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

A Grains Research & Development Corporation (GRDC) investment

2022 CEREAL RESULTS

Research hosted by:

WA CROP TECHNOLOGY CENTRE (ESPERANCE)

WA CROP TECHNOLOGY CENTRE (ALBANY)

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2022 WA Crop Technology Centre (Esperance)

Sown: 16 & 17 April 2022, (Trial 1 sown 17 May, Trial 4 sown 9 May).
Harvested: 16-17 November 2022 (barley), 3 December 2022 (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 W22-01

Objectives: To examine the influence of different soil amelioration and establishment methods on the performance of early sown wheat (late April – early May).

Key Messages

- There was significant variability between replicates of the same treatment, therefore trends in treatment effects appear more often than statistically significant differences.
- Mean grain yield (Catapult sown 17th May) was 5.87t/ha with no significant single treatment differences, and mean protein was 10.3%. There were significant interactions between amelioration/seeding method and nutrition treatments for yield and protein. The nutritional effects of additional N and NPKS were less evident in final grain yields with double Ripped or spade seeded crops, although there was a trend for the additional nutrition to increase harvest dry matter (DM).
- Harvest Index (HI) ranged from 30.3% to 37.68%, which is low by wheat standards, and indicated that there was a constraint on all treatments causing inefficient conversion of dry matter to grain yield.
- Spade seeding tended to increase plant establishment and tiller density, and significantly increased crop height and head density (630/m^2).
- Normalised Difference Vegetation Index (NDVI) measurements indicated that amelioration/seeding method was more influential on the crop in the early phases of development, while nutrition impacts did not appear until September.
- +N and +NPKS were the only treatments to significantly increase head density and grain protein above Standard nutrition.
- Positive non-significant trends existed at first node (GS31), mid-anthesis (GS65) and maturity (GS91) dry matter (DM) in the order of +NPKS greater than +N > standard nutrition, and Spade Seed >Double Rip (2019 & 2022 rip, tine DBS) >Single Rip (2019 rip, tine DBS).
- Standard, +N and +NPKS nutrition treatments were of particular interest and data for these was analysed as a subset. This produced significant differences in some of the assessment data.
    - Harvest DM was greater for double Rip/spade seeding (16.8t/ha) than double Rip and Single Rip by a minimum of 1.8t/ha, but HI was lower at 30.3% compared to 35.2% and 36.2% respectively.
- Based on the lack of response to +OM in most assessments, it seems likely that nutrient release from manure occurred too slowly to have significant crop effect in the year of application.
- Total applied nitrogen throughout the season was 159kg N/ha for standard and no additional nitrogen (+P, +K, and +S) treatments, while +OM, +N and +NPKS treatments received between 205 and 213kg N/ha. These levels were very similar to 2021 figures of 177 and 217kg N/ha, and 2020 figures of 164 and 198kg N/ha, for standard and +N treatments respectively.

For simplicity and brevity the names of the amelioration/seeding method treatments will be shortened throughout this report to ‘Single Rip’ (2019 ripped, tine DBS), ‘Double Rip’ (2019 & 2022 ripped, tine DBS), and ‘Spade Seed’ (2019 & 2022 ripped, spade seeder).

i) Influence of Amelioration/seeding method and Nutrition on grain yield.

There were significant interactions between amelioration/seeding method and nutrition on grain yield and protein. Double Rip with +N nutrition was the highest yielding treatment at 6.09t/ha, although all other Double Rip treatments were not significantly less. Interestingly, with Spade Seed amelioration/seeding method, only the +N and +NPKS nutrition treatments were significantly lower yielding than Double Rip/+N, while all Single Rip treatments except +NPKS and +P were significantly lower yielding (Table 1). Single Rip/+NPKS produced the highest protein grain at 11.2%, although not significantly more than Single Rip/+N, despite different yields. This was significantly higher than all other Single Rip nutrition treatments. The +N and +NPKS treatments also produced the highest protein within the Double Rip and Spade Seed amelioration/seeding method treatments. The lowest protein percentages were generally within Spade Seed treatments, although Double Rip by Standard or +OM were also in this category of statistically similar low protein (Table 1). This data is presented graphically in Figure 1.

Table 1. Influence of soil management (amelioration/seeding method) and nutrition on grain yield (t/ha) and protein (%).

		Yield		**Protein**	
		t/ha		%	
2019 Ripped, Tine DBS					
Standard		5.72	def	10.2	fgh
+N		5.61	ef	11.1	ab
+NPKS		5.92	a-d	11.2	a
+P		5.88	a-e	10.3	fgh
+S		5.61	f	10.3	fgh
+K		5.75	c-f	10.3	fg
+OM		5.82	b-f	10.3	ef
	Mean	5.76		10.5	
2019 + 2022 Double Ripped, Tine DBS					
Standard		5.9	a-d	9.8	k
+N		6.09	a	10.7	cd
+NPKS		6.07	ab	10.6	de
+P		5.94	a-d	10.1	hij
+S		6.01	abc	10.4	ef
+K		5.84	a-f	10.1	ghi
+OM		6.03	ab	9.9	ijk
	Mean	5.98		10.2	
2019 + 2022 Double Ripped, Spade Seeder					
Standard		5.94	a-d	9.8	k
+N		5.72	def	10.9	bc
+NPKS		5.7	def	10.9	c
+P		5.84	a-f	10	ijk
+S		5.95	a-d	9.8	k
+K		6.02	abc	9.9	ijk
+OM		5.83	a-f	9.9	jk
	Mean	5.86		10.2	

Mean	5.87	10.3
LSD	0.27	0.24
P Value	0.048	0.002

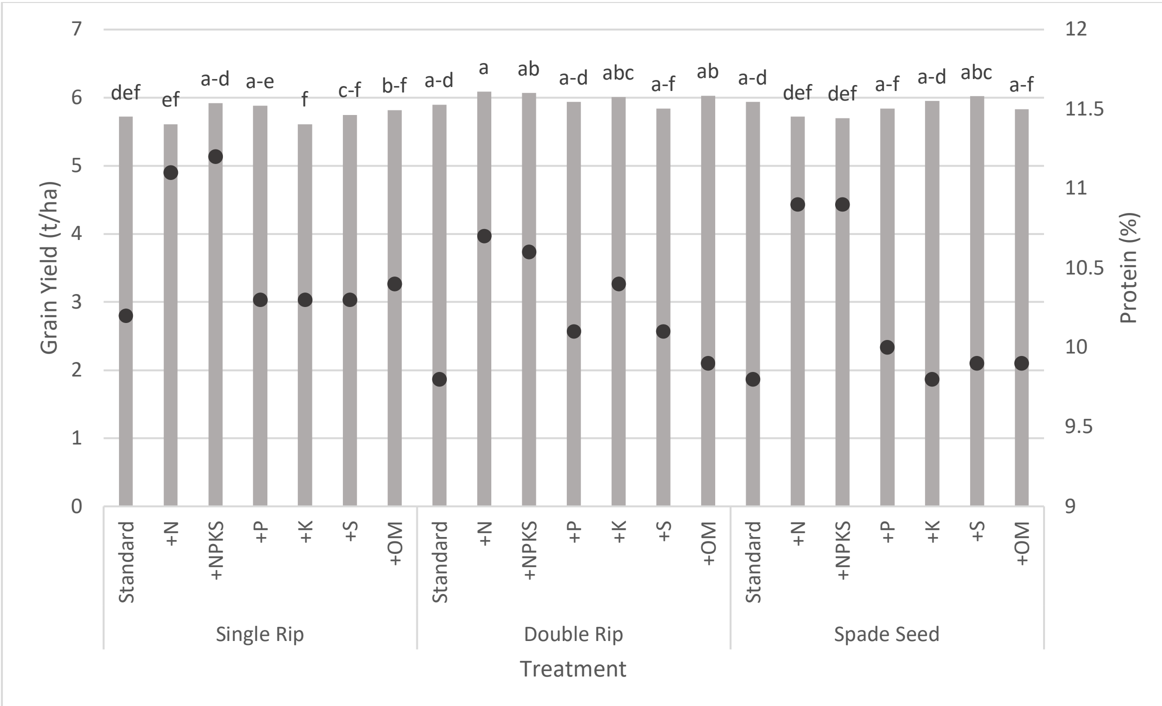

Figure 1. Influence of the interaction between amelioration/seeding method and nutrition on grain yield (t/ha) and protein (%).

ii) Influence of Amelioration/seeding method and Nutrition on establishment and crop structure.

There were no significant interactions between amelioration/seeding method and nutrition on crop establishment, head density or crop height (data not presented). Across all nutrition treatments, there was a non-significant reduction in plant numbers to 172/m^2 under Single Rip (2019) compared to the Double Rip (2019 & 2022) and Spade Seed treatments (193 and 194/m^2 respectively) (Table 2). Due to a high level of variability within treatments of this trial, it is common for non-significant differences to exist. This is also the case for tiller density, where the increase from 699 tillers/m^2 for Double Rip to 852 tillers/m^2 under Spade Seed was non-significant (Table 2). However, Spade Seed did produce significantly more heads at maturity (630/m^2 compared to 501/m^2 for Double Rip) and was approximately 2cm taller (Table 2). The reduction in head density compared to tiller density for all treatments is an indication that early crop growth and vigour could not be supported later in the season, with many tillers not developing heads. Head density for standard nutrition treatments alone was 471, 467 and 572/m^2 respectively for Single Rip, Double Rip and Spade Seed treatments (data not presented).

Table 2. Influence of Amelioration/Seeding method on establishment, tiller density, head density (LSD = 56.6, p-value = 0.001) and crop height (LSD = 1.56, p-value = 0.017).

	Establishment	**Tiller Density**	**Head Density**	**Crop Height**
	#Plants/m^2	#@Tillers/m^2	#Heads/m^2	#cm
Amelioration & Seeding Method	Mean of nutrition treatments	Standard nutrition treatment only	Mean of nutrition treatments	Mean of nutrition treatments

2019 Ripped, Tine DBS	172.3	-	654.4	-	475.2	b	99.2	b
2019 + 2022 Ripped, Tine DBS	192.9	-	698.9	-	501.1	b	99.3	b
2019 + 2022 Ripped, Spade Seeder	194.1	-	851.8	-	630.4	a	101.6	a
Mean	186.4		389.7		535.6		100.0	
LSD (P=0.05)	NS		NS (158.5)*		56.65		1.56	
P Value	0.138		0.051		0.001		0.017	

**LSD has been presented as the P-value of 0.051 indicates that the influence of amelioration treatment/seeding method on differences between tiller density is very close to being statistically significant.*

[#]Establishment was measured at GS12, tiller density at GS31, and head density and crop height at GS91.

[@]Tiller counts were only completed on the standard nutrition treatments.

Nutrition treatment did have a significant influence on mean head density across amelioration/establishment treatments, with +NPKS producing the most heads (580/m^2, Table 3), although +N was not significantly less. Standard, +K, +S and +OM treatments produced the lowest head density (Figure 2). Nutrition treatment did not have a significant effect on crop establishment or height at maturity (Table 3).

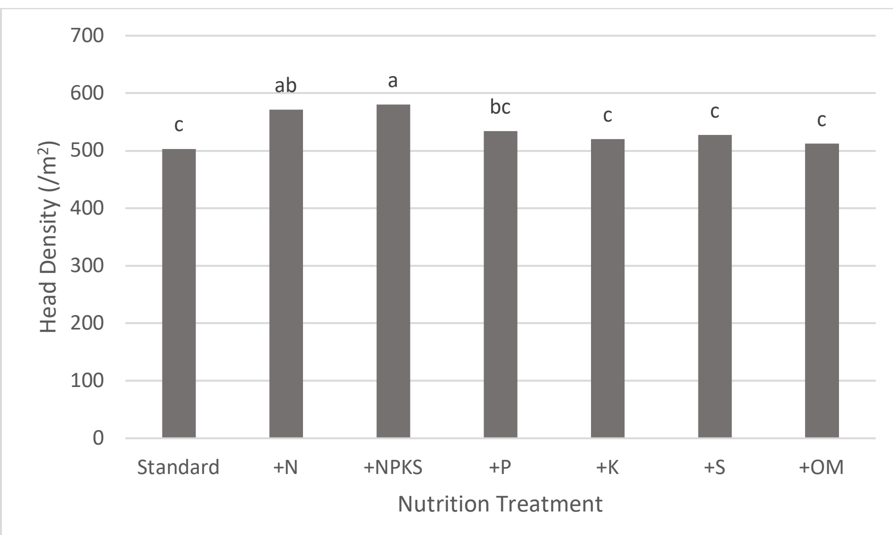

Figure 2. Influence of nutrition treatment on head density (/m^2) at GS91 (LSD = 40.19, p-value = 0.005).

Table 3. Influence of nutrition treatment on establishment, head density and crop height across all amelioration/seeding methods.

	Establishment		Head Density		Crop Height	
	Plants/m^2		Heads/m^2		cm	
Nutrition Treatment						
Standard	95.2	-	503.1	c	99.5	-
+N	102.9	-	571.5	ab	101.2	-
+NPKS	95.9	-	580.2	a	100.5	-

+P	100.4	-	534.1	bc	99.8	-
+K	101.1	-	520.2	c	99	-
+S	96.5	-	527.4	c	100.1	-
+OM	97.1	-	512.4	c	100.1	-
Mean	98.4		535.6		100.0	
LSD (P=0.05)	NS		40.19		NS	
P Value	0.822		0.005		0.298	

Dry Matter (DM) production at 3 key growth stages (GS31/first node, GS65/mid-anthesis and GS91/maturity) for the Standard, +N and +NPKS nutrition treatments is presented in Figure for all amelioration/seeding method treatments. There were no significant treatment differences, however there is variation in DM produced (ranged from 13.46 to 17.58 tonnes per hectare at maturity) and some trends associated with treatments. Spade Seed tended to produce greater DM at all 3 growth stages and appeared to produce greater responses in DM to increasing nutrition (+N or +NPKS compared to Standard nutrition), however since there were no associated increases in grain yield it would appear that increased nutrition in spade seeded plots led to lower harvest index. Double Rip produced smaller improvements in DM over Single Rip compared to Spade Seed. The +NPKS nutrition treatment tended to produce the greatest DM across all amelioration/seeding method treatments, but the benefit over the +N treatment was marginal or absent under Spade Seed) (Figure 3).

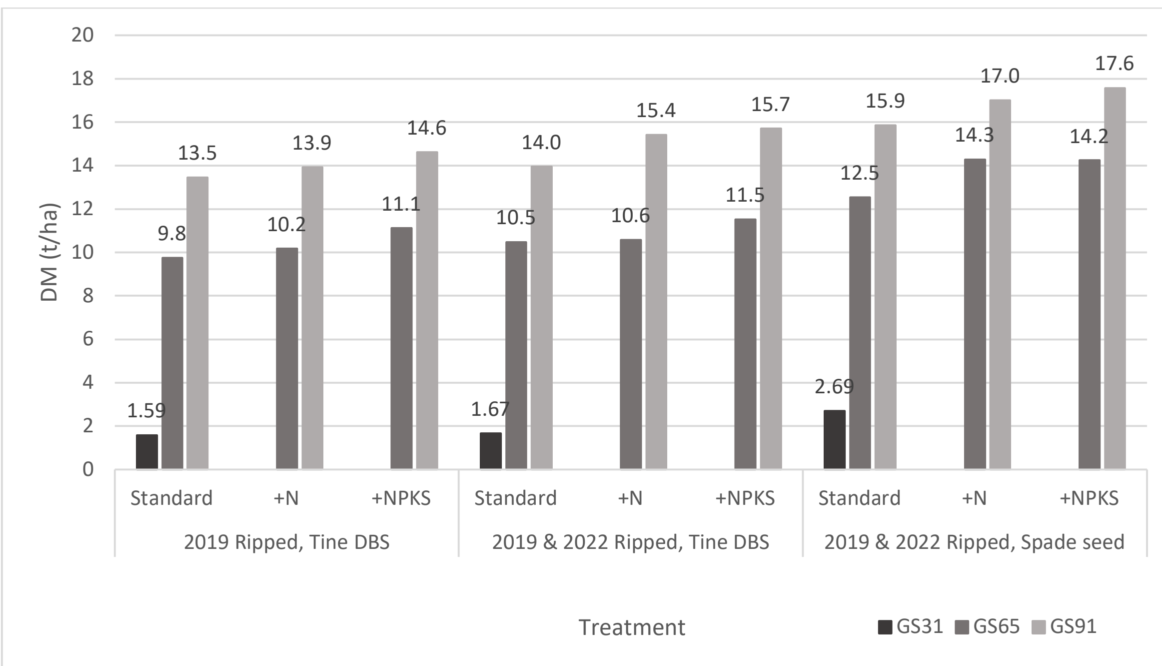

Figure 3. Influence of Amelioration/Seeding method and nutrition (for selected treatments of Standard, +N, and + NPKS) on Dry Matter (DM, t/ha) production at 3 key timings, being first node (GS31), mid-anthesis (GS65) and maturity (GS91). Actual values are displayed above the bars (no significant differences). DM at GS31 was only measured for Standard nutrition treatments.

iii) Influence of Nutrition **within** the Amelioration/Seeding method treatment of 2019 & 2022 Deep Ripped with Tine DBS seeding.

Consistency between replicates of nutrition treatments were observed to be greatest in those under Double Rip amelioration/seeding method treatments. Therefore, harvest DM data was only collected for all nutrition treatments within the Double Rip treatment level and is presented in Table 4 with no significant differences. Harvest DM allowed the calculation of Harvest Index (HI), which was also not significantly influenced by nutrition, although it tended to be lower for +N and +NPKS treatments (4). Mean HI was 36.2%, which is low compared to typical values for wheat, and indicates that some factors (potentially a lack of rainfall in late September immediately post anthesis, or effects of variable lodging on relative harvest grain losses) inhibited the crop's ability to convert DM to grain yield.

Table 4. Influence of nutrition treatments on head density, harvest dry matter, grain yield and Harvest Index (HI) within the 2019 & 2022 Deep Ripped/Tine DBS amelioration/seeding method treatment.

Nutrition Treatment	**Head Density**		**Harvest DM**		**Grain Yield**		**Harvest Index**	
	$/m^2$		t/ha		t/ha		%	
Standard	466.7	c	13.95	-	5.90	-	37.0	
+N	536.7	ab	15.41	-	6.09	-	34.8	-
+NPKS	563.3	a	15.71	-	6.07	-	33.9	-
+P	504.4	bc	14.73	-	5.94	-	35.7	-
+K	482.2	c	14.53	-	6.01	-	37.1	-
+S	486.1	c	13.7	-	5.84	-	37.6	-
+OM	468.3	c	14.02	-	6.03	-	37.7	-
Mean	501.1		14.58		5.98		36.26	
LSD (P=0.05)	46.5		NS		NS		NS	
P Value	0.002		0.226		0.298		0.353	

Figure 4 displays the subset of grain yield and protein data for all nutrition treatments within the Double Rip treatment. Values differ from the amelioration/seeding method means presented in Table 1, but similarly there were no significant differences in yield between nutrition treatments, although protein was greatest under +N and +NPKS and lowest under standard nutrition.

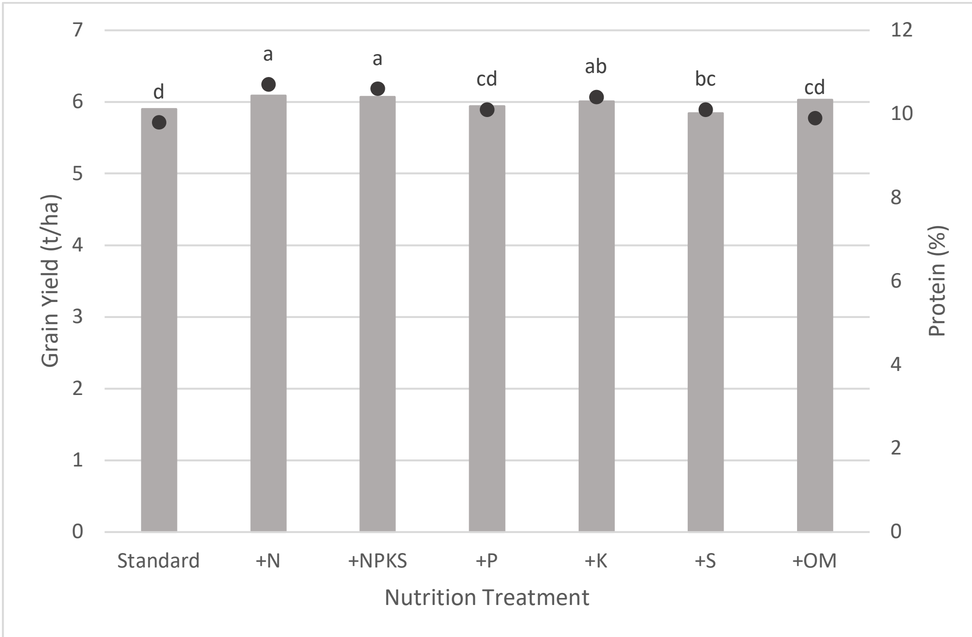

Figure 4. Influence of nutrition on grain yield (t/ha) and protein (%, LSD = 0.31, p-value <0.001) within the 2019 & 2022 ripped/spade seed amelioration/seeding method treatment only. Significance letters apply to protein data, where treatments that do not share the same letter are significantly different.

Figure 5 displays the subset of 9 September NDVI data for all nutrition treatments within the Double Rip treatment.

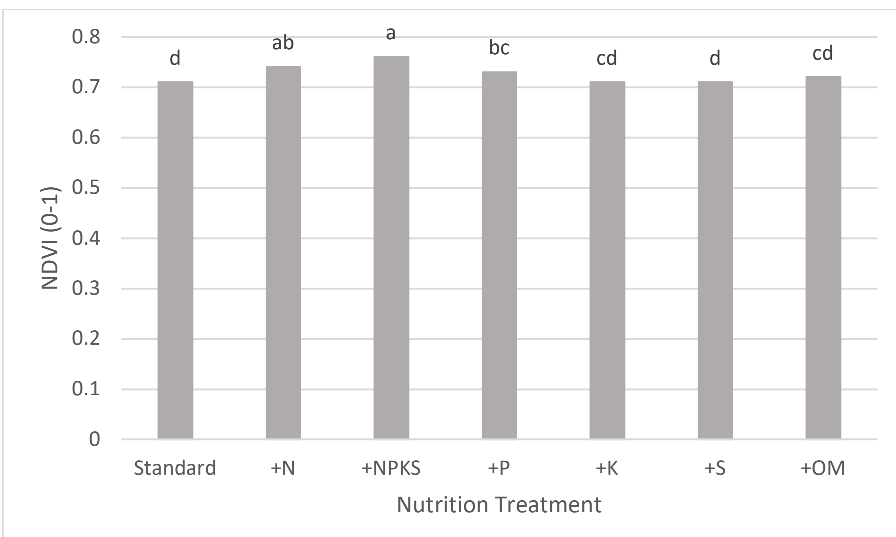

Figure 5. Influence of nutrition on NDVI at GS49 (9 September) within the 2019 & 2022 ripped/spade seed amelioration/seeding method treatment only (LSD = 0.31, p-value <0.001).

iv) Influence of amelioration/seeding method and nutrition only for Standard, +N and +NPKS treatments.

Standard, +N and +NPKS were determined to be the nutrition treatments of interest late in the season, so harvest dry matter was only measured across all amelioration/seeding method treatments for these nutrition treatments. The interaction between amelioration/seeding method and nutrition was not significant across any of these treatments for any measured outcomes (harvest dry matter, yield, protein, test weight and screenings). However, there were independent significant differences between amelioration/seeding method and nutrition treatment when only the standard, +N and +NPKS were analysed.

Table 5. Details of trial management (kg, g, L, ml/ha).

Sowing date:	**17 May (DBS seeded treatments sown 3 days after Spader seeded treatments)**	
Sowing rate:	200 seeds/m^2 (90kg)	
Sowing Fertiliser:	71kg/ha Summit Vigour and 71kg Monoammonium Phosphate (MAP)	
	(15 Kg N; 24.7 Kg P; 8.5 Kg K; 4.9 Kg S)	
Nutrition:		
Pig Manure applied 10 May to +OM	54 kg N; 19.8 kg P; 35.6 kg K; unknown S	
80kg Urea/20kg MOP applied 1st June	37 kg N; 9.9 kg K	
150kg Urea applied 17 July	70 Kg N	
Various nutrition treatments applied 21st July (refer to Table 7)	Various	
60kg Urea applied 10 September	28 kg N	
PGR:	---	
Fungicide:	17 May	Flutriafol 500 – 200 mL
	24 August	Amistar Xtra – 400 mL
	23 September	Elatus Ace – 500 mL

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

Table 6. Total nutrient applied throughout the season to the various nutrition treatments. Variations were applied either through pig manure for the +OM treatment on 10 May, or through various synthetic products (MAP, Urea, Ammonium Sulfate and Muriate of Potash) for other non-standard treatments on the 21st July.

	Total Nutrient applied throughout season (kg/ha)			
Nutrition Treatment	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Sulfur (S)
Standard	159	24.7	18.4	4.9
Standard plus extra N (+N)	211	24.7	18.4	4.9
Standard plus extra NPKS (+NPKS)	213	30.6	43.7	15.5
Standard plus extra P (+P)	159	30.6	18.4	5.4
Standard plus extra K (+K)	159	24.7	42.7	4.9
Standard plus extra S (+S)	159	24.7	18.4	15
Standard plus pig manure (+OM)*	205	44.5	54	4.9

*Pig manure (+OM) rate was targeted to match nitrogen of +N and +NPKS treatments. Phosphorus and Potassium may have been oversupplied. Pig manure analysis did not contain data for Sulfur, so this has not been accounted for despite there being S present in pig manure. Plant availability, particularly of P and S in manure can be quite low, and organic N can also be released quite slowly.

Trial 2. Early sown germplasm (winter vs spring) x management interaction trial

Trial Code: FAR WAE W22-02

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

Key Messages:

- The 2022 season at Gibson was characterised by a relatively warm dry period during late May/early June and again in July, along with high powdery mildew pressure later in the season, and a soft finish.
- Dry Matter (DM) and grain yield, averaged across all cultivars, was significantly reduced by grazing (8.78t/ha and 4.52t/ha respectively) and increased under high input management with an additional 46kg N/ha, fungicide and plant growth regulator (PGR) (11.45t/ha and 5.62t/ha respectively), compared to standard management (9.96t/ha and 4.85t/ha respectively).
- Grazing was still more profitable compared to other management levels for some cultivars, when a feed value is attributed to the dry matter removed.
- High input management produced significantly higher yields, protein, test weight and lower screenings, but was not more profitable than standard management for all varieties as there were significant interactions between cultivar and management.
- Accroc and Scepter (the extremes of the maturity types) produced the lowest density of heads and dry matter at maturity, although a higher Harvest Index (HI) allowed Accroc to out-yield Scepter. This season exposed the risks of sowing Scepter earlier than its optimum window, with the warm dry period hastening development, reducing tiller and biomass production, and causing extremely early flowering on the 26 July. Conversely, Accroc did not flower until the 14 October, one month later than the ideal period.
- The strongest yielding cultivars were the mid-slow springs and quickest winter, LRBP19-14343, which reached mid flower by 28 July to 15 August. Flowering earlier than the theoretically ideal window of mid-September was not an issue in this low frost-risk environment.
- Rockstar yielded consistently well across all management treatments and produced the strongest GM due to achieving higher quality than other similar yielding cultivars.
- LRBP19-14343 (quality grade unconfirmed) and Denison also performed well.
- Beaufort was the highest yielding variety under all management levels, producing on average 5.59t/ha. It was very responsive to high input management with this producing the highest yield of all treatments at 6.44t/ha. However, Beaufort was not the most profitable variety due to classification as feed and the associated price penalty.
- Illabo produced the highest DM under standard management, but the lowest yield despite flowering closest to the ideal window and expressing minimal disease. HI improved under high input management, resulting in greater yield despite the same DM production.

- Scepter and Rockstar had the greatest levels of powdery mildew infection, while expression of other foliar diseases was minimal across all varieties.

ii) Influence of cultivar and management on yield and harvest index

Beaufort was significantly higher yielding than all other cultivars, producing 5.59t/ha on average across all management levels (Table 1), despite flowering one month earlier than the ideal window for this region. Scepter and Illabo were the lowest yielding varieties, producing less than 4.5t/ha, while all other varieties produced on average between 5.01 and 5.25t/ha (Table 1). There was a significant interaction between variety and management input (p=<0.001). Rockstar (spring), LRBP19-14343 (short season winter), Beaufort (spring feed) and RGT Accroc (long season winter) performed well under standard management in terms of grain yield, being above the mean however, relative performance of varieties for grain yield did not match harvest DM as Accroc and Beaufort yielded well despite relatively low DM production, while Denison and Illabo had high dry matter but inefficiently converted it into grain yield. As a result, harvest DM was a poor predictor of grain yield, compared to harvest index, a result in keeping with 2020 and 2021 results. Illabo had a particularly low HI of 33-40%, while Beaufort (44-50%) efficiently converted dm to grain yield.

Table 1. Influence of cultivar and management on yield and harvest index (HI).

	Canopy Management - Grain Yield (t/ha) and Harvest Index (HI)									
	Standard Input			**"Grazed" Standard***			**High Input**			**Mean**
Cultivar (Type)	t/ha		HI	t/ha		HI	t/ha		HI	t/ha
Illabo (Winter)	4.14	j	0.33	3.95	j	0.37	5.06	d-g	0.40	**4.39**
Rockstar (Spring)	5.04	efg	0.42	4.62	hi	0.49	6.1	ab	0.51	**5.25**
LRPB19-14343 (Winter)	5.14	d-g	0.43	4.73	ghi	0.45	5.43	cde	0.39	**5.1**
Beaufort (Spring)	5.28	def	0.48	5.04	e-h	0.50	6.44	a	0.44	**5.59**
Denison (Spring)	4.79	gh	0.40	4.93	fgh	0.51	5.78	bc	0.41	**5.16**
RGT Accroc (Winter)	5.22	def	0.51	4.34	ij	0.44	5.48	cd	0.40	**5.01**
Scepter (Spring)	4.32	ij	0.43	4.01	j	0.40	5.07	d-g	0.47	**4.47**
Mean	**4.85**			**4.52**			**5.62**			
LSD Cultivar p = 0.05				0.25		P Value		<0.001		
LSD Management p = 0.05				0.28		P Value		<0.001		
LSD Cultivar x Management p = 0.05				0.43		P Value		<0.001		

**"Grazed Standard" – simulated grazing using mechanical defoliation*

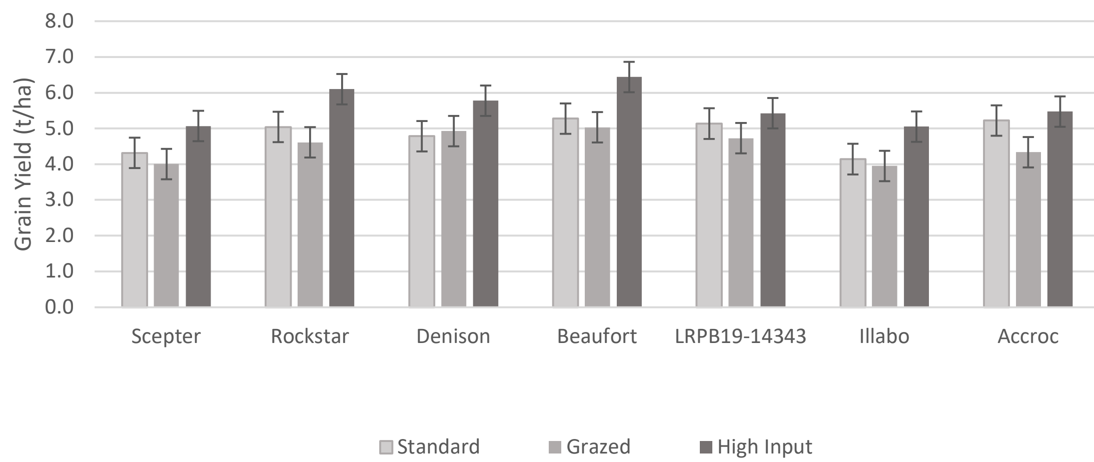

Figure 1. Influence of cultivar and management on grain yield (t/ha) (LSD=0.43, P value < 0.001).

iii) Influence of cultivar and management on canopy structure and dry matter.

Average plant density across varieties was 148 plants/m^2, which is very close to the target of 150 plants/m^2. LRBP19-14343 had the lowest plant density of 110/m^2, while Beaufort and RGT Accroc were the highest at 168 and 171/m^2 respectively (Table 2).

There were significant differences between cultivars under standard management in the number of heads/m^2, measured on the 27 October. LRBP19-14343 had compensated strongly to produce the greatest number of heads at 337/m^2 (Table 2), this was statistically more heads than RGT Accroc and Scepter. The slow developing winter maturity of RGT Accroc had a large number of tillers (observation) but later tillers developed too late and aborted. Scepter had the lowest head density (262/m^2, Table 2) as a result of the very short vegetative period prior to GS30.

Table 2. Influence of cultivar on plant and head density/m^2) and dry matter production (t/ha) at maturity under standard management.

	Canopy Structure					
Cultivar (Type)	Plants		Heads		Maturity Dry Matter	
	/m^2		/m^2		t/ha	
Illabo (Winter)	157	-	301	abc	11.12	a
Rockstar (Spring)	143	-	311	ab	10.42	ab
LRPB19-14343 (Winter)	110	-	337	a	10.44	ab
Beaufort (Spring)	168	-	311	ab	9.63	abc
Denison (Spring)	146	-	313	ab	10.52	ab
RGT Accroc (Winter)	171	-	283	bc	8.87	bc
Scepter (Spring)	141	-	262	c	8.7	c
Mean			303		9.96	
LSD			39.5		0.5	
P Value			0.416		0.0001	

Head counts were much lower this season than in 2021 (303 compared to 379 under standard management), which likely correlates with and explains the lower grain yields produced in 2022. Crop height was significantly greater in the standard treatments (86.8cm) compared to grazed and high input, which were equal (81.6cm, data not presented). Therefore, the plant growth regulators had the same effect as grazing in terms of reducing plant height, despite greater applied nitrogen rates under high input management. There were no significant differences in low levels of lodging between management levels, although high input and grazed did result in more and less lodging respectively compared to standard management (data not presented).

Management level had a strong influence on dry matter (DM) at both mid-flowering (GS65) and harvest, although only harvest data has been presented in Figure 2. Grazing significantly lowered biomass (DM) compared to standard and high input treatments at both timings, although the relative reduction was less by the time of harvest. Conversely, high input management resulted in greater biomass compared to the standard treatment at both timings, although the difference was not significant at mid-flower. This indicates that both the grazed and high input treatments developed greater biomass late in the season (post GS65) compared to the standard management level.

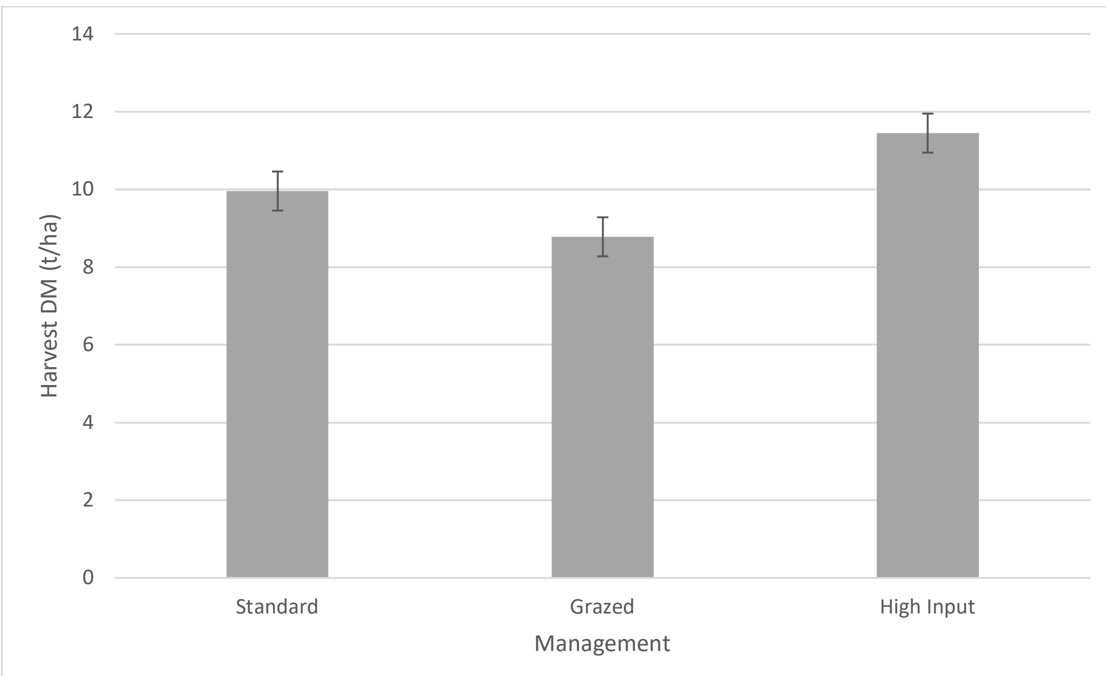

Figure 2. Influence of management on harvest dry matter (t/ha) averaged across all cultivars (LSD=0.504, P value=0.0001).

There was a significant interaction between cultivar and management treatment on harvest dry matter (t/ha) (Table 3).

Table 3. Influence of cultivar and management on harvest dry matter (t/ha).

	Canopy Management (Harvest Dry Matter t/ha)							
	Standard		**"Grazed" Standard***		**High Input**		**Mean**	
Cultivar (Type)	t/ha		t/ha		t/ha		t/ha	
Illabo (Winter)	11.12	a-d	9.3	fgh	11.04	b-e	**10.48**	**a**
Rockstar (Spring)	10.42	d-g	8.33	h	10.48	c-f	**9.74**	**ab**

LRPB19-14343 (Winter)	10.44	c-g	9.26	fgh	12.15	ab	**10.62**	**a**
Beaufort (Spring)	9.63	d-h	8.77	h	12.67	a	**10.35**	**a**
Denison (Spring)	10.52	c-f	8.46	h	12.33	ab	**10.44**	**a**
RGT Accroc (Winter)	8.87	gh	8.66	h	12.02	abc	**9.85**	**ab**
Scepter (Spring)	8.7	h	8.69	h	9.49	e-h	**8.96**	**b**
Mean	**9.96**	**b**	**8.78**	**c**	**11.45**	**a**		
LSD Cultivar p = 0.05			0.92	P Value	0.008			
LSD Management p = 0.05			0.50	P Value	<0.001			
LSD Cultivar x Management p = 0.05			1.59	P Value	0.041			

"Grazed Standard" – simulated grazing using mechanical defoliation

Figure 3 displays harvest DM (t/ha) for all cultivar by management treatments, along with the biomass removed by grazing for grazed treatments. There was no significant difference in DM removed by grazing between the varieties, but this graph reveals which varieties were most positively or negatively impacted by grazing or high input management.

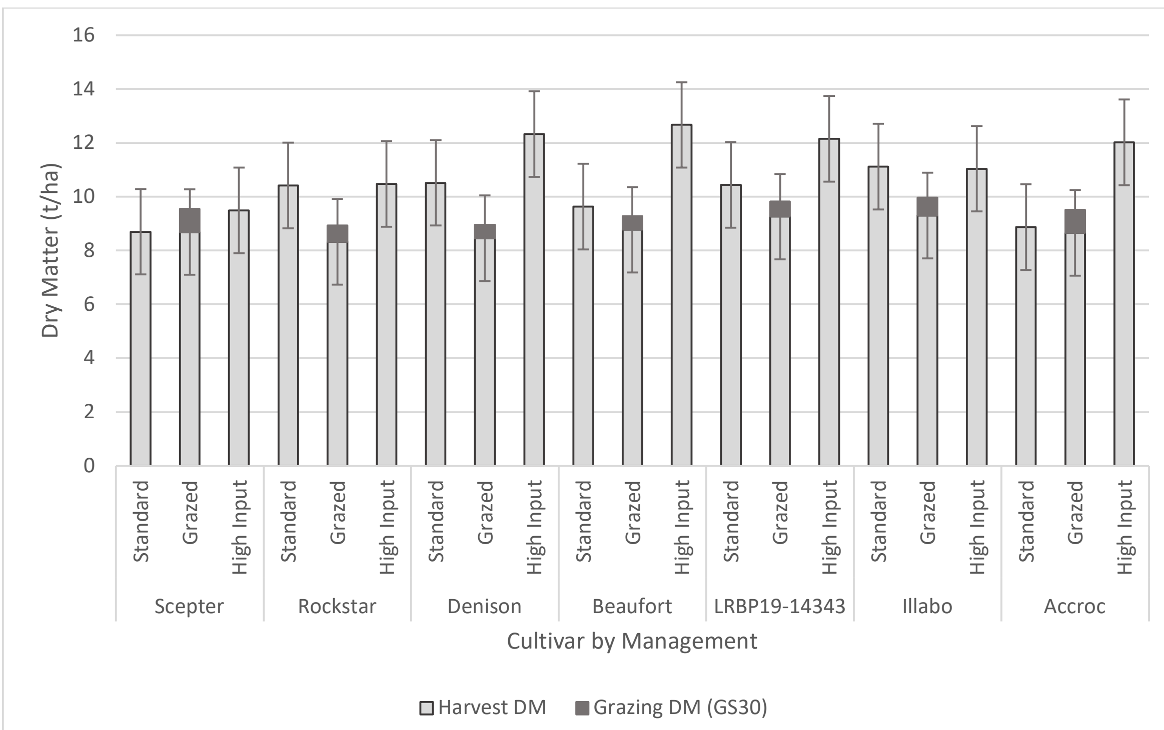

Figure 3. Influence of cultivar and management on harvest dry matter (t/ha) and the dry matter (t/ha) removed by grazing, the timing of which differed between cultivars depending on approximate timing of GS30. For harvest DM, LSD=1.59 and P value=0.0412. There was no significant difference between cultivars in the DM removed by grazing at GS30 (LSD=0.281). Cultivars are in order of increasing maturity length.

Severity of Yellow Leaf Spot and *Staganospora nodorum* diseases was minimal in all varieties and management levels. There was greater severity of Powdery Mildew (greatest plot infection average of 10.3% in grazed Rockstar) with significant differences in severity between varieties (Figure 4).

Rockstar and Scepter exhibited the highest levels of infections (6.8 and 8% respectively), while LRPB19-14343 and RGT Accroc exhibited the least (0.1 and 0% respectively). Differences in Powdery Mildew severity between management treatments were not significant, although there was a trend for disease levels to be greatest under grazed management and lowest under the high input system. The same trends between varieties existed regardless of management strategy.

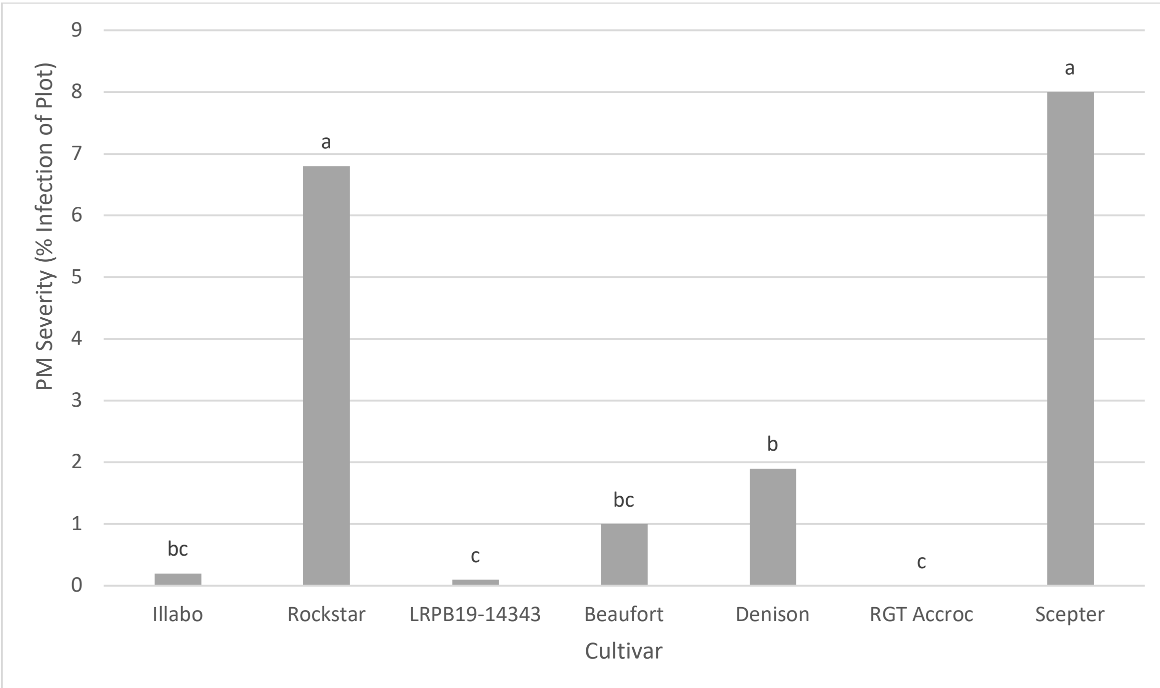

Figure 4. Influence of cultivar on Powdery Mildew (PM) severity as measured on a percent infection of plot basis on 22 September. Letters above bars on graph indicate significance with treatments not sharing the same letter being significantly different.

iiii) Influence of cultivar on phenology

The 2022 season included a warmer than normal period in late May to early June, which increased the rate of development of the spring cultivars and reduced early vegetative biomass, particularly of Scepter as previously described. The sequence in which varieties reached stem elongation (GS30) mostly aligns with the published maturity type of each, although Denison and Beaufort should be slower than Rockstar. Grazing treatments were applied close to GS30, although RGT Accroc was grazed early on 22 July at the tillering stage (25 days later than other winters), however it was still unable to recover sufficient biomass to maintain grain yield.

Temperatures were also above average for the majority of July and this seems to have had a stronger influence on the rate of development of LRBP19-14343 compared to Illabo, which reached the middle of flowering on 3 and 14 September respectively (Table 4). LRBP19-14343 is described as a 'winter Scepter' with relatively quick development once it reaches the reproductive phase, which aligns with this observation of faster development in July compared to Illabo. These were the only 2 cultivars to flower near the optimum period of mid-September for this region. Interestingly Illabo was the lowest yielding variety despite flowering closest to the theoretically ideal window. The longer maturity and slower development of Denison and Beaufort compared to Rockstar also becomes more apparent at this later growth stage. All spring varieties flowered from late July to mid-August, and the slow winter RGT Accroc did not flower until mid-October. These results are consistent with previous results.

Table 4. Calendar date and Days After Sowing (DAS) that each cultivar under standard management reached stem elongation (GS30) and the middle of flowering (GS65).

Cultivar (type)	Date GS30	DAS GS30	Date GS65	DAS GS65
Illabo (Winter)	28 June	73	14 September	151
Rockstar (Spring)	10 June	55	28 July	103
LRPB19-14343 (Winter)	25 June	70	3 September	140
Beaufort (Spring)	11 June	56	15 August	121
Denison (Spring)	8 June	53	11 August	117
RGT Accroc (Winter)	28 July	103	14 October	181
Scepter (Spring)	5 June	50	26 July	101

iiv) Influence of cultivar and management on grain quality.

Scepter had the highest protein level at 12.6% combined with a relatively high test weight and lower screenings which would relate to its lower grain yield (Table 5.). Illabo, the other lowest yielding variety, also had low screenings, but the lowest test weight, which can be typical of this cultivar, and caused quality to be downgraded to General Purpose (GP). Of the higher yielding varieties, Beaufort and LRBP-19-14343 showed some dilution of protein, greater screenings (LRBP19-14343 was the highest at 1.93%), and reduced test weight (Beaufort was lowest at 71.9Kg/hL, but this had no impact on quality grade as this is a red feed wheat). However, Rockstar and Denison maintained above average protein and test weight despite yielding statistically similar to LRBP19-14343. RGT Accroc had the highest test weight, but the lowest protein, despite only producing an average yield.

Table 5. Influence of cultivar on grain yield (t/ha) and quality (%, kg/hL) (mean of three management strategies).

	Yield		**Protein**		**Test weight**		**Screenings (<2mm)**	
Cultivar (Type)	t/ha		%		Kg/hL		%	
Illabo (Winter)	4.38	c	11.84	bc	72.8	e	0.69	d
Rockstar (Spring)	5.25	b	12.03	b	76.1	c	0.89	c
LRPB19-14343 (Winter)	5.1	b	10.63	d	74.9	d	1.93	a
Beaufort (Spring)	5.59	a	10.7	d	71.93	f	1.24	b
Denison (Spring)	5.16	b	11.52	c	76.63	bc	1.26	b
RGT Accroc (Winter)	5.0	b	9.69	e	78.6	a	1.02	c
Scepter (Spring)	4.47	c	12.55	a	76.81	b	0.85	cd
Mean	4.99		11.3		75.4		1.1	
LSD	0.25		0.33		0.64		0.17	
P Value	<0.001		<0.001		<0.001		<0.001	

Protein and test weight were significantly higher, and screenings significantly lower in the high input management treatment compared to the standard and grazed management treatments, despite greater yield (Table 6). The increased protein can be explained by the additional 46kg/ha of nitrogen applied throughout the season, although test weight and screenings may be expected to decline under higher yields. Extended green leaf retention due to strobilurin component of the second foliar fungicide may have counteracted this. Screenings were significantly higher under grazed management (1.4% compared to 1.0% for standard and 0.9% for high input), despite producing the lowest yield, while protein and test weight were lowest of all the treatments, but not significantly less than standard management. No additional nitrogen was applied to grazed treatments above standard management to compensate for nitrogen removed in plant material at grazing.

Table 6. 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	4.85	b	11.2	b	75.1	b	1.0	b
Standard Grazed Management	4.52	c	10.7	b	74.9	b	1.4	a
High Input Management	5.62	a	12.0	a	76.2	a	0.9	c
Mean	5.00		11.3		75.4		1.1	
LSD	0.28		0.55		0.52		0.08	
P Value	<0.001		0.004		0.002		<0.001	

Table 7. Influence of cultivar and management on gross margin ($/ha).

		Canopy Management (Gross Margin $/ha)				
	Quality Grade	**Standard Input**	**"Grazed" Standard***		**High Input**	**Mean**
Cultivar (Type)		$/ha	$/ha		$/ha	$/ha
Illabo (Winter)^	GP	1,326	1,446	(181)	1,412	1,402
Rockstar (Spring)	H2	2,017	2,008	(162)	**2,235**	2,100
LRP19-14343 (Winter)[@]	GP	1,644	1,666	(151)	1,532	1,632
Beaufort (Spring)*	Feed	1,584	1,648	(138)	1,727	1,677
Denison (Spring)	APW1	1,770	1,956	(132)	1,932	1,909
RGT Accroc (Winter)*	Feed	1,567	1,530	(230)	1,437	1,500
Scepter (Spring)	H2[#]	1,727	1,838	(235)	1,924	1,788
Mean		**1,662**	**1,727**		**1,743**	**1,715**

**Feed price assumed for Red Feed wheats*

[#]High input Scepter achieved H1 grading and was priced accordingly

^Illabo was downgraded due to low hectolitre weight

[@]No confirmed quality grading for LRBP19-14343

Grain price assumptions ($/tonne): H1 - 420, H2 - 400, APW1 - 370, GP - 320, Feed - 300

Value of DM removed in grazing treatment assumed to be $0.27/kg and listed in brackets.

GM values do not account for all costs, only those relative between treatments. Therefore the same costs were applied to standard and grazed treatments, while high input management incurred an additional $205.46/ha of fertiliser, fungicide and PGR costs.

Table 8. Details of the three management levels (kg, g, ml/ha).

Plant pop'n:		**200 seeds/m² (150 plants/m² target) sown 16 of April**		
		Standard	**"Grazed" Standard**	**High Input**
Grazed:		----	✓	----
Seed treatment:			Vibrance/ Gaucho	
Basal Fertiliser:	71kg Summit Vigour compound and 71kg Monoammonium Phosphate (MAP)			
Nitrogen:	1 June	37 kg N (10K)	37 kg N (10K)	37 kg N (10K)
	15 June	----	----	23 kg
	17 July	70 kg N	70 kg N	70 kg
	23 July	---	---	23 kg
PGR:	GS31	----	----	100mL Moddus Evo
				1.3L Errex
Fungicide:	GS00	----	----	Systiva
	GS31	150mL Prosaro	150mL Prosaro	300mL Prosaro
	GS39	500mL Opus	500mL Opus	840mL Radial
	GS59/61	----	---	500mL Opus

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

Trial 3. Wheat early sown germplasm screening trial – winter and spring

Trial Code: FAR WAE W22-03

Objectives: To assess new short-season winter wheats and longer season spring wheats for mid-April (16 April) sowing opportunities.

Key Messages:

- All coded lines of winter wheat included in the trial were significantly slower than the spring cultivars Scepter and Catapult, but quicker than Illabo, the current standard winter wheat grown in the Esperance Port Zone.
- There were differences between these varieties in the rate of development during vegetative and reproductive phases.
- All coded lines reached mid-flower (GS65) between the 22nd of August and 1st of September, which is before the theoretically ideal window of mid-September.
- Despite this, 3 coded lines (LTU001-038, LTU002-18-01, and LTU001-066) yielded significantly greater than all other varieties in the trial at 4.44 - 4.56t/ha, compared to the average of 4.22t/ha for the trial as a whole.
- These yields did dilute protein in LTU002-18-01 and LTU001-066 to 11 and 11.2% respectively, although protein for LTU001-038 remained at 12.2%. Protein was highest in Scepter at 13.1%.
- Illabo and LTU01-039 were the lowest yielding varieties, producing less than 4t/ha.

- Test weight for Illabo, LTU001-039 and LTU001-092 were lower than other varieties and would restrict these cultivars to delivery as General Purpose (GP).
- LTU002-18-01 was the tallest cultivar at 102.7cm, while LTU001-038 was shorter than Scepter and Illabo at 81.2cm.
- Some coded lines exhibited a greater degree of lodging, with LTU001-039 being the most affected with a score of 60 (/500), however with a score of 60 the degree of severity was very low (crop leaning).
- The incidence of foliar disease was low throughout the trial, although LTU001-092 exhibited significantly higher levels of Yellow Leaf Spot than other varieties, while Powdery Mildew was more severe in Scepter, Catapult and LTU001-066, especially compared to Illabo, LTU001-038 and LTU001-039.

i) Influence of cultivar on phenology

It was very difficult to accurately determine growth stages of coded winter cultivars due to the variability in phenotype caused by off-types within the same plot. LTU001-039 was assessed to have the poorest purity and LTU002-18-01 the best, while LTU001-038, LTU001-066 and LTU001-092 were of moderate purity.

The 2022 season included a warmer and drier than normal period in late May to early June, and temperatures were also above average for the majority of July which would have influenced development particularly of spring varieties. There was only three days' difference in development of the spring cultivars at GS30, but this had extended by GS65 with Catapult reaching mid-flower 16 days later than Scepter. All winter coded lines reached stem elongation between the 20 and 29 of June, which was 15 to 16 days earlier than Illabo, the current standard winter wheat for the Esperance Port Zone. Mid-flower for Illabo occurred in the theoretically ideal window of mid-September (14 September, Table 1), however all coded winter lines flowered 13 to 23 days earlier in Mid-August to the 1st of September.

Table 1. Calendar date and Days After Sowing (DAS) that each cultivar reached stem elongation (GS30) and the middle of flowering (GS65) based on the Zadoks Growth Scale (GS00-99).

Cultivar (type)	Date GS30	DAS GS30	Date GS65	DAS GS65	Days from GS30 to GS65
Scepter (Spring)	7 June	52	24 July	99	47
Illabo (Winter)	5 July	80	14 September	151	71
LTU001-038 (Winter)	21 June	66	22 August	128	62
LTU001-039 (Winter)	20 June	65	27 August	133	68
LTU001-066 (Winter)	29 June	74	30 August	136	62
LTU001-092 (Winter)	23 June	68	28 August	134	66
LTU002-18-01 (Winter)	22 June	67	1 September	138	71
Catapult (Spring)	10 June	55	10 August	116	61

There were differences between the coded winter cultivars in how they developed, despite all flowering within 10 days of each other. LTU001-038 was the quickest variety, reaching GS65 in 128 days on the 22 August. LTU001-066 was relatively long overall but tended to develop more slowly through the vegetative phase and then develop more quickly in the stem elongation to flowering phase. Conversely, the slowest coded cultivar, LTU002-18-01 developed at a moderate pace until GS30 then progressed slowly, taking the same amount of time between GS30 and GS65 as Illabo.

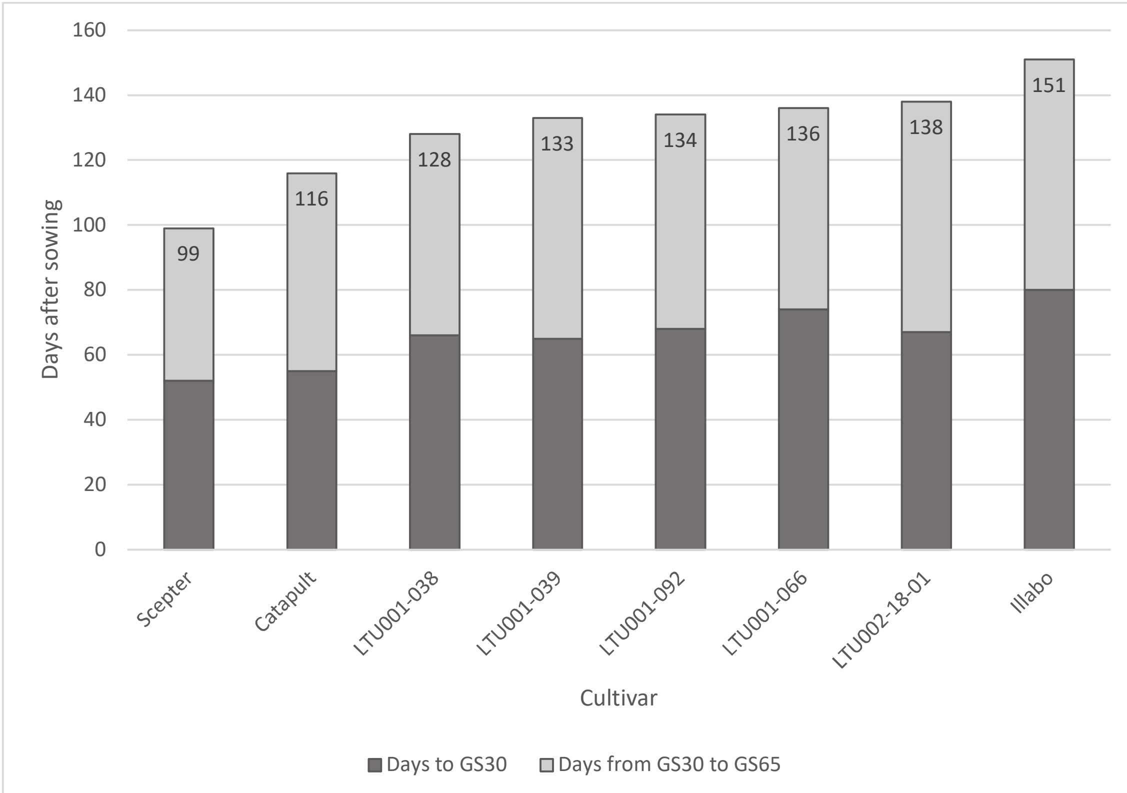

Figure 1. Phenology of cultivars (in order of maturity length) as measured by days between sowing and GS30, days between GS30 and GS65, and total days from sowing to GS65 as indicated by the labelled numbers at the top of the bars.

ii) Influence of cultivar on canopy structure and disease

Plant density averaged 145 plants/m^2 (data not presented), with no significant difference between varieties. There were significant differences in crop height (cm) and Lodging Index (scale of 0 to 500) at maturity (growth stage at time of assessment varied from 83 to 92), however these results should be considered with caution as the coded winter wheats displayed significant phenotypic variability and impurity. LTU002-18-01 was the tallest cultivar at 102.7cm, while LTU001-038 was shorter than even Scepter and Illabo at 81.2cm (Table 2). All other coded lines were similar in height to Catapult. There does seem to be a trend of increased risk of lodging in winter varieties of taller plant height, particularly for LTU001-039, LTU001-066 and LTU001-092.

Table 2. Influence of cultivar on crop height (cm) and lodging index (0-500) at maturity (GS83-92).

	Crop Height		**Lodging Index**	
Cultivar (Type)	cm		0-500	
Scepter (Spring)	89.7	c	0	b
Illabo (Winter)	85.7	c	0	b
LTU001-038 (Winter)	81.2	d	0.3	b
LTU001-039 (Winter)	97.2	b	60	a
LTU001-066 (Winter)	95.9	b	28.8	ab
LTU001-092 (Winter)	95	b	26.4	ab
LTU002-18-01 (Winter)	102.7	a	3.8	b
Catapult (Spring)	94.8	b	0	b

Mean	92.8	14.9
LSD	4.3	39.3
P Value	<0.001	0.037

There were no significant differences between varieties in expression of *Staganospora nodorum*, and only LTU001-092 exhibited significantly higher levels of Yellow Leaf Spot than other varieties, although still at very low levels. There were significant varietal differences in the level of powdery mildew expression. Scepter displayed the greatest level of plot infection at 3.3% of leaf area, but not significantly more than Catapult or LTU001-066; while Illabo, LTU001-038 and LTU001-039 expressed the least infection (Table 3) and may have useful varietal resistance for powdery mildew management. Powdery Mildew infection may be underestimated for spring cultivars as disease lesions had started to dry out by the time of assessment for these varieties, and infection levels in Scepter were lower than the same variety in the wheat germplasm by management by environment trial.

Table 3. Influence of cultivar on severity of infection by the foliar diseases, Powdery Mildew, Yellow Leaf Spot and Stagonospora nodorum.

	Powdery Mildew		**Yellow Leaf Spot**		***Stagonospora nodorum***	
Cultivar (Type)	%		%		%	
Scepter (Spring)	3.3	a	0	b	0.3	-
Illabo (Winter)	0.1	c	0.1	b	0	-
LTU001-038 (Winter)	0.3	c	0.2	b	0.4	-
LTU001-039 (Winter)	0.1	c	0.1	b	0.3	-
LTU001-066 (Winter)	2.4	ab	0	b	0	-
LTU001-092 (Winter)	1.4	bc	0.5	a	0.3	-
LTU002-18-01 (Winter)	0.6	bc	0	b	0	-
Catapult (Spring)	1.5	abc	0.1	b	0	-
Mean	1.18		0.12		0.15	
LSD	1.85		0.28		0.53	
P Value	0.013		0.021		0.6	

iii) Influence of cultivar on grain yield and quality

The average yield across all cultivars was 4.22t/ha, with the significantly higher yielding varieties being LTU001-038 and LTU002-18-01 at 4.44t/ha, and LTU001-066 at 4.56t/ha (Table 4). Flowering time of these highest yielding varieties was spread throughout the 10-day window in late August to 1st September of the coded winter lines. Illabo and LTU001-0039 were the lowest yielding cultivars, producing less than 4t/ha. Protein was significantly higher in Scepter (13.1%) than for all other varieties, while LTU002-18-01 and LTU001-066 had the lowest protein at 11 and 11.2% respectively. These were two of the higher yielding varieties, while LTU001-038 maintained protein at 12.2% despite its superior yield. Test weight was lowest for Illabo at 71.2Kg/hL, while LTU001-39 and LTU001-092 were also below the threshold to grade above General Purpose (GP). Screenings were not a quality issue for any cultivar, but were significantly higher in LTU001-039 and LTU002-18-01.

Table 4. Influence of variety on grain yield and quality (protein, test weight and screenings).

	Yield		Protein		Test Weight		Screenings	
Cultivar (Type)	t/ha		%		Kg/hL		%	
Scepter (Spring)	4.1	b	13.1	a	76	ab	0.4	c
Illabo (Winter)	3.93	bc	12.1	b	71.2	e	0.7	c
LTU001-038 (Winter)	4.44	a	12.2	b	76.2	a	0.7	c
LTU001-039 (Winter)	3.9	c	12.3	b	73.9	cd	3.2	a
LTU001-066 (Winter)	4.56	a	11.2	c	75	bc	1.6	b
LTU001-092 (Winter)	4.03	b	12.2	b	73.3	d	1.8	b
LTU002-18-01 (Winter)	4.44	a	11	c	75.3	ab	2.8	a
Catapult (Spring)	4.38	b	12.3	b	75.2	ab	0.7	c
Mean	4.22		12.02		74.5		1.49	
LSD	0.2		0.51		1.22		0.51	
P Value	<0.001		<0.001		<0.001		<0.001	

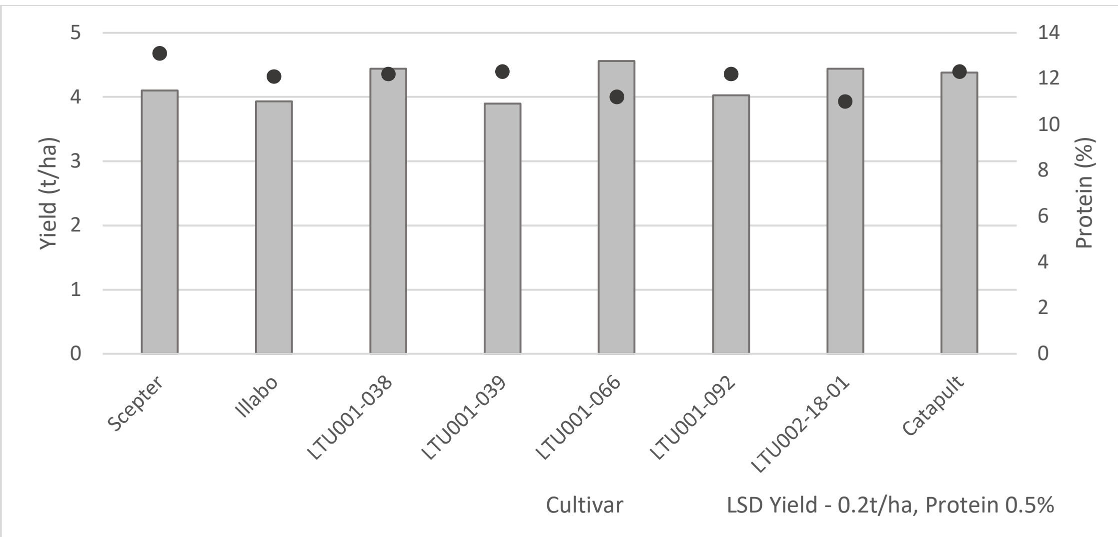

Figure 2. Influence of cultivar on grain yield (t/ha) and protein (%).

Table 5. Details of the management levels (kg, g, ml/ha).

Sowing date:		**16 April**
Seed Rate:		200 Seeds/m^2
Sowing Fertiliser:	71kg Summit Vigour Compound and 71kg Monoammonium Phosphate (MAP)	
Seed Treatment:		Vibrance / Gaucho
Grazing:		Nil
Nitrogen:	1 June	37 kg N (10K)
	17 July	70 kg N
PGR:		-
Fungicide:	GS31	300mL Prosaro
	GS39*	500mL Opus

**Second fungicide was delayed. Spring cultivars were treated on 23 July at GS45-59. Winters were treated on 13 August at GS39 for Illabo and GS49-61 for coded lines.*

Trial 4. Main Season Sowing Elite Germplasm Evaluation

Trial Code: FAR WAE W22-04

Objectives: To assess the performance of wheat sown in the traditional May sowing window (sown 9 May) on the same site as early sown wheat.

Key Learnings:

- The onset of flowering (GS61) varied greatly between spring cultivars, with a 19-day range between Sting, the fastest maturing variety and Valiant and Catapult, which were the slowest of the springs.
- In a frost-free environment, there was a clear correlation between early flowering and high yields.
- Although not statistically comparable, Scepter, Rockstar and Denison sown in May produced a higher yield, greater biomass and more heads/m^2 than when sown early (17 April) in an adjacent trial.
- Anapurna, the only winter variety, was significantly lower yielding than the majority of spring cultivars.
- Susceptibility to Powdery Mildew (PM) and Yellow Leaf Spot (YLS) varied greatly between varieties, with Denison and Trojan showing high levels of resistance to both diseases.

Table 1. Cultivar effect on the onset of flowering (GS61) and the interaction with yield (t/ha).

Cultivar	Onset of Flowering (GS61)	DAS GS61	Yield (t/ha)	
Scepter (Spring, Milling)	2-Sep	116	5.4	ab
Valiant (Mid-Long spring, AH)	12-Sep	126	4.84	cd
Anapurna (Winter, Feed)	14-Oct	168	4.44	d
Rockstar (Mid-Late Flower, AH)	2-Sep	116	5.77	a
Vixen (Early-Mid Flower, AH)	28-Aug	111	5.41	ab
Trojan (Spring, APW)	2-Sep	116	4.95	c
Catapult (Mid-Long Spring, AH)	12-Sep	126	5.03	bc
Denison (Spring, APW)	15-Sep	129	5.14	bc
Sting (Spring, AH)	24-Aug	107	5.56	a
Devil (Spring, AH)	28-Aug	111	5.61	a
LSD = 0.05			**0.416**	

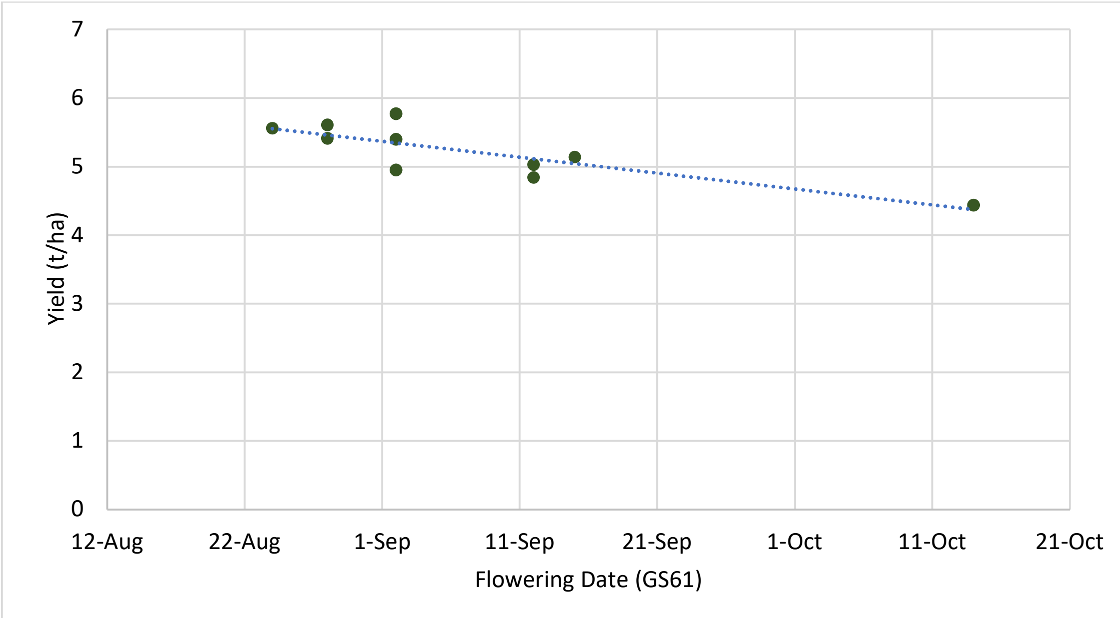

Figure 1. Variety effect on flowering date (GS61) and the intereaction with yield (t/ha).

In a relatively frost free environment, phenology of spring cultivars had a large inpact on yield, with fast maturing varieties producing a higher yield when compared to later flowering or winter cultivars. The fastest cultivar to reach flowering was Sting, which occured 107 days after seeding. Anapurna, the only winter varitiey in the trial, took an additional 61 days to reach this same growth stage and produced 0.77t/ha less then the average yield for the trial (5.25t/ha). Rockstar was the highest yielding variety which produced 5.77t/ha

Table 2. Comparison of harvest dry matter (t/ha), head count/m^2 and yield (t/ha) between three spring varities (Scepter, Rockstar and Denison) sown either early on the 16 April (trial 2), or later on the 9 May (trial 4).

Variety	**Harvest Dry Matter (t/ha)**		**Head Count/m2**		**Yield (t/ha)**	
	April Sown	May Sown	April Sown	May Sown	April Sown	May Sown
Scepter	8.70	11.02	262	334	4.32	5.40
Rockstar	10.42	12.72	311	416	5.04	5.77
Dension	10.52	11.48	313	419	4.79	5.14
**Note that as these results are across two trials, they cannot be directly compared hence the lack of Significant values.*						

Although not statistically comparable, there are general trends apparent from the two sowing dates. In a frost-free environment, delaying seeding until the traditional May sowing period for spring cultivars produced larger dry matter at harvest, higher number of heads, and overall greater yields. Scepter, the fastest maturing variety of the three had the largest range in harvest dry matter (8.7-11.02t/ha) and yield (4.32-5.4t/ha) highlighting the importance of matching sowing date to variety phenology.

Table 3. Variety effects on grain yield (t/ha) and quality (Protein %, Test Weight kg/hL and Screenings %).

Variety	Yield (t/ha)		Protein (%)		Test Weight (kg/hL)		Screenings (%)	
Scepter	5.4	ab	10.9	bcd	76.4	b	2	bc
Valiant	4.84	cd	11.5	a	78.2	a	1.6	d
Anapurna	4.44	d	11.1	abc	70.8	c	1.9	bcd
Rockstar	5.77	a	10.5	cd	77.1	ab	2.3	b
Vixen	5.41	ab	11	abc	76.3	b	1.6	cd
Trojan	4.95	c	11.3	ab	76	b	3.8	a
Catapult	5.03	bc	10.7	bcd	76	b	2.3	b
Denison	5.14	bc	10.5	cd	76.4	b	3.6	a
Sting	5.56	a	11.2	ab	75.8	b	2	bc
Devil	5.61	a	10.4	d	76.1	b	1.8	cd
Grand Mean	5.215		10.88		75.9		2.28	
LSD P=.05	0.416		0.56		1.32		0.44	
Treatment Prob(F)	0.0001		0.0055		0.0001		0.0001	

Table 4. Powdery Mildew (PM) and Yellow Leaf Spot (YLS) incidence (%) across two dates on 10 different varieties.

Variety	PM Incidence (%)				YLS Incidence (%)	
	24/08/2022		28/09/2022		28/09/2022	
Scepter	7.5	abc	8.8	a-d	0.5	c
Valiant	11.3	a	11	ab	0.5	c
Anapurna	0	e	0	e	1.8	ab
Rockstar	5.8	bcd	9.5	abc	0	c
Vixen	9	ab	13.3	a	0	c
Trojan	2.3	de	3.3	de	0.8	bc
Catapult	5	bcd	5.5	b-e	0	c
Denison	3.1	de	4.3	cde	0.1	c
Sting	4.5	cd	6.3	bcd	2	a
Devil	5.8	bcd	12	a	0	c
Grand Mean	5.41		7.38		0.56	
LSD P=.05	4.02		5.62		1.08	
Treatment Prob(F)	0.0002		0.0007		0.0023	

Incidence of Powdery Mildew and Yellow Leaf Spot highlighted the genetic resistance differences between varieties. Anapurna did not show any PM infection but did however have the highest percentage of infection from YLS. Trojan and Dension had low levels of both PM and YLS suggesting a strong genetic disease package.

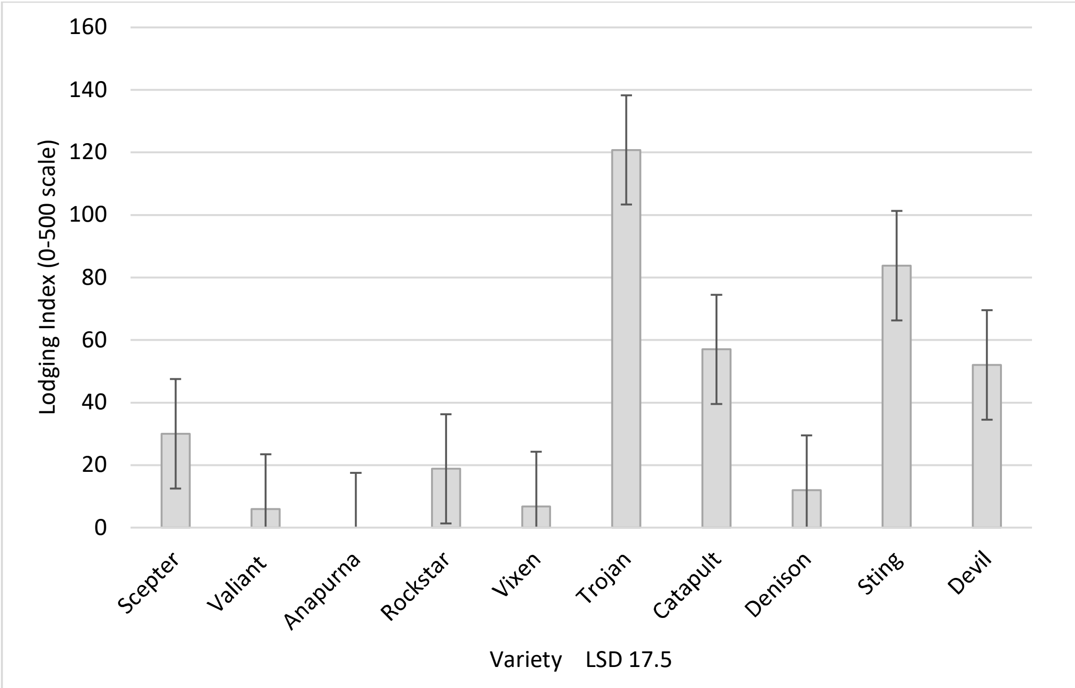

Figure 2. Variety effect on the lodging index (0-500).

The trial exhibited very low levels of lodging with small differences between varieties, Trojan having the highest index of 120 out of 500. Some of the faster maturing cultivars, Sting and Devil, also had a higher level of lodging which could be attributed to a high yield and a delay in harvest. Anapurna was the only variety which didn't exhibit any signs of lodging.

Table 5. Details of the management levels (kg, g, ml/ha).

Sowing date:		**9 May**
Seed Rate:		200 Seeds/m^2
Sowing Fertiliser:	71kg Summit Vigour Compound and 71kg Monoammonium Phosphate (MAP)	
Seed Treatment:		Vibrance / Gaucho
Grazing:		Nil
Nitrogen:	1 June	37 kg N (10K)
	17 July	70 kg N
PGR:		-
Fungicide:	16 July (GS31)	150mL Prosaro
	12 Aug (GS37-49)	500mL Opus

Trial 5. Early sown barley germplasm (winter vs spring) x management interaction trial

Trial Code: FAR WAE B22-05

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

Key Learnings:

- Despite earlier phenology, Rosalind grown with higher inputs of nitrogen (46N extra over 120N), fungicide (three units instead of two) and PGR produced significantly higher yields than other cultivar/management combinations.
- In part, higher spot form of net blotch and powdery mildew infection made it the most fungicide input responsive cultivar.
- RGT Planet was significantly lower yielding than Laperouse under lower input management but yielded almost identically when grown under higher input; fungicide input looked to be the most influential input in this result - a result identical to the 2021 season.
- There was a significant interaction between cultivar and management indicating that cultivars responded differently to the management strategies applied.
- There was no advantage to growing a short season winter barley (cv Urambie) despite the mid-April sowing date resulting in spring barley cultivars reaching GS31 in mid – late June. (Note: this is a generally frost-free location, with no frost experienced this year).
- Grain yields resulting from management input correlated strongly to crop canopy dry matter at harvest. For the high input management, the highest yield had a harvest index of 51.1% (grain yield based on 0% moisture).
- Mechanical defoliation simulating grazing carried out when individual cultivars reached GS30 significantly reduced the yields of Urambie, Planet and Rosalind.

Table 1. Grain yield across all varieties and treatments.

	Canopy Management (Grain Yield t/ha)						
Variety	**Standard Input**		**"Grazed" Standard**		**High Input**		**Mean**
Laperouse (spring)	6.73	cde	6.35	efg	7.29	b	**6.79**
Urambie (winter)	6.03	gh	5.26	j	6.82	cd	**6.03**
RGT Planet (spring)	6.25	fg	5.74	hi	7.28	b	**6.42**
Maximus CL (spring)	6.45	def	6.18	fg	7.11	bc	**6.58**
Rosalind	6.05	fgh	5.55	ij	8.05	a	**6.55**
Mean	**6.3**		**5.81**		**7.31**	**-**	
LSD Cultivar p = 0.05		0.23				P Value	0.0001
LSD Management p=0.05		0.35				P Value	0.0001
LSD Cultivar x Management P=0.05		0.40				P Value	0.0001

Notes: Simulated grazing carried out by mechanical defoliation.

In all cultivars, the simulated grazed management produced the lowest yields (5.81t/ha average) and the treatments managed under higher inputs produced the highest (7.31t/ha average). Although Rosalind produced the highest yield of 8.05t/ha, it also had the largest range in yield due to management (5.55-8.05t/ha) giving a 2t/ha response to greater nitrogen, fungicide and PGR input. In comparison, Laperouse had the lowest range in yields (6.35-7.29t/ha) suggesting that this variety had a stronger genetic disease package so wasn't as reliant on higher management input.

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

	Canopy Management (% Protein)						
Cultivar (Type)	**Standard Input**		**"Grazed" Standard***		**High Input**		**Mean**
Laperouse (Spring)	11.3	e	9.9	g	12.2	b	**11.1**
Urambie (Winter)	10.0	g	9.2	h	11.4	de	**10.2**
RGT Planet (Spring)	10.5	f	10.0	g	11.6	cde	**10.7**
Maximus CL (Spring)	12.0	bc	10.5	f	12.8	a	**11.8**
Rosalind (Spring)	11.6	cde	10.6	f	11.8	bcd	**11.3**
Mean	**11.1**		**10.0**		**12.0**		**11.0**
LSD Cultivar p = 0.05			0.26		**P Value**	<0.001	
LSD Management p=0.05			0.85		**P Value**	0.004	
LSD Cultivar x Management P=0.05			0.45		**P Value**	0.001	

CV 2.83

Protein levels varied significantly between management and varieties (Table 2) with the addition of an extra 46 units of N increasing protein levels by 0.8 – 1.4% (high input 164N – standard 120). As would be expected simulated grazing reduced grain proteins by 0.5 – 1.5%. At 164 kg N/ha with high input, cultivars were at the top end of the receival standards for malt.

Table 3. Grain quality assessment of test weight (kg/hL), retention (%) and screenings (%) by variety (averaged across all three treatments).

Variety	**Test Weight (kg/hL)**		**Retention (%)**		**Screenings (%)**	
Laperouse (Spring)	67.3	a	94.1	a	1	d
Urambie (Winter)	65.0	b	72.7	d	4.7	a
RGT Planet (Spring)	64.0	c	90.0	b	1.8	c
Maximus CL (Spring)	67.2	a	91.8	ab	1.4	cd
Rosalind (Spring)	65.5	b	84.4	c	2.7	b
LSD P=.05	0.64		3.16		0.67	
CV	1.18		4.4		34.72	
P Value	0.0001		0.0001		0.0001	

Laperouse produced the highest test weights (67.3kg/hl) with RGT Planet producing the lowest test weights (64kg/hl). Urambie generated significantly smaller grains than other cultivars with a retention of 72.7% and screenings of 4.7%.

Table 4. Influence of cultivar on Harvest Dry Matter (t/ha) under different canopy management regimes

	Canopy Management (Harvest dry matter t/ha)							
Cultivar (Type)	**Standard Input**		**"Grazed" Standard***		**High Input**		**Mean**	
Laperouse (Spring)	11.3	cd	9.8	ef	13.8	a	**11.6**	**-**
Urambie (Winter)	11.3	cd	8.3	g	13.2	ab	**10.9**	**-**
RGT Planet (Spring)	11.1	d	9.8	ef	12.3	bc	**11.1**	**-**
Maximus CL (Spring)	11.3	cd	8.8	fg	13.8	a	**11.3**	**-**
Rosalind (Spring)	10.4	de	9.7	ef	13.8	a	**11.3**	**-**
Mean	**11.1**	**b**	**9.3**	**c**	**13.4**	**a**		
LSD Cultivar p = 0.05		NS.		**P Value**	0.200			
LSD Management p=0.05		1.34		**P Value**	<0.001			
LSD Cultivar x Management P=0.05		1.07		**P Value**	0.009			

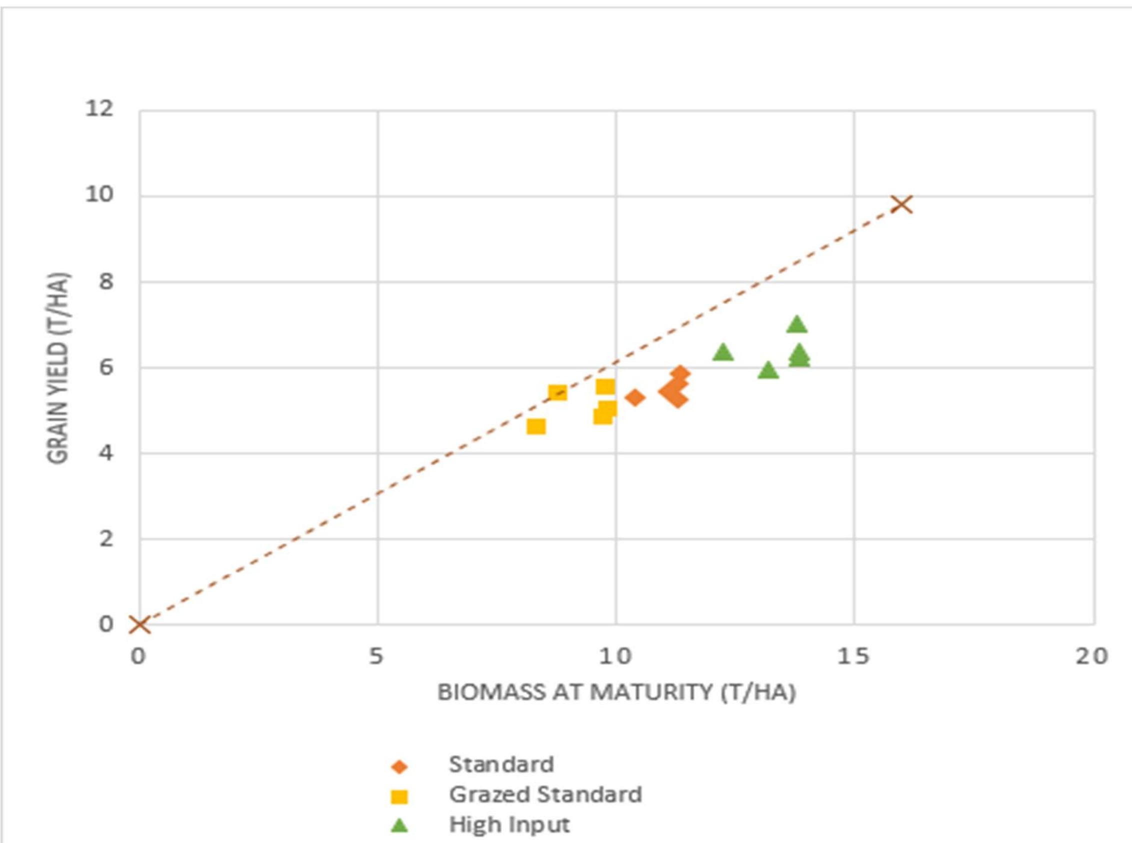

Figure 1. Relationship between final biomass and grain yield (0% Moisture) across different management groups at Esperance in 2022. The dashed line represents a theoretical maximum yield for each level of biomass (HI).

As observed in 2021 a more robust fungicide regime significantly reduced disease when the standard and high input management was compared. Where SDHI and QoI (Group 7 and 11 chemistry) was used in the high input approach, there was a significant reduction in spot form of net blotch (SFNB) pressure. However, whilst all cultivars gave their lowest disease levels under a more robust fungicide regime, the reduction in SFNB was relatively small and not significant with Laperouse and Maximus CL which displayed a far greater level of genetic resistance to the disease. Significantly with Planet and Rosalind the high input management gave the greatest reductions in disease and largest improvements in yields when compared to standard input based purely on Group 3 triazole chemistry. Defoliation did reduce SFNB in Planet and Rosalind, but its effects were small in comparison to using better fungicide chemistry.

Table 5. Disease assessment of Spot Form Net Blotch (SFNB) as a percentage of total incidence in the plot, recorded on the 24 August (GS43-79).

			SFNB incidence (%)		**24-Aug**		
Cultivar (Type)	**Standard Input**		**"Grazed" Standard***		**High Input**		**Mean**
Laperouse (Spring)	2.5	cde	1.9	de	0.2	e	**1.5**
Urambie (Winter)	4.8	c	3.3	cd	0.4	e	**2.8**
RGT Planet (Spring)	10.8	a	8	b	2.5	cde	**7.1**
Maximus CL (Spring)	2.5	cde	1.6	de	0.4	e	**1.5**
Rosalind (Spring)	12.5	a	4.8	c	0.4	e	**5.9**
Mean	**6.6**		**3.9**		**0.8**		
LSD Cultivar p = 0.05		1.34			**P Value**	<0.001	
LSD Management p=0.05		1.24			**P Value**	<0.001	
LSD Cultivar x Management P=0.05		2.32			**P Value**	<0.001	

Table 6. Disease assessment of SFNB as a percentage of total incidence in the plot, recorded on the 20 September (GS79-88).

			SFNB incidence (%)		**20-Sep**			
Cultivar (Type)	**Standard Input**		**"Grazed" Standard***		**High Input**		**Mean**	
Laperouse (Spring)	4	f	4	f	0.6	g	2.9	d
Urambie (Winter)	12	cd	8	e	2.4	fg	7.5	c
RGT Planet (Spring)	16	b	12.8	c	2.8	fg	10.5	b
Maximus CL (Spring)	4.5	f	3.8	f	1.3	g	3.2	d
Rosalind (Spring)	25	a	10.3	de	0.9	g	12	a
Mean	**12.3**	a	7.8	b	1.6	c		
LSD Cultivar p = 0.05		1.37			**P Value**	<0.001		
LSD Management p=0.05		2.63			**P Value**	<0.001		
LSD Cultivar x Management P=0.05		2.37			**P Value**	<0.001		

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

Plant pop'n:	**200 seeds/m² (150 plants/m² target) sown 16 April**		
	Standard	**"Grazed" Standard**	**High Input**
Grazed:	----	✓ (14 June)	----
Seed treatment:	Vibrance/ Gaucho		
Basal Fertiliser:	71kg Summit Vigour compound and 71kg Monoammonium Phosphate (MAP)		

Nitrogen:	1 June	37 kg N (10K)	37 kg N (10K)	37 kg N (10K)
	15 June	----	----	23 kg
	16 July	----	----	23 kg
	17 July	70 kg N	70 kg N	70 kg
PGR:	GS31	----	----	200mL Moddus Evo
	GS39	----	----	200mL Moddus Evo
Fungicide:	GS00	----	----	Systiva
	GS31	150mL Prosaro	150mL Prosaro	300mL Prosaro
	GS39	500mL Opus	500mL Opus	840mL Radial

Trial 7. Basal phosphorous response in barley

Trial code: FAR WAE B22-07

Objective: To determine what rate of Monoammonium Phosphate (MAP) fertiliser should be applied to optimise yield and margin based on the higher cost of fertiliser in the 2022 season.

Key Learnings:

- In terms of absolute yield, there was no measurable benefit of applying more then 75kg of MAP as this treatment produced the highest yield of 6.66t/ha (cv Planet).
- Although there were significant differences in mid flowering dry matter due to increasing P rate, there was no significant difference in yield between 11 - 44 units of P/ha.
- When no MAP was applied, plots significantly lacked both growth and vigour and showed signs of phosphorus deficiency, causing a reduction in yield of 1.01t/ha compared to the optimum.
- There were higher levels of both spot form net blotch (SFNB) and net form net blotch (NFNB) in higher MAP treatments as a denser canopy created a favourable environment for disease, but early in the season the observations were that deficiency led to more SFNB in the 0 MAP.
- Given the higher cost of fertiliser in the 2022 season, all MAP treatments produced a positive net margin, regardless of rate over cutting back to zero.
- However, there was no evidence from a one-year effect that exceeding the standard control (75 kg/ha MAP) or cutting back was financially beneficial.
- Clearly the results don't take account of any carryover effects.

Table 1. Treatment effects on grain yield and quality

Treatment			**Yield (t/ha)**		**Protein (%)**		**Test Weight (kg/hl)**		**Screenings (%<2.2mm)**		**Retention (%)**	
1	0 MAP	0 P	5.65	b	11.4	-	66.4	a	1.3	bc	92.8	a
2	50 MAP	11 P	6.42	a	11.9	-	66.1	ab	1	cd	93.9	a
3	75 MAP (control)	16.5 P	6.66	a	11.9	-	65.8	abc	0.9	d	93.9	a
4	100 MAP	22 P	6.42	a	11.9	-	65.5	bc	1.2	cd	92.6	a
5	150 MAP	33 P	6.61	a	11.7	-	65.3	c	1.4	ab	90.6	b
6	200 MAP	44 P	6.57	a	11.8	-	65.5	bc	1.6	a	89.9	b

Mean		6.387	11.76	65.77	1.23	92.27
LSD		0.246	0.41	0.68	0.26	1.38
P value		0.0001	0.0785	0.0229	0.0002	0.0001

**Differences in N at application were removed with Urea application at seeding.*
Soil testing in 2022 recorded 39mg/kg P in the top 10cm of soil and 23mg/kg of P at 10 -20cm.

Based on local practice, the control treatment of 75kg/ha MAP (16.5P) produced the highest yield of 6.66t/ha, with a trial average of 6.39t/ha (Table 1). The 0 P treatment produced a significantly lower yield of 5.65t/ha. The two treatments with the highest P rate produced significantly higher screenings (1.4-1.6%) and lower retention percentages (89.9-90.6%).

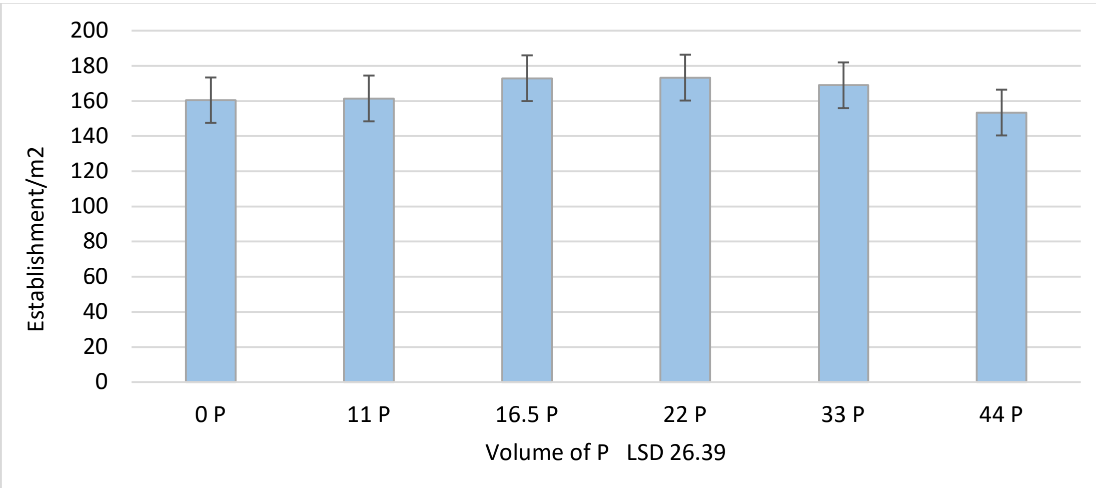

Figure 1. Treatment difference on establishment rate per metre squared at Z11.

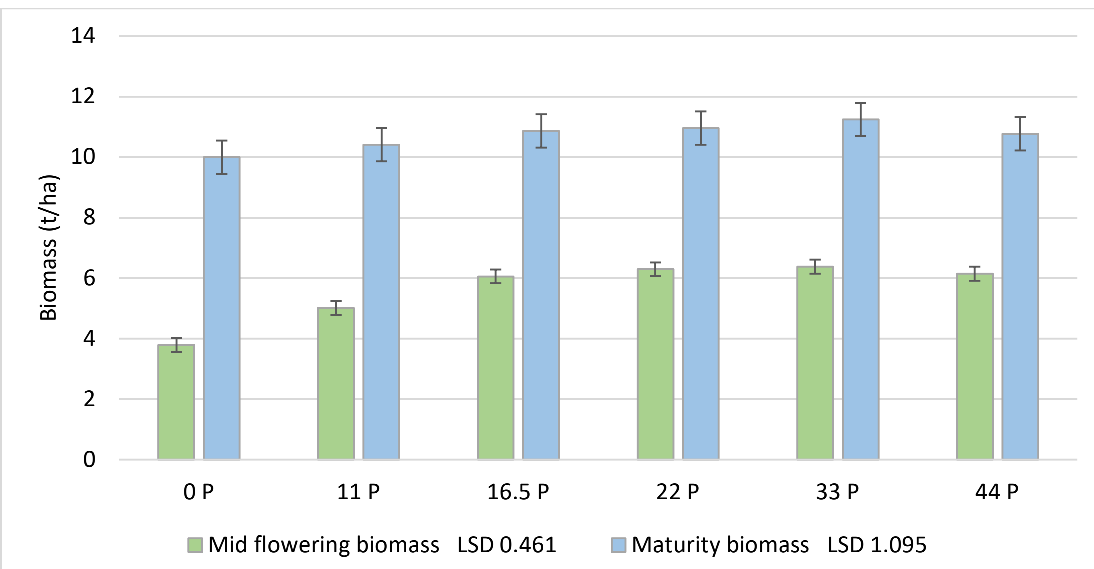

Figure 2. Treatment effect on total dry matter (t/ha) taken at mid flowering (Z65) and maturity (Z89).

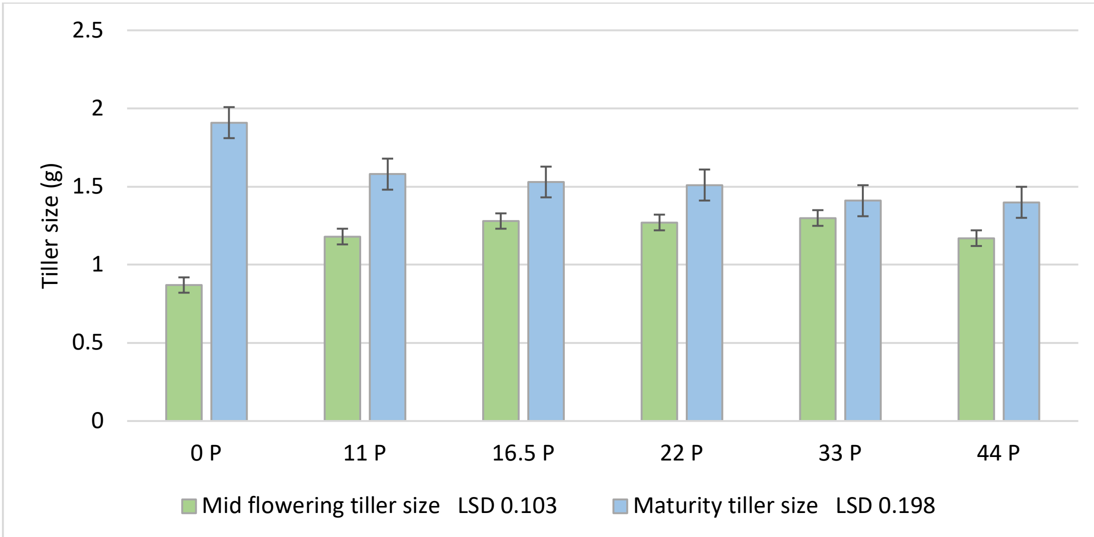

Figure 3. Treatment effect on tiller size (g) taken at mid flowering (65) and maturity (Z89).

There were no significant differences in plant establishment at the one leaf stage (Z11), however the 16.5P and 22P produced slightly more plants/m^2 (Figure 1). Results taken at mid flowering (Z65) show a significant difference in dry matter between 0P (3.79 t/ha) and 11P (5.02t/ha) when compared to higher levels of P application (Figure 2). Although this trend is followed in the maturity dry matter figures, there was no statistically significant difference between the results. Tiller size was also recorded at both these times, with 0P producing the smallest tillers (0.87g) and 33P the highest (1.38g) at mid flowering (Figure 3), however at maturity the reverse was the case as 0P had the largest tillers of 1.91g and higher rates of P produced smaller tillers (1.4g). This was linked to lower head numbers in plots where no P was applied.

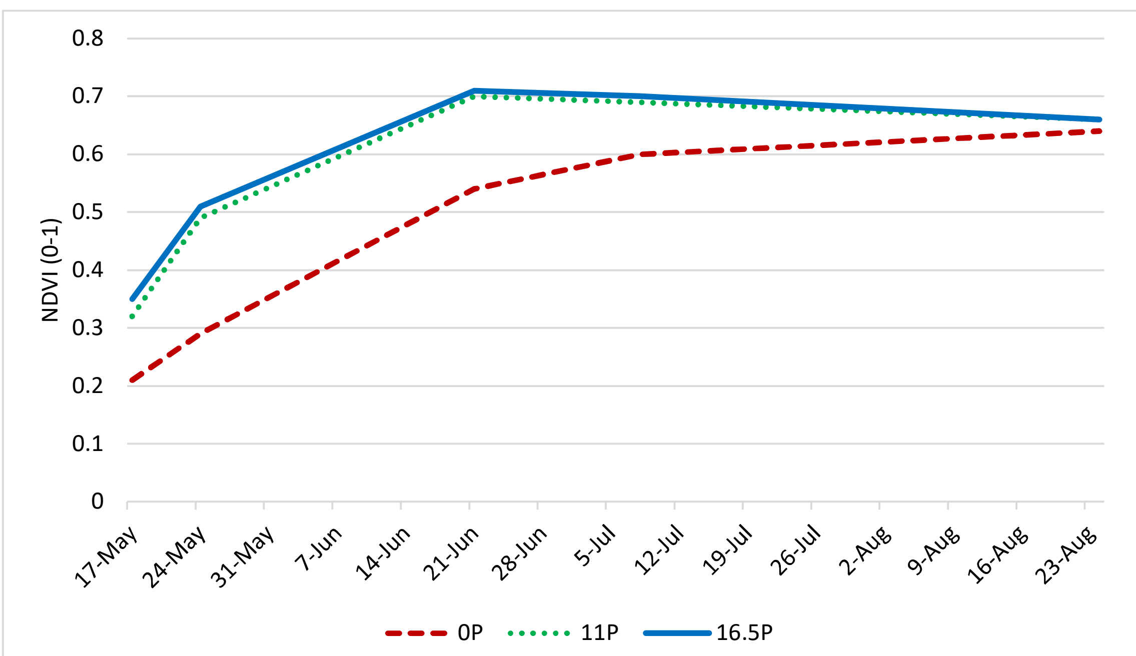

Figure 4. Normalized Difference Vegetation Index (NDVI) values over 4 months between 3 different treatments.

**Note that treatments over 16.5 units of P aren't shown as there were no significant differences.*

NDVI values highlight the effects of phosphorus deficiency, with 0P plots showing a lack of initial growth and vigour (Figure 4). However, by the end of August as root depth increased these differences become very minimal (0.64-0.66).

Table 2. Net Form Net Blotch (NFNB) and Spot Form Net Blotch (SFNB) severity on Flag-2 and Green Leaf Retention (GLR) on Flag-3, 18 August, Z70.

Treatment		**F-2**				**F-3**	
		SFNB Severity		**NFNB Severity**		**GLR %**	
1	0 P	0.2	c	0.7	d	95.9	a
2	11 P	0.7	bc	2.5	bc	65.9	b
3	16.5 P	1.2	ab	2	cd	67.3	b
4	22 P	1	ab	2.3	cd	51.5	bc
5	33 P	1.4	a	4.6	a	25.7	d
6	44 P	1.4	ab	4.2	ab	35.3	cd
Mean		0.98		2.73		56.92	
LSD		0.65		1.82		21.16	
P value		0.0152		0.0033		0.0001	

Phosphorous rate also influenced SFNB and NFNB severity on Flag-2 and the GLR on Flag-3 (Table 2). Treatments with no added MAP had significantly lower infection levels of the blotch diseases (0.2 and 0.7) when compared to the treatment with the highest fertiliser rate (1.4 and 4.2). GLR was also affected by treatment as 0P had a significantly higher value of 95.9%. Initial observations in May (data not shown) suggested more disease in the more stressed 0P plots.

Table 3. Influence of rate of MAP application on net margin ($/ha) (value of additional grain margin after fertiliser cost deducted).

Treatment			**Yield (t/ha)**	**Yield benefit of treatments (t/ha)**	**Financial benefit of treatments ($)**	**Net Margin ($)**
1	0 MAP	0 P	5.65	0	0	0.00
2	50 MAP	11 P	6.42	0.77	231	182.15
3	75 MAP	16.5 P	6.66	1.01	303	**229.73**
4	100 MAP	22 P	6.42	0.77	231	133.30
5	150 MAP	33 P	6.61	0.96	288	141.45
6	200 MAP	44 P	6.57	0.92	276	80.60

**Note yield and finical benefits were compared against treatment 1 with no added MAP*
MAP cost was based upon $952/t, with a $25/t cartage fee.
Receival price for Barley at Esperance was assumed at $300/t.

16.5P treatment produced the highest net margin of $229.73/t (Table 3). All the P application treatments produced a positive net margin over the 0P plots.

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

Sowing date:		**16 April**
Seed Rate:		200 Seeds/m^2
Sowing Fertiliser:	Monoammonium Phosphate (MAP) rate from 0-200kg	
Seed Treatment:		Vibrance / Gaucho
Grazing:		Nil
Nitrogen:	1 June	37 kg N (10K)
	21 June	Various
	16 July	Various
	17 July	70 kg N
	Total N	185kg
PGR:		-
Fungicide:	18 June (GS31)	300mL Prosaro
	16 July (G45-51)	500mL Aviator Xpro

It is important to note that the phosphorous use efficiency (PUE) is generally low the year of application, but instead accumulates as mostly inorganic forms. Paddock testing revealed a very low Phosphorous Buffering Index (PBI), indicating that this P was not bound as tightly to soil or other ions, increasing the availability to plants. In summary, even if treatments had no or low levels of MAP applied this season, residual plant available P would still be absorbed, which may have influenced the results.

Esperance Farm Inputs

Table 5. Crop Nutrition inputs at Shepwok Downs.

Date	**Product**	**Rate/ha**	**Placement**
16 April	MAP / MOP Blend	142kg	IBS
1 June	Urea	80kg	Farm spread
	MOP	20kg	
17 July	Urea	150kg	Farm spread

Table 6. Crop Protection inputs at Shepwok Downs.

Date	**Product**	**Rate/ha**	**Placement**
15 April	Gramoxone 360	2 L	IBS
	Trifluralin	1.5 L	
	Boxer Gold	2.5 L	
8 July	Radicate	1 L	Broadleaf
	Lontrel	40 g	
3 October	Mouse Off	1 kg	Hand Spread
14 October	Glyphosate*	2L	Tractor sprayer
4 September	Alpha-Cypermethrin 100 EC	160mL	Tractor Sprayer

**Only applies to Trial 7 and Rosalind in Trial 5.*

2022 WA Crop Technology Centre (Albany)

Photo credit Evan Collis

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. Two trials were pursued that allowed the research team to compare the economics of wheat winter and spring germplasm sown in the traditional ANZAC day sowing window.

Sown: 20 - 21 April 2022.
Harvested: 20 December 2022.
Rotation position: 1st Cereal after canola.
Soil type: Forest gravel loam.

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

Trial code: FAR WAA W22-01

Objectives: To assess a comparison of winter and spring wheat germplasm under different levels of management sown on 20 April.

Key Messages:

- The 2022 season at Frankland River was characterised by a soft finish with a relatively cool spring, which was extremely wet in October following a relatively dry period in September.
- In an environment where mild frost events were recorded throughout the growing season, winter varieties were in general significantly higher yielding than the spring cultivars.
- Higher yields from winter wheats were correlated to higher harvest dry matters compared to the spring cultivars.
- There was a significant interaction between cultivar and management (<p=0.001) indicating that cultivars responded differently to the managements imposed, although all cultivars tested gave their highest yield with greater N input, fungicide and PGR input.
- RGT Accroc, the slowest developing winter variety (flowering mid-October), produced the highest yield in the trials, with a result that will have been supported by cooler temperatures and an additional 40mm and 30mm above the monthly rainfall average for October and November, respectively.
- Scepter, the quickest spring variety flowered on the 19 August one month prior to the calculated optimum for the region (Sept 15-25) and consistently produced the lowest yield across all three management regimes.
- In general, there was a positive correlation between higher harvest biomass and higher yields.
- Some varieties showed signs of lodging however, plant height had a large influence as the taller cultivars had a higher lodging index.
- Based on the gross margin, growing Accroc under high management was the most profitable treatment, even when being sold as FED1 ($330/t).

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

	Canopy Management (Grain Yield t/ha)							
Variety	Standard Management		Grazed Management		High Input Management		Mean	
Illabo (winter)	4.17	g	3.91	hi	4.92	e	**4.33**	e
Rockstar (spring)	4.26	fg	4.07	gh	4.89	e	**4.41**	de
LPRB19 (winter)	5.01	e	4.45	f	5.75	bc	**5.07**	b
Kinsei (spring)	4.50	f	3.77	ij	5.31	d	**4.53**	cd
Denison (spring)	4.49	f	4.17	g	5.03	e	**4.56**	c
Accroc (winter)	5.89	b	5.59	c	6.45	a	**5.97**	a
Scepter (spring)	3.61	j	3.12	k	4.19	g	**3.64**	f
Mean	**4.56**	b	**4.15**	c	**5.22**	a		**4.65**
LSD Cultivar p=0.05			0.14		**P Value**		<0.001	
LSD Management p=0.05			0.15		**P Value**		<0.001	
LSD Cultivar x Management p=0.05			0.24		**P Value**		<0.001	

There was a significant interaction between (p=0.001) between cultivar and management at the Frankland River site, with the four spring and three winter varieties responding differently to the three levels of management (standard, grazed and high input). Accroc, a winter red feed wheat, consistently yielded the highest across all management levels (5.97t/ha), closely followed by the coded line LRPB19-14347, a faster developing winter wheat (5.07t/ha). Illabo, the other winter variety was no higher yielding than the best of the spring varieties that were tested (Denison and Kinsei), which were the slower developing. Kinsei had the largest range in yield (3.77-5.31t/ha), suggesting this cultivar was the most affected by treatment differences.

Table 2. Approximate calendar date that each cultivar reached stem elongation (GS30) and the beginning of flowering (GS61) – 28 April sown.

Cultivar (type)	Date GS30	Date GS61
Illabo (Winter)	1 July	26 September
Rockstar (Spring)	16 June	30 August
LRP19-14347 (Winter)	1 July	12 September
Kinsei (Spring)	16 June	30 August
RGT Accroc (Winter)	16 June	14 October
Scepter (Spring)	2 Aug	19 August
Denison (Spring)	16 June	9 September

It is important to note that the soft finish of the 2022 season, with cooler temperatures in October and November, and above average rainfall of about 70mm across the two months, allowed the later flowering varieties to express their true yield potential without heat or water stress.

Table 3. Influence of cultivar on dry matter at maturity (t/ha) under different canopy management regimes.

Variety	Harvest Biomass (t/ha)						
	Standard Management		Grazed Management		High Input Management		Mean
Illabo (winter)	12.76	cde	9.90	ij	15.36	a	**12.67**
Rockstar (spring)	11.08	f-i	10.17	hi	12.16	c-f	**11.14**
LPRB19 (winter)	11.90	d-g	9.75	ij	13.47	bc	**11.71**
Kinsei (spring)	11.67	efg	8.70	jk	12.10	c-f	**10.82**
Denison (spring)	12.11	c-f	11.20	f-i	13.28	bcd	**12.20**
Accroc (winter)	14.26	ab	11.63	e-h	15.37	a	**13.75**
Scepter (spring)	9.98	ij	8.02	k	10.44	ghi	**9.48**
Mean	**11.96**		**9.91**		**13.17**		
LSD Cultivar p=0.05			0.85	**P Value**	<0.001		
LSD Management p=0.05			0.58	**P Value**	<0.001		
LSD Cultivar x Management p=0.05			1.46	**P Value**	<0.001		

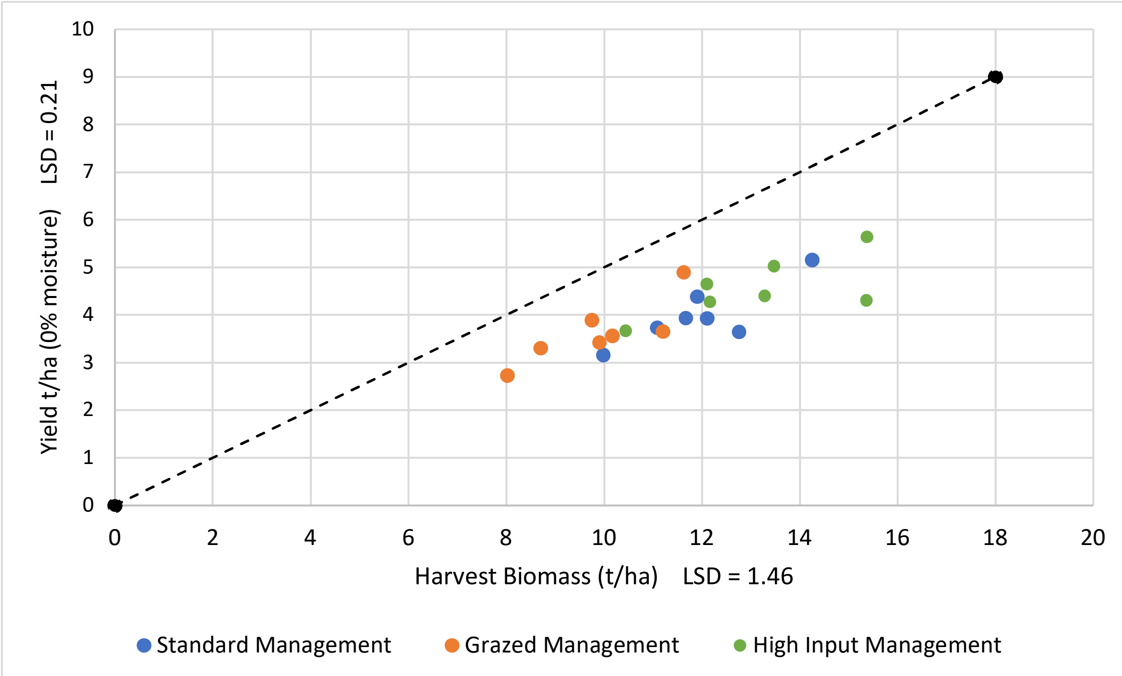

Figure 1. Correlation of grain yield (t/ha reported at 0% moisture) with harvest dry matter (t/ha reported at 0%) at maturity under different canopy management regimes (using an average of each treatment). The trendline represents a Harvest Index (HI) of 50%.

Higher harvest biomass was in general associated with higher yields, with management having large effect on both (Figure 1). The exception was Illabo which produced on average the second highest dry matter (12.67t/ha) but this didn't translate into yield (4.33t/ha) giving rise to generally lower harvest index.

The high input management produced significantly higher harvest dry matter with winter varieties and the slowest spring Denison but had less influence on the shorter season springs. Other inputs added under high management (fungicides and PGRs) appeared to have little effect as there was little disease and no issues with lodging.

Table 4. Influence of cultivar and management on grain protein (%)

Variety	**Canopy Management (Protein %)**						
	Standard Management		Grazed Management		High Input Management		Mean
Illabo (winter)	10.88	g	10.58	g	11.68	def	**11.04**
Rockstar (spring)	12.45	c	11.65	def	12.53	c	**12.21**
LPRB19 (winter)	10.00	h	9.75	h	10.78	g	**10.18**
Kinsei (spring)	11.88	d	11.50	ef	12.00	d	**11.79**
Denison (spring)	11.43	f	10.68	g	11.83	de	**11.31**
Accroc (winter)	7.88	j	7.70	j	8.88	i	**8.15**
Scepter (spring)	13.63	a	13.15	b	13.9	a	**13.56**
Mean	**11.16**		**10.71**		**11.65**		
LSD Cultivar p=0.05			0.21		**P Value**		<0.001
LSD Management p=0.05			0.2		**P Value**		<0.001

LSD Cultivar x Management p=0.05	0.36	P Value	<0.001

Additional nitrogen significantly increased grain protein, with the higher input canopy management (Table 4). As additional nitrogen was not topped up to account for the dry matter removed in the simulated grazing treatments, protein percentages were lower, although the differences were not always significant compared to standard management. There is a correlation between lower protein and higher yielding, with Accroc, the highest yielding variety, having significantly lower protein (8.2%) and Scepter, the lowest yielding variety, having the highest protein percentage (13.8%).

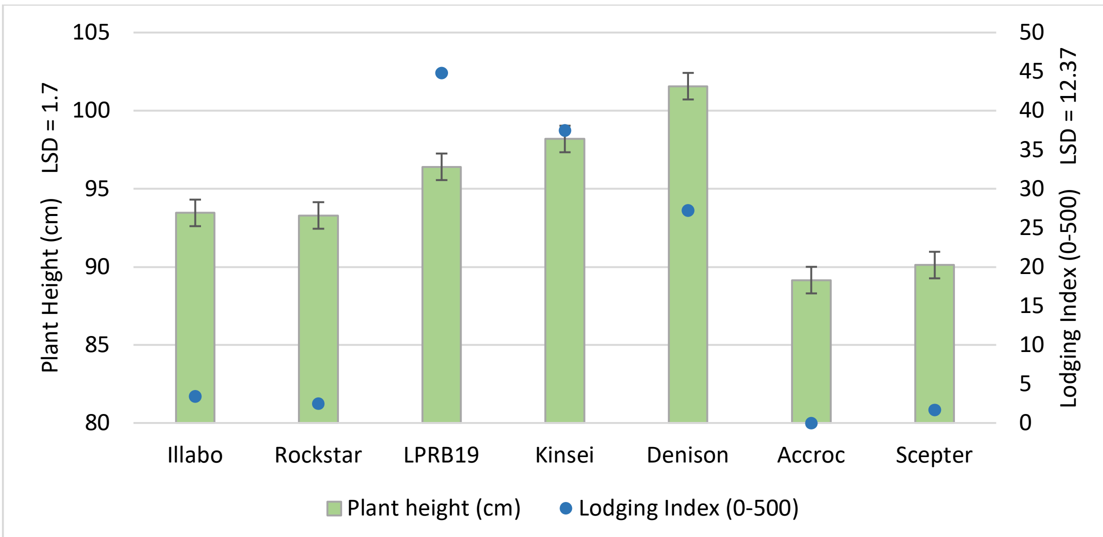

Figure 2. Relationship between plant height (cm) and Lodging Index (0-500) between varieties (values are averages of all treatments).

Varieties which were taller than 95cm at maturity (measured base to the tip of the head excluding awns), had a slightly higher lodging index compared to shorter varieties (Figure 3), but it should be emphasised that crops were leaning slightly, not lodging (index of 100 on a 0-500 scale). Although the use of a PGR in the high input management did result in significantly shorter crops, there was no difference in the lodging index between the three management levels (data not shown).

Table 5. Influence of cultivar and management on gross margin ($/ha) – (grain price of grade obtained minus cost of inputs)

		Canopy Management (Gross Magin $/ha)			
Variety	**Grade**	**Standard**	**Grazed**	**High Input**	**Mean**
Illabo	AGP1	775.16	929.15 (243)	877.37	779.56
Rockstar	H2	1129.24	1118.60 (70.50)	1232.40	1136.58
LPRB19	AGP1	1065.62	1071.160 (199.50)	1162.62	1033.30
Kinsei	ANW2	1095.88	882.37 (69)	1255.16	1054.80
Denison	APW1	1133.05	1089.40 (82.50)	1191.32	1110.43
Accroc	Feed	1280.33	1364.30 (181.50)	1307.68	1256.94
Scepter	H1	888.27	756.53 (78)	981.15	849.32
Mean		1052.51	1030.22	1143.96	1031.56

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

Using typical grain prices for the region, the results were translated into net margins where the yields, grades obtained and input costs were used to generate net margins for the trial (Table 5).

Table 6. Details of the three management levels (kg, g, L, mL/ha).

Plant pop'n:		200 seeds/m² (150 plants/m² target)		
		Standard	**Standard Grazed**	**High Input**
Grazed:		----	✓	----
Seed treatment:		Vibrance/ Gaucho		
Basal Fertiliser:		139kg MAP / MOP		
Nitrogen:	31-May	55 kg N/ha	55 kg N/ha	55 kg N/ha
	30-Jun	32 kg N/ha	32 kg N/ha	32 kg N/ha
	20-Jul	----	----	25 kg N/ha
Total N (With 13 N at sowing)		**100 kg N/ha**	**100 kg N/ha**	**125 kg N/ha**
PGR:	GS31	----	----	Moddus Evo 200mL
Fungicide:	GS00	----	----	Systiva
	GS31	150mL Prosaro	150mL Prosaro	300mL Prosaro
	GS39 GS65	500mL Opus	500mL Opus	840mL Radial Opus 500mL

Trial 2. Wheat early sowing germplasm screening trial – winter and spring

Trial Code: FAR WAA W22-02

Objective: To assess new, short season winter wheats and longer season spring wheats for early - mid April sowing opportunities.

Key Messages:

- New faster developing winter cultivars showed potential when sown on the 20 April but were not significantly higher yielding than the Illabo control.
- Two coded varieties, LTU001-066 and LTU002-18-01, significantly out yielded (4.79 and 4.73t/ha) the traditional spring variety control Scepter (3.93t/ha), although Catapult was as equally high yielding.
- When comparing the phenology of the five coded lines there was a large amount of variability due off-type impurity, however they were faster developing than Illabo and slower than Scepter.
- Plant height varied between varieties with a strong correlation between taller cultivars having a higher lodging index, but was characterised more by leaning than lodging as most index readings were less than 100 on 0 - 500 scale.

Table 1. Variety effects on grain yield (t/ha) and quality (Protein %, Test Weight kg/hL and Screenings %).

Variety	Yield (t/ha)		% Yield of Mean		Protein %		Test Weight kg/hL		Screenings %	
Scepter (Spring)	3.93	c	89.5	c	13.6	a	77.1	bc	0.5	d
Illabo (Winter)	4.60	a	104.8	a	11.0	cd	72.5	d	0.7	cd
LTU001-038 (Winter)	3.98	c	90.6	c	13.3	a	77.4	bc	0.5	d
LTU001-039 (Winter)	4.04	c	92.1	c	11.8	b	76.9	c	1.2	b
LTU001-066 (Winter)	4.79	a	109.1	a	11.2	c	77.3	bc	1.0	bc
LTU001-092 (Winter)	4.33	b	98.5	b	11.9	b	77.8	b	0.7	d
LTU002-18-01 (Winter)	4.74	a	107.9	a	10.6	d	78.8	a	1.6	a
Catapult (Spring)	4.72	a	107.5	a	11.3	c	77.6	bc	0.7	d
Mean	4.39		100		11.8		76.9			
LSD p=.05	0.21		4.8		0.4		0.9		0.217 - 0.332	
P Value	<0.001		<0.001		<0.001		<0.001		<0.001	

Protein levels ranged between 10.95-13.55%, with higher yields generally correlating with lower protein levels. Test weight in general didn't vary too much between the varieties with the exception of Illabo (72.5kg/hL), which was the only cultivar which would have suffered a downgrade from APW1 to AGP1 due to this standard.

Table 2. Zadok's growth stage of the eight varieties across seven dates throughout the season.

Variety	20 July	2 Aug	25 Aug	12 Sep	26 Sep	5 Oct	17 Oct
Scepter (Spring)	45	53	65	72	76	79	83
Illabo (Winter)	31	31	38	53	61	71	74
LTU001-038 (Winter)	32	32	53	64	71	73	77
LTU001-039 (Winter)	32	32	49	67	71	72	76
LTU001-066 (Winter)	32	32	50	64	71	72	74
LTU001-092 (Winter)	32	32	52	67	71	73	74
LTU002-18-01 (Winter)	31	32	47	63	69	71	74
Catapult (Spring)	33	47	58	71	71	73	78

Scepter was the fastest maturing variety reaching mid flowering (GS65) on the 25 August, which in an environment which experiences frost, may be too early. Catapult, a slower spring variety reached this same growth stage about 10 days after Scepter, followed by the coded lines which were around the middle of September. Illabo, the slowest variety reached mid flowering around the 1 Oct, 37 days later then Scepter.

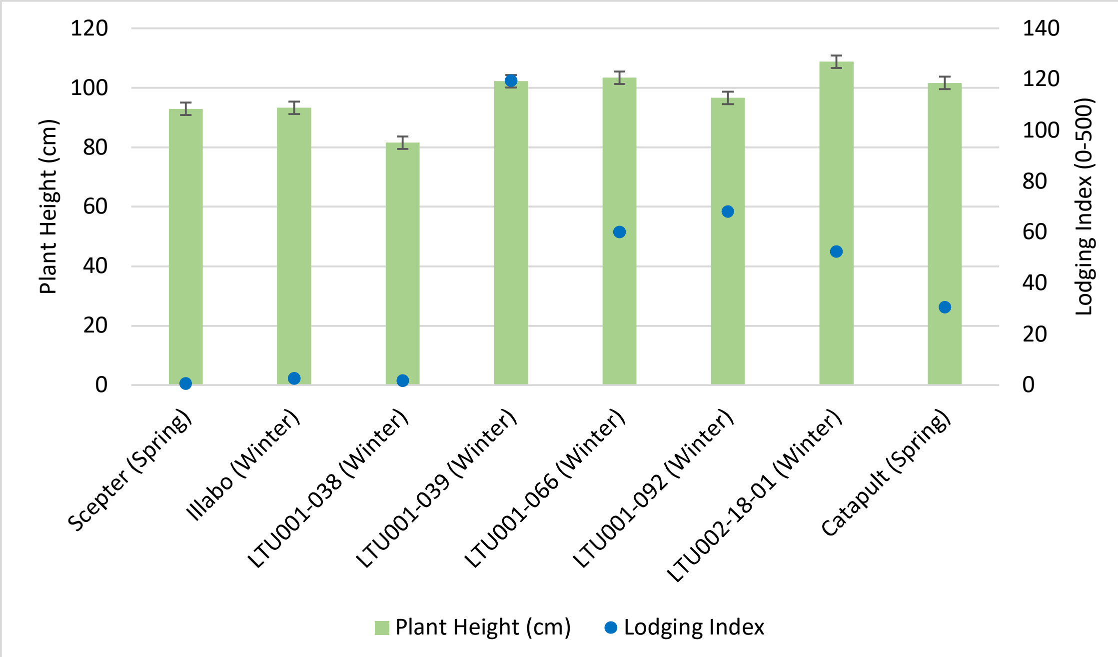

Figure 1. Variety plant height (cm) and Lodging Index assessment (0-500) between varieties.

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

Sowing date:		**20 April**
Seed Rate:		200 Seeds/m^2
Sowing Fertiliser:	139kg Monoammonium Phosphate (MAP) / Muriate of Potash (MOP)	
Seed Treatment:		Vibrance / Gaucho
Grazing:		Nil
Nitrogen:	31 May	55kg N/ha (20K)
	30 June	32 kg N/ha
PGR:		-
Fungicide:	29 June (GS30)	300mL Prosaro
	31 July (G38-55)	500mL Aviator Xpro

Frankland Farm Inputs

Table 4. Crop Nutrition inputs for Gunwarrie.

Date	**Product**	**Rate/ha**	**Placement**
21 April	MAP/MOP	139kg	IBS
31 May	Urea	120kg	Farm spread
	MOP	40kg	
30 June	Urea	70kg	Farm spread

Table 5. Crop Protection inputs for Gunwarrie.

Date	**Product**	**Rate/ha**	**Placement**
11 April	Logran	10g	Farm Sprayed
	Voraxor	240mL	
	Glyphosate	1.5L	
15 June	Manganese	2kg	Broadleaf

	Jaguar	1L	
	Trojan	10mL	
29 August	Epoxiconazole	400mL	Farm Sprayed
	Trojan	10mL	
	Copper	250g	

APPENDICES 1

Esperance Meteorological Data

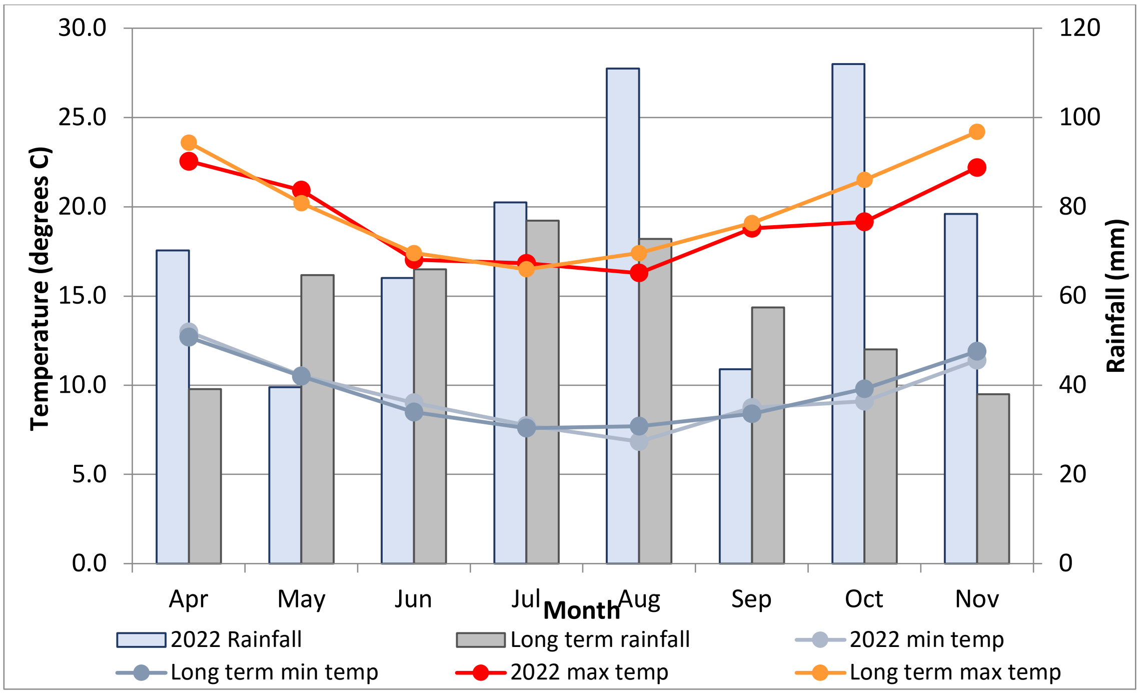

Figure 1. 2022 growing season rainfall and long-term rainfall, 2022 min and max temperatures and long-term min and max temperatures (1950-2022) (recorded at Esperance Aero). *Growing season rainfall (April to October) = 599.8mm.*

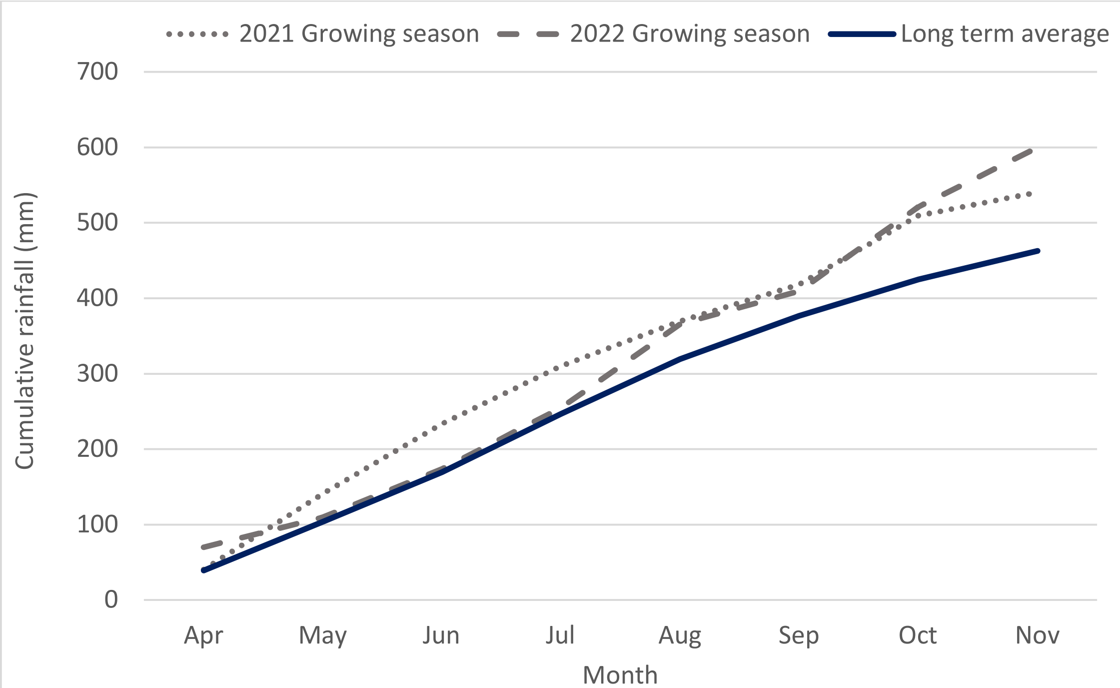

Figure 2. Cumulative growing season rainfall for 2021, 2022 and the long-term average for the growing season.

APPENDICES 2

Frankland River (Rock Gully) Meteorological Data

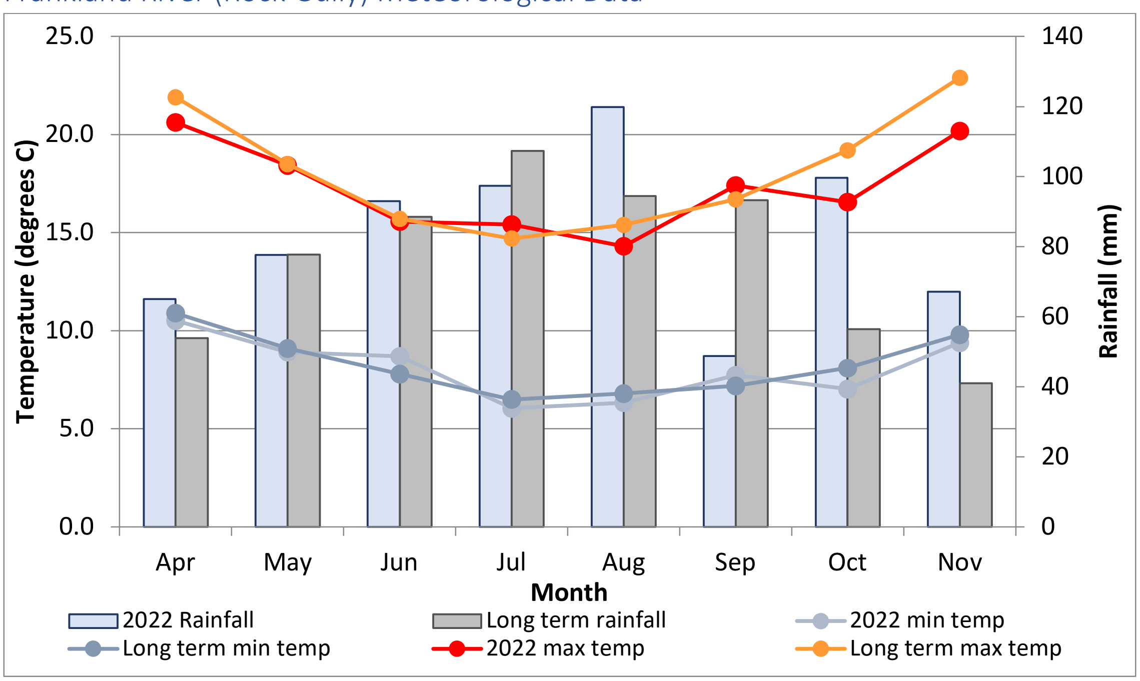

Figure 1. 2022 growing season rainfall and long-term rainfall, 2022 min and max temperatures and long-term min and max temperatures (1996-2022) (recorded at Rock Gully). *Growing season rainfall (April to October) = 601.2mm.*

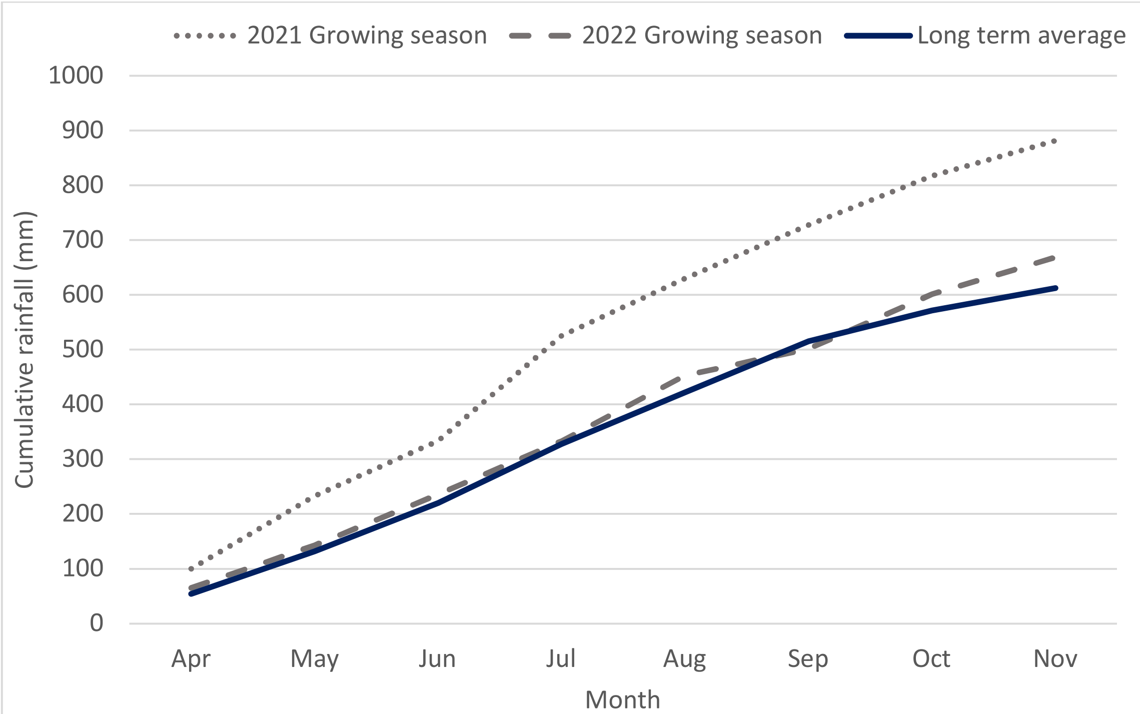

Figure 2. Cumulative growing season rainfall for 2021, 2022 and the long-term average for the growing season.

Gunwarrie Rainfall 2015-2022

Table 1. Annual rainfall for the host farm at Frankland River for 2015-2022, and the average of these years. When compared to the climate data from Rocky Gully, Gunwarrie received 104mm less annual rainfall in 2022, and 125mm less in the growing season (April-November).

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
2015									30.0	34.0	5.3	34.3	**104**
2016	118.8	10.3	28.0	78.3	83.3	63.0	55.5	112.5	57.5	61.8	17.3	38.0	**724**
2017	1.3	55.0	32.8	7.5	29.5	14.8	89.8	93.5	71.3	34.5	13.5	34.3	**478**
2018	25.5	19.8	9.2	28.0	24.6	57.4	97.4	130.2	21.6	32.7	17.2	31.2	**495**
2019	4.8	0.0	57.8	36.0	31.4	72.8	50.6	98.3	39.0	36.8	9.2	4.4	**441**
2020	9.2	71.4	27.8	13.6	70.2	53.8	46.4	94.2	66.2	27.6	52.4	18.2	**551**
2021	23.0	59.8	25.2	114.8	82.1	55.7	118.0	77.3	68.2	79.0	61.8	5.2	**770**
2022	2.8	3.6	49.0	50.2	56.0	72.4	76.4	88.4	46.8	108.6	45.0	5.2	**604**
Average	26.5	31.4	32.8	46.9	53.9	55.7	76.3	99.2	52.9	43.8	27.7	21.3	**568**

APPENDICES 3. Esperance Soil Testing

	Depth	Gravel	Texture	Ammonium Nitrogen	Nitrate Nitrogen	Phosphorus Colwell	Potassium Colwell
	cm	%		mg/kg	mg/kg	mg/kg	mg/kg
Unripped	0-10	5.00	1.5	< 1	27	32	38
Unripped	10-20	5	1.5	< 1	31	32	41
Unripped	20-30	55-60	1	1	3	3	37
Unripped	30-40	65-70	1	< 1	2	2	49
Unripped	40-50	5-10	2	< 1	3	2	137
Unripped	50-60	0	2.5	< 1	4	< 2	236
Unripped	60-70	0	2.5	< 1	3	< 2	201
Unripped	70-80	0	2.5	< 1	2	< 2	243
Unripped	80-90	0	2.5	< 1	2	2	278
Ripped	0-10	0	1.5	< 1	23	39	45
Ripped	10-20	0	1.5	< 1	33	23	54
Ripped	20-30	55-60	1.5	< 1	3	3	55
Ripped	30-40	55-60	1.5	< 1	2	3	55
Ripped	40-50	0	2.5	< 1	3	< 2	169
Ripped	50-60	0	2.5	< 1	2	< 2	237
Ripped	60-70	0	2.5	1	< 1	< 2	263
Ripped	70-80	0	2.5	< 1	< 1	< 2	217
Ripped	80-90	0	2.5	< 1	< 1	< 2	353

	Depth	Sulfur	Organic Carbon	Conductivity	pH Level (CaCl2)	pH Level (H2O)	DTPA Copper	DTPA Iron
	cm	mg/kg	%	dS/m			mg/kg	mg/kg
Unripped	0-10	11.1	1.06	0.099	6.0	6.7	0.43	118.10
Unripped	10-20	12.3	1.67	0.118	5.3	6.0	0.39	136.00
Unripped	20-30	3.6	0.14	0.029	5.8	6.7	0.08	44.50
Unripped	30-40	3.8	0.11	0.025	5.5	6.8	0.20	27.40
Unripped	40-50	15.4	0.16	0.077	5.8	7.0	0.20	43.90
Unripped	50-60	25.2	0.16	0.108	5.7	7.0	0.05	20.40
Unripped	60-70	33	0.11	0.097	6.0	7.4	0.05	21.30
Unripped	70-80	30	0.14	0.107	5.8	7.1	0.09	27.30
Unripped	80-90	25.3	0.11	0.112	6.0	7.3	0.40	23.10
Ripped	0-10	8.5	1.09	0.096	5.2	6.0	0.93	149.10
Ripped	10-20	14.3	1.40	0.129	5.9	6.3	0.41	101.50
Ripped	20-30	3.3	0.16	0.029	5.6	6.5	0.28	50.60
Ripped	30-40	3.6	0.08	0.032	5.9	7.3	0.06	17.90
Ripped	40-50	18	0.13	0.084	5.7	7.2	0.03	42.30
Ripped	50-60	31.3	0.06	0.116	6.0	7.4	0.04	19.50
Ripped	60-70	24.6	< 0.05	0.093	6.1	7.6	0.08	22.70
Ripped	70-80	25.7	0.07	0.113	6.4	7.9	0.06	36.80
Ripped	80-90	25.9	0.12	0.145	6.4	7.9	0.12	13.50

	Depth	DTPA Manganese	DTPA Zinc	Exc. Aluminium	Exc. Calcium	Exc. Magnesium	Exc. Potassium
	cm	**mg/kg**	**mg/kg**	**meq/100g**	**meq/100g**	**meq/100g**	**meq/100g**
Unripped	0-10	0.51	0.74	0.070	4.01	0.41	0.10
Unripped	10-20	0.37	1.13	0.060	4.23	0.42	0.10
Unripped	20-30	0.17	0.12	0.070	0.77	0.24	0.09
Unripped	30-40	0.47	0.09	0.060	0.70	0.33	0.09
Unripped	40-50	0.89	0.17	0.110	1.76	2.82	0.31
Unripped	50-60	0.10	0.08	0.170	3.09	6.18	0.55
Unripped	60-70	0.07	0.05	0.190	2.74	5.90	0.55
Unripped	70-80	0.63	0.10	0.170	3.03	6.55	0.63
Unripped	80-90	0.32	0.11	0.130	3.17	6.82	0.68
Ripped	0-10	0.36	1.04	0.080	2.29	0.29	0.12
Ripped	10-20	0.85	0.67	0.080	4.23	0.48	0.14
Ripped	20-30	0.44	0.12	0.130	0.81	0.36	0.11
Ripped	30-40	0.07	0.12	0.140	0.64	0.68	0.11
Ripped	40-50	0.34	0.04	0.110	1.76	4.06	0.43
Ripped	50-60	0.09	0.04	0.130	2.51	6.33	0.64
Ripped	60-70	0.19	0.11	0.180	2.55	6.04	0.69
Ripped	70-80	1.17	0.12	0.210	2.19	4.77	0.56
Ripped	80-90	0.20	0.13	0.180	3.58	7.04	0.85

	Depth	Exc. Sodium	Boron Hot CaCl2	PBI
	cm	**meq/100g**	**mg/kg**	
Unripped	0-10	0.12	0.48	15.3
Unripped	10-20	0.12	0.46	21.8
Unripped	20-30	0.07	0.32	10.4
Unripped	30-40	0.13	0.32	16.0
Unripped	40-50	0.93	1.36	141.5
Unripped	50-60	1.75	2.82	298.3
Unripped	60-70	1.63	3.01	282.8
Unripped	70-80	1.94	3.18	276.1
Unripped	80-90	2.19	3.93	236.6
Ripped	0-10	0.10	0.41	29.2
Ripped	10-20	0.12	0.47	17.3
Ripped	20-30	0.09	0.42	23.0
Ripped	30-40	0.23	0.54	27.9
Ripped	40-50	1.37	2.36	181.3
Ripped	50-60	2.18	4.38	293.5
Ripped	60-70	2.36	4.75	236.2
Ripped	70-80	2.08	5.08	205.1
Ripped	80-90	3.27	6.64	181.8

APPENDICES 4. Frankland River Soil Testing

	Depth	pH	pH	Electrical conductivity	TTS	Ca	Mg	Na
	cm	Water	CaCl	uS/cm	ppp	ppm	ppm	ppm
East	0-10	6.5	6.0	136.0	448.6	1866.0	105.0	25.3
	10-20	5.9	5.3	53.7	177.2	678.0	76.9	15.8
	20-30	5.9	5.3	39.2	129.4	466.0	178.8	19.3
North	0-10	6.5	6.0	241.0	795.3	2660.0	160.8	42.1
	10-20	6.1	5.5	35.8	118.1	580.0	75.8	19.3
	20-30	6.3	5.7	30.2	99.7	726.0	282.0	32.9
South	0-10	6.2	5.7	178.0	587.4	2060.0	127.2	47.4
	10-20	6.1	5.5	44.6	147.2	540.0	112.1	28.5
	20-30	6.5	5.9	43.8	144.5	446.0	210.0	43.0
West	0-10	6.7	6.2	334.0	1102.2	3760.0	238.8	77.5
	10-20	5.9	5.3	49.6	163.7	604.0	60.7	19.0
	20-30	6.3	5.7	28.5	94.1	476.0	86.4	21.8
Average	0-10	6.5	6.0	222.3	733.4	2586.5	158.0	48.1
	10-20	6.0	5.4	45.9	151.6	600.5	81.4	20.7
	20-30	6.3	5.7	35.4	116.9	528.5	189.3	29.3

	Depth	N	P	K	S	Cu	Zn	Fe	Mn
	cm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
East	0-10	35.1	21.0	178.2	18.0	2.1	0.8	10.0	4.0
	10-20	7.6	5.2	84.6	13.7	0.7	0.2	15.0	1.0
	20-30	4.8	1.4	58.9	30.9	0.5	0.2	8.0	0.0
North	0-10	79.2	16.7	164.6	20.9	1.8	0.7	9.0	2.0
	10-20	5.3	3.3	52.7	6.7	0.5	0.2	21.0	2.0
	20-30	2.5	0.4	46.4	5.6	0.3	0.1	5.0	0.0
South	0-10	46.0	9.9	133.0	18.6	3.0	0.8	32.0	7.0
	10-20	6.7	3.1	56.6	13.0	1.4	0.2	33.0	2.0
	20-30	3.7	0.6	48.4	15.0	1.3	0.1	15.0	0.0
West	0-10	166.0	18.1	185.6	27.0	3.1	1.0	11.0	5.0
	10-20	14.6	5.6	67.1	7.8	1.3	0.3	50.0	5.0
	20-30	4.8	2.4	62.4	5.6	1.0	0.1	22.0	2.0
Average	0-10	81.6	16.4	165.4	21.1	2.5	0.8	15.5	4.5
	10-20	8.5	4.3	65.2	10.3	1.0	0.2	29.8	2.5
	20-30	4.0	1.2	54.0	14.3	0.8	0.1	12.5	0.5

	Depth	Co	Mo	B	Organic matter	Organic Carbon	Exc Ca
	cm	ppm	ppm	ppm	%	%	meq/100 of soil
East	0-10	0.1	0.2	0.5	6.5	3.2	8.5
	10-20	0.4	0.1	0.5	1.9	1.0	3.2
	20-30	0.3	0.1	0.6	1.1	0.5	2.2
North	0-10	0.1	0.2	0.5	11.2	5.6	11.7
	10-20	0.1	0.3	0.4	1.8	0.9	2.8
	20-30	0.3	0.3	0.6	1.9	0.9	3.5
South	0-10	0.4	0.4	0.6	6.7	3.4	9.2
	10-20	0.3	0.6	0.5	1.4	0.7	2.5
	20-30	0.3	0.4	0.5	0.6	0.3	2.1
West	0-10	0.2	0.2	0.5	10.0	5.0	16.3
	10-20	0.3	0.2	0.4	1.9	0.9	2.9
	20-30	0.3	0.2	0.4	0.7	0.3	2.3
Average	0-10	0.2	0.2	0.5	8.6	4.3	11.4
	10-20	0.3	0.3	0.4	1.7	0.9	2.8
	20-30	0.3	0.3	0.5	1.0	0.5	2.5

	Depth	Exc Mg	Exc Na	Exc K	Exc H	CEC
	cm	meq/100 of soil	meq/100 of soil	meq/100 of soil	meq/100 of soil	meq/100 of soil
East	0-10	0.8	0.1	0.4	5.8	15.6
	10-20	0.6	0.1	0.2	5.3	9.4
	20-30	1.4	0.1	0.1	4.5	8.4
North	0-10	1.2	0.2	0.4	6.8	20.2
	10-20	0.6	0.1	0.1	4.7	8.2
	20-30	2.3	0.1	0.1	4.8	10.9
South	0-10	0.9	0.2	0.3	6.5	17.1
	10-20	0.9	0.1	0.1	4.3	7.9
	20-30	1.6	0.2	0.1	3.4	7.4
West	0-10	1.7	0.3	0.4	6.4	25.2
	10-20	0.5	0.1	0.2	5.8	9.4
	20-30	0.7	0.1	0.2	2.9	6.1
Average	0-10	1.2	0.2	0.4	6.4	19.5
	10-20	0.6	0.1	0.2	5.0	8.7
	20-30	1.5	0.1	0.1	3.9	8.2