, although the tall awnless varieties 21GXE010 and 21GXE012 showed no signs of lodging. Winter types looked very clean all year, despite receiving no fungicide. Ananpurna did not reach stem elongation until September, whilst quick spring varieties like Vixen, Sting and Scepter were in their final stages of flowering at the same time (see Table 1).

Table 1. Zadoks growth Stages (0-99) of each cultivar on 13 July, 7 August, 15 September, 6 October, 8 November and 24 November.

Variety	13 July	7 Aug	15 Sept	6 Oct	8 Nov	24 Nov
21GXE010	VE	31	37	52	71-73	78
Trojan	31	37	63	65	83	90
LPB17-5691	30	33-37	58	65	77	88
LPB16-0582	VE	31	37-39	57	73	82
21GXE008	VE	32	37-39	49-51	71-73	78
Valiant CL Plus	30	33-37	52	65	75-77	85
V12167-048	30	32	57	65	75	85
Devil	VE	37-39	67	69-71	77-83	90
Rockstar	30	33-37	59	65-69	75	88
SUN1087I	30-31	37-39	61	65	83	85
L13070-027	VE	30	41	61	77	82
RGT Accroc	VE	VE	32	49-51	69	75
Magenta	VE	32	58	61-65	77-83	88
Vixen	31	39	69	75-77	87	90
LPB16-0598	VE	30	37	52	73-75	78
Sting	31	41	69	71	87	90
Anapurna	VE	VE	33	49-51	71	75
V11068-085-047	VE	VE	41	65	83	85
Scepter	32	37-39	69	73-75	83	90
Catapult	31	32	59	65	77-81	88
Illabo	30	31	47	61	75	82
21GXE012	VE	31	37	49-51	71	78
21GXE014	VE	32	37	45	69	75-78
Denison	30	37-39	58	61	83	85

*VE = Vegetative/Tillering – pre GS30

Table 2. Details of the management levels (kg, g, ml/ha).

Sowing date:		**29 April**
Seed Rate:		200 Seeds/m^2
Sowing Fertiliser:		139 kg MAP/MOP Blend
Seed Treatment:		Nil
Grazing:		Nil
Nitrogen:	June	52 kg N/ha
	July	32 kg N/ha
	August	32 kg N/ha
PGR:		Nil
Fungicide:		Nil

Trial 3. Barley seeding depth by variety interaction trial

Trial code: FAR WAA W21-08

Objectives: To assess a comparison of four spring barley cultivars, sown at 2 depths (2-4 cm v 8-9cm) on 1 May

Key Messages:

- Deep planting (8-9cm) significantly reduced plant establishment relative to shallow plantings (2-4cm) irrespective of cultivar and its associated coleoptile length (mean of 4 cultivars).
- Differences observed in plant establishment and initial ground cover did not significantly influence grain yield, with an average yield of 7.81t/ha for deep planting versus 7.94t/ha for shallow planting.
- Observations on coleoptile length indicated that Fathom produced a longer coleoptile from deeper planting than La Trobe and RGT Planet.

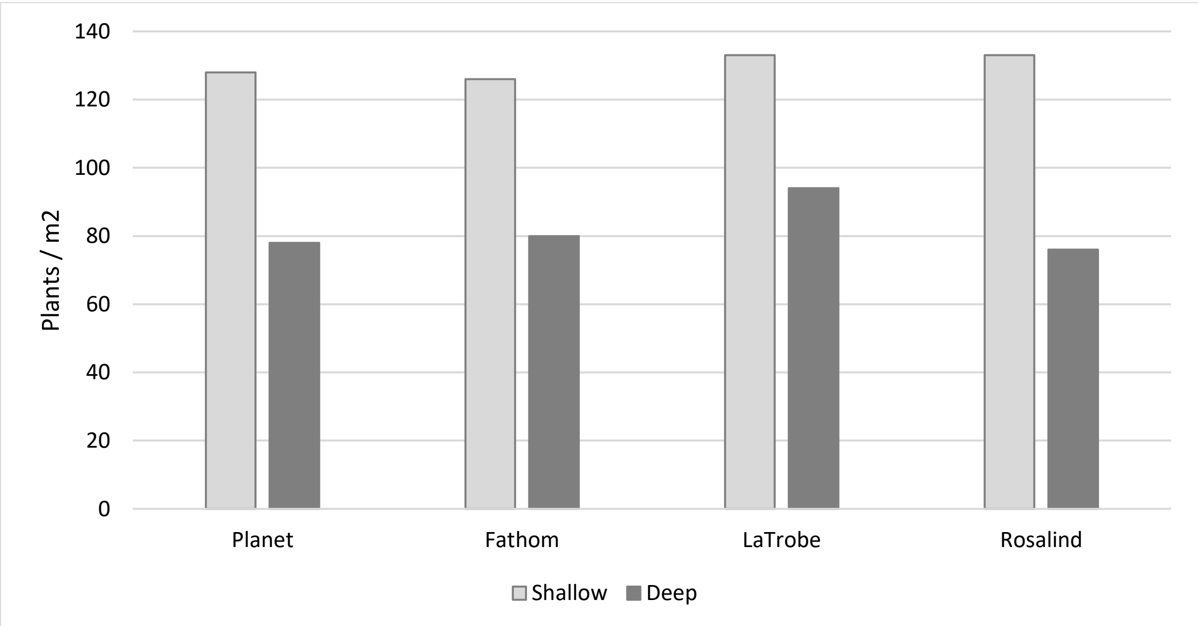

Figure 1. Influence of Seeding depth and cultivar on plant establishment.

Table 1. Influence of cultivar on grain yield (t/ha) and quality (%, kg/hL) (mean of seeding depth).

	Yield		Protein		Test weight		Screenings (<2mm)	
	t/ha		%		Kg/hL		%	
Cultivar								
RGT Planet	7.60	-	10.1	c	64.8	b	1.4	b
Fathom	7.93	-	11.4	a	60.5	c	1.2	bc
LaTrobe	7.98	-	10.6	b	67.5	a	1.8	a
Rosalind	7.99	-	10.4	bc	66.6	a	0.9	c
Mean	7.9		10.6		64.8		1.3	
LSD	0.76		0.56		1.06		0.33	
P Value	ns		<0.001		<0.001		0.003	
CV	13.5							

Table 2. Influence of planting depth on coleoptile length (mm) – 23 June

Seed to coleoptile node (mm)			
	Deep	Shallow	**Average**
Fathom	78	35	**56**
La Trobe	53	15	**34**
Planet	60	25	**43**
Rosalind	40	15	**28**
Average	**58**	**23**	**40**

Seed to crown node (mm)			
	Deep	Shallow	**Average**
Fathom	78	35	**56**
La Trobe	70	15	**43**
Planet	60	25	**43**
Rosalind	63	15	**39**
Average	**68**	**23**	**45**

Seed to surface (mm)			
	Deep	Shallow	**Average**
Fathom	93	48	**70**
La Trobe	90	30	**60**
Planet	83	35	**59**
Rosalind	83	30	**56**
Average	**87**	**36**	**61**

Table 3. Influence of cultivar on grain yield (t/ha) and quality (%, kg/hL) (mean of four cultivars).

	Yield		Protein		Test weight		Screenings (<2mm)	
	t/ha		%		Kg/hL		%	
Seeding Depth								
Deep	7.81	-	10.7	-	64.9	-	1.4	a
Shallow	7.94	-	10.6	-	64.8	-	1.2	b
Mean	7.88		10.7		64.9		1.3	
LSD	0.51		0.30		0.68		0.24	

P Value	ns	ns	ns	0.046
CV	12.7			

Table 4. Details of the management levels (kg, g, ml/ha).

Sowing date:		**1 May**
Seed Rate:		200 Seeds/m^2
Sowing Fertiliser:		139 kg MAP/MOP Blend
Seed Treatment:		Nil
Grazing:		Nil
Nitrogen:	June	52 kg N/ha
	July	32 kg N/ha
	August	32 kg N/ha
PGR:		Nil
Fungicide:	GS31	Prosaro – 300 mL
	GS39	Tazer Xpert – 2 L

Table 5. Each cultivar paired with its sowing depth; images all taken September 20.

Fathom, shallow sown (left), deep sown (right)

LaTrobe, shallow sown (left), deep sown (right)

RGT Planet, deep sown (left), shallow sown (right)

Rosalind, shallow sown (left), deep sown (right)

Appendices

Appendix 1. Gibson (Esperance Crop Technology Centre)

i) Overall Site inputs (unless otherwise stated the following inputs were applied to the trials at the Esperance Centre)

Crop Rotation:	2020 Canola, 2019 Barley, 2018 Wheat	
Crop Nutrition:		
IBS	130 Kg Summit Vigour Compound	
19 May	55 Kg N/ha	
11 July	46 kg N/ha	
18 August	28 kg N/ha	
Crop Protection:		
27 December	LV Ester 680	600 mL
	Glyphosate 450	2.5 L
	Metsulfuron 600 WG	4 g
	Ammonium-Sulphate	1 %
	Li-700 Surfactant	120 mL
13 March	LV Ester 680	600 mL
	Glyphosate 450	2.5 L
	Ammonium-Sulphate	1 %
	Li-700 Surfactant	120 mL
15 April	Overwatch	1.25 L
	Gramoxone	1 L
12 May	Trojan	15 mL
	Torpedo	100 mL
	Bromicide MA	500 mL
18 May	Mouse-off	2 kg
25 August	Mouse-off	2 kg
	Lorsban	600 mL

ii) Meteorological Data

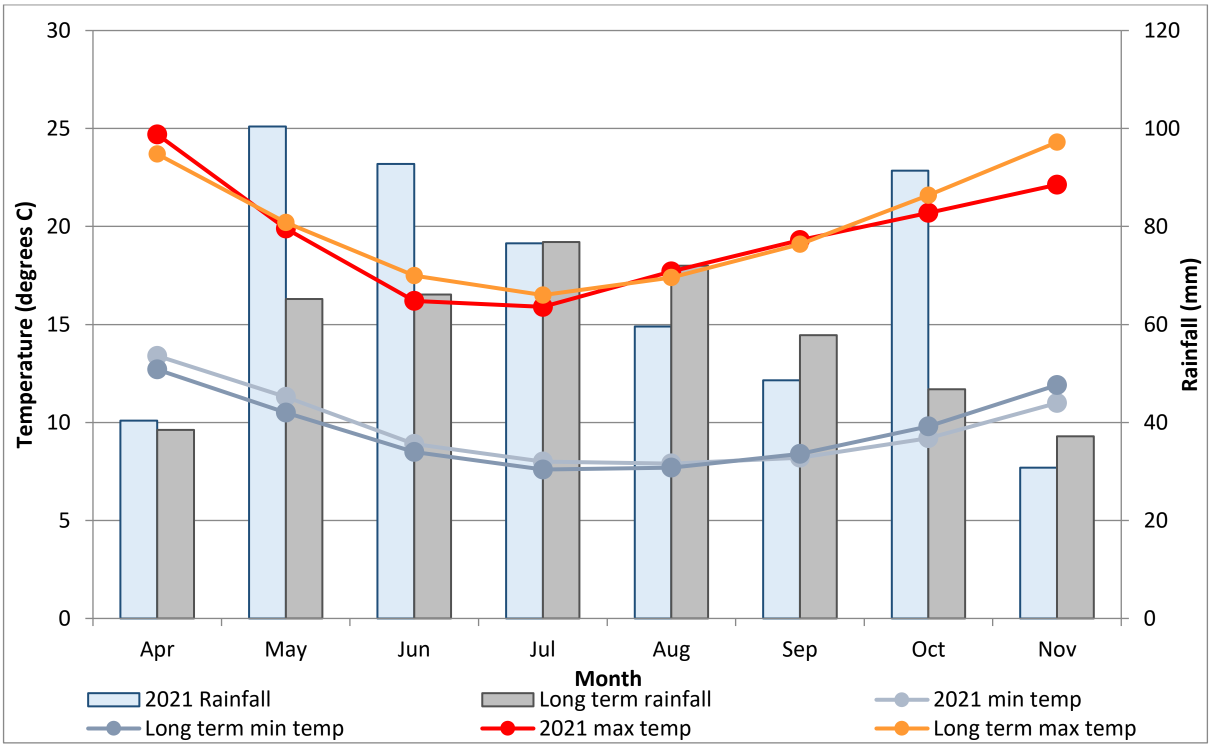

Figure 1. 2021 growing season rainfall and long-term rainfall, 2020 min and max temperatures and long-term min and max temperatures recorded **Esperance Aerodrome** (1950-2021) for the growing season (April-November).

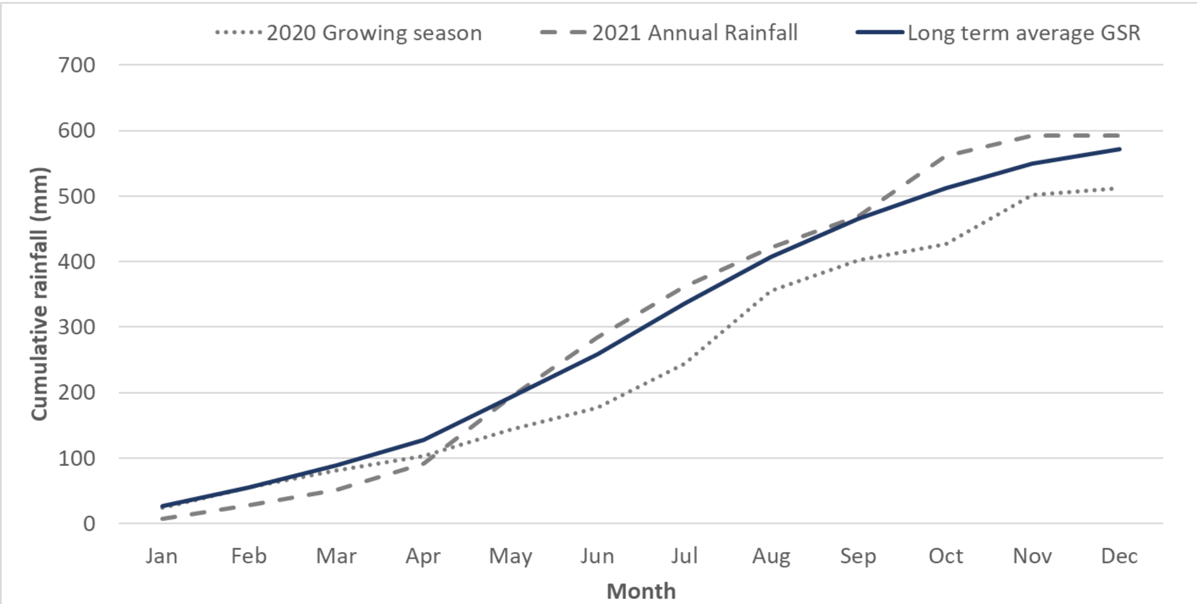

Figure 2. 2021 rainfall, 2020 rainfall and long-term average rainfall for **Esperance Aerodrome** (1950-2021).

iii) Soil Test Results (Esperance Crop Technology Centre)

Analysis Results

CSBP Soil and Plant Laboratory

71376
Farm & General EOPP

	Lab No	ZLS21068	ZLS21069	ZLS21070	ZLS21071	ZLS21072	ZLS21073	ZLS21074	ZLS21075
	Name	Ripped	Ripped	Ripped	Ripped	Ripped	Ripped	Ripped	Ripped
	Code	Gibson Cores	Gibson Cores	Gibson Cores	Gibson Cores	Gibson Cores	Gibson Cores	Gibson Cores	Gibson Cores
	Customer	FAR	FAR	FAR	FAR	FAR	FAR	FAR	FAR
	Depth	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
Colour		GR	BK	GRYW	LTGR	BRGR	GRBR	GRBR	GRYW
Gravel	%	0	0	0	35-40	55-60	55-60	55-60	25-30
Texture		1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.5
Ammonium Nitrogen	mg/kg	2	1	2	2	1	< 1	1	1
Nitrate Nitrogen	mg/kg	9	7	13	10	6	4	2	2
Phosphorus Colwell	mg/kg	17	27	4	< 2	< 2	< 2	< 2	< 2
Potassium Colwell	mg/kg	60	39	50	81	111	76	64	101
Sulfur	mg/kg	3.4	7.8	8.6	14.3	16.1	22.4	22.2	30.5
Organic Carbon	%	0.44	0.18	0.12	0.11	0.18	0.17	0.17	0.16
Conductivity	dS/m	0.041	0.044	0.072	0.061	0.052	0.052	0.056	0.080
pH Level (CaCl2)		5.1	4.4	4.4	5.2	5.5	5.6	5.8	5.8
pH Level (H2O)		6.2	5.3	5.1	5.8	6.1	6.2	6.5	6.7
DTPA Copper	mg/kg	0.23	0.30	0.22	0.18	0.19	0.13	0.12	0.12
DTPA Iron	mg/kg	50.70	103.80	58.80	104.30	116.60	66.50	72.10	19.20
DTPA Manganese	mg/kg	0.48	0.21	0.38	3.62	1.69	0.86	0.77	0.34
DTPA Zinc	mg/kg	0.39	0.18	0.12	0.31	0.12	0.17	0.15	0.19
Exc. Aluminium	meq/100g	0.190	0.480	0.600	0.290	0.190	0.190	0.220	0.320
Exc. Calcium	meq/100g	1.17	0.42	0.47	0.63	0.75	0.60	0.60	0.90
Exc. Magnesium	meq/100g	0.17	0.14	0.21	0.35	0.42	0.46	0.73	2.17
Exc. Potassium	meq/100g	0.15	0.09	0.13	0.22	0.29	0.17	0.14	0.25

CSBP Lab. Extract Value.

PREDICTA B
DNA Soilborne disease tests

SARDI Plant & Soil Health
Gate 2B, Hartley Gr. P 08 8303 9360
URRBRAE SA 5064 F 08 8303 9393

Sample: **AAG5543**
Paddock: YONGA WEST B
Grower: SHEPWOK DOWNS
Nearest town: GIBSON

Report date: 26/03/2021
Sampling strategy: Random
Stubble added: Yes
Region: Western

Paddock history	2 years ago	Last year	This year
Crop / variety	Barley	Canola	Wheat

TEST	RESULT		DISEASE RISK*			
			Not Detected	Low	Med	High
CCN	<0.05	eggs /g soil	■			
Stem nematode	<0.5	nematodes/100 g soil	■			
Take-all	<0.8	log(pg DNA/g soil)	■			
Take-all - Oat Strain	<0.8	log(pg DNA/g soil)	■			
Rhizoctonia	<0.5	log(pg DNA/g soil)	■			
Crown rot	0.29	log(pg DNA/g soil)		■		
Pratylenchus neglectus	<0.1	nematodes /g soil	■			
Pratylenchus quasitereoides	<0.1	nematodes/g soil	■			
Blackspot	<1.2	log(pg DNA/g soil)	■			
Blackspot (Phoma koolunga)	<1.2	log(pg DNA/g soil)	■			

*Risk categories should be used as a guide only, may be subject to regional and seasonal differences, and may be revised over time.

UNDER EVALUATION

TEST	RESULT		POPULATION DENSITY**			
			Not Detected	Low	Med	High
Common root rot	<0.6	log(pg DNA/g soil)	■			
Pythium clade f	0.89	log(pg DNA/g soil)		■		
Yellow leaf spot	<0.3	log(kDNA copies/g soil)	■			
Eyespot	<0.3	log(kDNA copies/g soil)	■			
White grain disorder	<0.3	log(kDNA copies/g soil)	■			
Pratylenchus penetrans	<0.1	nematodes /g soil	■			
Pratylenchus thornei	<0.1	nematodes/g soil	■			
Charcoal rot	1.38	log(kDNA copies/g soil)			■	
Ascochyta blight of chickpea	<0.05	log(kDNA copies/g soil)	■			
Sclerotinia stem rot	2.65	log(kDNA copies/g soil)			■	

**Population densities are based on the distribution of pathogen levels detected in PreDicta samples over several years. These are not disease risk categories.

Appendix 2. Frankland River (Albany Crop Technology Centre)

i) Overall Site inputs

Crop Rotation:	2020 Canola, 2019 Oaten Hay, 2018 Canola	
Crop Nutrition:		
IBS	130 kg MAP / MOP Blend	
June	52 kg N	
July	32 kg N	
August	32 kg N	
Crop Protection:		
27 December	LV Ester 680	0.5 L
	Glyphosate 450	2.0 L
	Logran 750WG	5 g
	Wetter 1000	0.10 %
23 April	LV Ester 680	0.5 mL
	Glyphosate 450	2.0 L
	Logran 750WG	5 g
	Wetter 1000	0.10 %
28 April	Paraquat 250	3.0 L
	Trifluralin	2.0 L
	Overwatch	1.25 L
	Diuron	300 g
26 May	Jaguar	1.0 L
	MCPA LVE 570	0.4 L
	Manganese Sulphate	2 kg
12 August	Trojan	15mL
	Chlorpyrifos	150 mL

ii) Meteorological Data

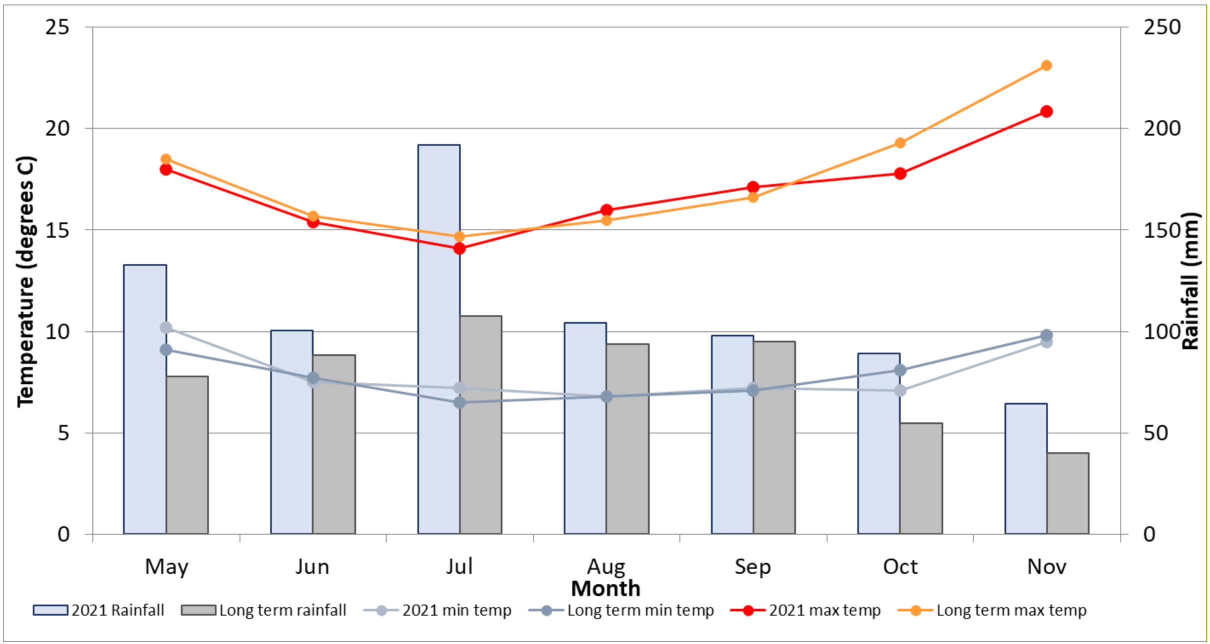

Figure 1. 2021 growing season rainfall and long-term rainfall, 2021 min and max temperatures and long-term min and max temperatures recorded at **Rocky Gully** (1995 to 2021) for the growing season (May to October).

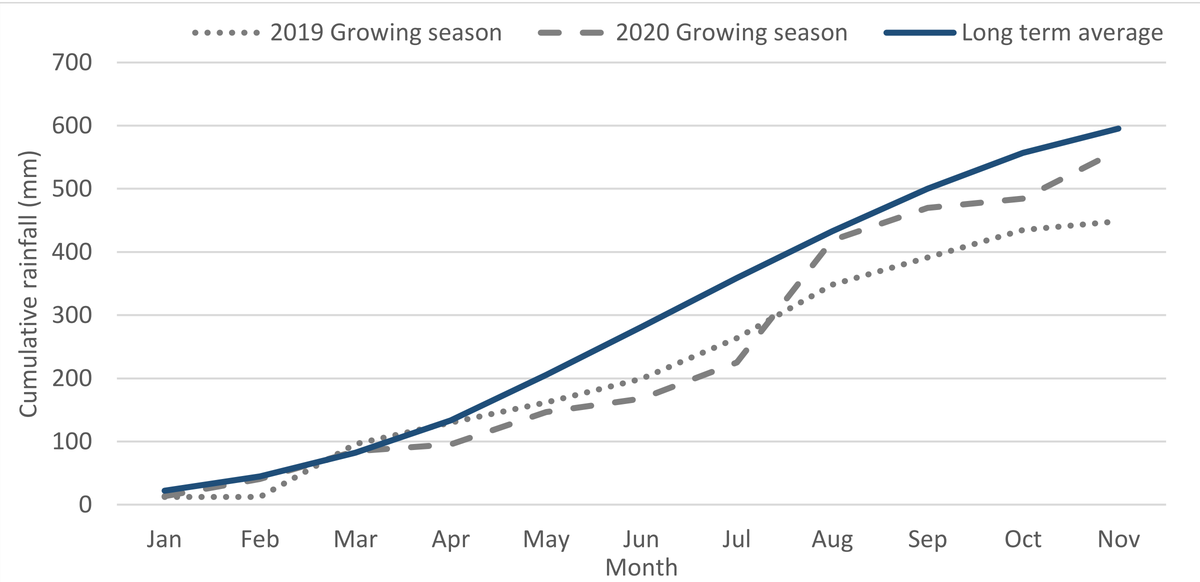

Figure 2. 2020 rainfall, 2021 rainfall and long-term average rainfall for Rocky Gully (1995 to 2021).

iii) Soil Test Results (Albany)

PREDICTA B
DNA Soilborne disease tests

SARDI Plant & Soil Health
Gate 2B, Hartley Gr. **P 08 8303 9360**
URRBRAE SA 5064 **F 08 8303 9393**

Sample: AAG7597
Paddock: **HANGING FIRE**
Grower: **GUNWARRIE**
Nearest town: **FRANKLAND RIVER**

Report date: **01/04/2021**
Sampling strategy: **Random**
Stubble added: **Yes**
Region: **Western**

Paddock history	**2 years ago**	**Last year**	**This year**
Crop / variety	Oaten Hay	Canola	Wheat

TEST	**RESULT**		**DISEASE RISK*** Not Detected	Low	Med	High
CCN	<0.05	eggs /g soil	■			
Stem nematode	<0.5	nematodes/100 g soil	■			
Take-all	<0.8	log(pg DNA/g soil)	■			
Take-all - Oat Strain	<0.8	log(pg DNA/g soil)	■			
Rhizoctonia	<0.5	log(pg DNA/g soil)	■			
Crown rot	0.82	log(pg DNA/g soil)		■		
Pratylenchus neglectus	52.3	nematodes /g soil				■
Pratylenchus quasitereoides	1.1	nematodes/g soil		■		
Blackspot	<1.2	log(pg DNA/g soil)	■			
Blackspot (Phoma koolunga)	<1.2	log(pg DNA/g soil)	■			

*Risk categories should be used as a guide only, may be subject to regional and seasonal differences, and may be revised over time.

UNDER EVALUATION

TEST	**RESULT**		**POPULATION DENSITY**** Not Detected	Low	Med	High
Common root rot	<0.6	log(pg DNA/g soil)	■			
Pythium clade f	<0.6	log(pg DNA/g soil)	■			
Yellow leaf spot	<0.3	log(kDNA copies/g soil)	■			
Eyespot	<0.3	log(kDNA copies/g soil)	■			
White grain disorder	<0.3	log(kDNA copies/g soil)	■			
Pratylenchus penetrans	<0.1	nematodes /g soil	■			
Pratylenchus thornei	<0.1	nematodes/g soil	■			
Charcoal rot	1.45	log(kDNA copies/g soil)			■	
Ascochyta blight of chickpea	<0.05	log(kDNA copies/g soil)	■			
Sclerotinia stem rot	0.51	log(kDNA copies/g soil)		■		

**Population densities are based on the distribution of pathogen levels detected in PreDicta samples over several years. These are not disease risk categories.

APAL Australian Precision Ag Laboratory

Apal Test Method Codes															TMs-004A
Crop	Actual Crop	SubmissionID	SamplingDate	DateReceived	BatchID	Batch Position No.	AgentName	ClientName	SampleName	Barcode	SampleDepth	Postcode	Transect GPS Start	Transect GPS Finish	pH 1:5 water
															pH units
		65984	2021-01-18	2021-01-21	21488	43	Frankland Rural - Tim Trezise	Gunwarrie	Hanging Fire 5	110433123	0-10	6396	-34.33102813815,117.24362188779	N/A	6.75
		65984	2021-01-18	2021-01-21	21488	44	Frankland Rural - Tim Trezise	Gunwarrie	Hanging Fire 5	110433122	10-20	6396	-34.33102813815,117.24362188779	N/A	6.38
		65984	2021-01-18	2021-01-21	21488	45	Frankland Rural - Tim Trezise	Gunwarrie	Hanging Fire 5	110433124	20-30	6396	-34.33102813815,117.24362188779	N/A	

TMs-004B4	TMs-004B1	TMs-006A	TMs-047	TMs-007NO3	TMs-007NH4	TMs-009B	TMs-009I2	TMs-026	TMs-018	TMs-010D	TMs-015E	TMs-015E	TMs-015E
pH CaCl2 (following 4A1)	pH CaCl2 (Direct)	Organic Carbon (W&B)	MIR - Aus Soil Texture	Nitrate - N (2M KCl)	Ammonium - N (2M KCl)	Colwell Phosphorus	PBI + Col P	DGT-P	Colwell Potassium	KCl Sulfur (S)	Calcium (Ca) - NH4Cl/BaCl2	Magnesium (Mg) - NH4Cl/BaCl2	Potassium (K) - NH4Cl/BaCl2
pH units	pH units	%		mg/kg	mg/kg	mg/kg		µg/L	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
6.22		3.05	Sand	26	2.5	35	150	20	61	15	2180	114	64
5.51				6.3	1.1	8			31				
	5.55												

TMs-015E	TMs-015E	TMs-015E	TMs-015E	TMs-015E	TMs-015G	TMs-015G	TMs-015G	TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-028	TMs-003
Sodium (NH4Cl/BaCl2)	Ca:Mg ratio	K:Mg ratio	GTRI	ECR	Exchangeable acidity	Exchangeable aluminium	Exchangeable hydrogen	ECEC	Calcium	Magnesium	Potassium	Sodium	Aluminium	Hydrogen	CaCl2 extr. Aluminium	Salinity EC 1:5
cmol/kg					cmol/kg	cmol/kg	cmol/kg	cmol/kg	%	%	%	%	%	%	mg/kg	dS/m
0.117	12	0.18		2.3	<0.02	<0.02	<0.02	12.1	89.9	7.7	1.4	1	0	0		0.13
																0.038
															<0.1	

TMs-Cal03	TMs-012C	TMs-012A	TMs-012A	TMs-012A	TMs-012A	TMs-003
Ece	Boron	Iron (Fe)	Manganese (Mn)	Copper (Cu)	Zinc (Zn)	TDS
dS/m	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/L
2.9	0.7	24	1.3	1.2	0.79	81
						24

FAR AUSTRALIA