

2018

Annual Results Report

[Yardstick demonstrations for the Albany
and Esperance port zones]

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Report Sensitivity

Does the report have any of the following sensitivities?

Intended for journal publication	NO
Results are incomplete	NO
Commercial/IP concerns	NO
Embargo date	NO

Key Messages

- There was little evidence from these trials in 2018 to support the idea that the latest released varieties of wheat, barley and canola necessarily differ in their response to increasing N and P nutritional inputs.
- These results suggest growers need only consider a crop and not specific varieties in their agronomic management.
- True time of sowing comparisons at Hyden and Gibson, where seasonal conditions were conducive to early emergence of sowing time one, clearly showed a yield benefit from early seeding.
- N and P nutrition data supports current farmer practices of adequate basal nutrient upfront for the season, followed by post-emergent nitrogen as season and yield potential warrant.
- Conclusions of this study are limited by the site-specific growing conditions and choice of varieties.

Summary

Regionally specific agronomy has been identified as a need by growers in RCSN Open Local Forums. This project aimed to improve variety specific agronomic management by testing variety performance at different sowings times under nutrition regimes representing different decision-making processes.

Two recent release varieties each of wheat, barley and canola were sown in small plot trials on expectant N responsive soils covering a range of rainfalls. Trials were located close to Hyden, Kojonup, Jerramungup, South Stirling, Mt Madden, Munglinup, Gibson and Scadden. Crop performance was assessed for early growth, yield and grain quality at two times of sowing whilst subjected to N and P nutrition representing expected decile 1, 3, 6 seasons and a reactive “play the season” practise. Each trial contained three replications with sowing times located in adjacent blocks.

P was banded and N topdressed at seeding. Decile 3 and 6 and “play the season” received equivalent N at seeding and then Decile 6 and “play the season” received N top-up at 6 weeks after seeding and “play the season” was to receive a further top-up at 10 weeks after seeding if required. This was not required.

The 2018 season was characterised by summer rainfall, of 56-175mm, emergence from the first sowing constrained by a late break at most sites with opening rains at the end of May, and a dry September. The first time of sowing was seeded dry for most cereal and canola trials and the second sowing followed opening rains.

True time of sowing comparisons were difficult to examine in 2018 because of seasonal conditions, however early emergence of TOS1 at Hyden and Gibson provided such an opportunity and clearly showed yield benefits. Other sites were subject to adverse weather conditions at TOS1. Jerramungup and South Stirling suffered damaging pre-frontal winds that sand blasted TOS1, severe frost at Kojonup reduced yield in TOS1 and low winter rainfall gave poor yield in wheat, barley and canola at Mt Madden.

Increasing N and P inputs above Decile 1 rates tended to increase grain yield at each site when averaged across varieties however there was no clear take home message. Yield improvement and rates of N and P were contingent on crop and sowing time. Significant yield increases were measured at Hyden, Munglinup, Gibson and Scadden but specific yield improvements depended on crop and sowing time at each site. At Hyden, for example, yield of wheat TOS2 only was increased yet yield of barley was not increased above Decile 1 inputs. Yield in cereals at Munglinup was increased at both sowing times yet at Gibson only the first sowing time recorded a significant yield increase.

Significant yield increases from N and P inputs above Decile 1 rates were also recorded in wheat and canola TOS2 crops at South Stirling and wheat, barley and canola at Kojonup. Low rainfall was the prime driver for yield at Mt Madden with improved nutrition above Decile 1 inputs having no impact on yield in wheat, barley or canola at this site.

Increasing N and P also led to a general increase in grain protein in wheat and barley at most sites. Canola oil level was not increased by N and P rates above Decile 1.

There was little evidence to support the idea that the latest varieties differ in their response to increasing N and P inputs in wheat, barley and canola such that it could be exploitable by growers. The lack of consistent variety x fertiliser interactions in these environments suggests growers need only consider a crop and not specific varieties in their agronomic management.

Some interactions between variety and nutrition were identified but responses were isolated and varied with crop and site. Significant interactions were measured for TOS1 wheat yield at Gibson and TOS2 protein percent at South Stirling; barley TOS1 yield at Jerramungup, TOS1 protein at Hyden, TOS2 protein at South Stirling and TOS2 screenings at Kojonup; canola TOS2 yield at Gibson and TOS1 oil content at Hyden.

It must be remembered that the results of this trial series are really only pertinent to the 2018 growing season at these sites and to the choice of varieties used.

Background

Regionally specific agronomy has been identified as a need by growers in RCSN Open Local Forums, in particular in using regionally specific agronomy demonstrations that use best district practice to assist the decision making of growers.

The aim of this project is to understand crop performance at different sowings times, crop type, and nutrition regime representing different decision-making processes depending on budget and season. This information is then available for growers to help decide which variety to grow and with what nutrition regime within their local farming system.

Objectives

To use best district practice to assist grower's decisions to improve variety specific agronomic management through understanding crop performance with differing inputs.

Methods

'Yardstick' demonstrations were established as small plot trials across the Albany and Esperance port zones, covering a range of soil type and rainfall zones. At each site wheat, barley and canola were examined with two varieties chosen per crop. Each variety was assessed for crop performance at two times of sowing whilst subjected to varying N and P nutrition inputs representing expected decile 1, 3, 6 seasons along with a reactive "play the season" nutrition practise. Sulphate of Potash was applied to all sites at 150 kg/ha prior to seeding.

Specific N and P levels for each location are shown below. P was banded at seeding. All treatments received N topdressed immediately before seeding. Decile 6 received half the N topdressed approximately 6 weeks after seeding (Decile 3 ~ Decile 6 ~ "Play the season" for N at seeding). "Play the season" received a top-up at 6 weeks after seeding and a further top-up at 10 weeks after seeding if required. This was not required.

Nutrition treatments

Location	Decile 1		Decile 3		Decile 6		Play the season		PE units N
	Units N	Units P	Units N	Units P	Units N	Units P	Units N	Units P	
Hyden	15	4	30	8	60	16	30	8	
Kojonup	20	5	45	10	90	16	45	10	60 6WAS
Jerramungup	25	6	50	12	100	18	50	12	
South Stirling	25	6	50	12	100	18	50	12	30 6WAS
Mt Madden	15	4	30	8	60	16	30	8	
Munglinup	25	6	50	12	100	18	50	12	
Gibson	25	6	50	12	100	18	50	12	
Scadden	20	5	45	10	90	16	45	10	

The first time of sowing was seeded dry for most cereal and canola trials with the second sowing time following opening rains. Seasonal opening rains were received towards the end of May for most sites, with the exception of Hyden, Gibson and South Stirling where TOS1 emerged on early soil moisture.

Crop performance was assessed by rating establishment and early vigour followed by NDVI measurements between booting and flowering, and tiller counts at heading/flowering in cereals. Trials were sown using a small plot cone seeder with knife points and press wheels. Plots were harvested using small plot header and sampled for yield and physical grain quality measured. Each trial contained three replications with time of sowings located in adjacent blocks. Trial data was analysed statistically as a factorial within each time of sowing to assess the interaction between variety and nutrition regime.

Location & Sowing Time

	Time of sowing	Latitude (decimal degrees)		Longitude (decimal degrees)	
Trial Site #1	4 th May & 2 nd June	32.396910	S	119.2871993	E
Nearest Town	Hyden (wheat and barley)				
Trial Site #2	4 th May & 3 rd June	32.397638	S	119.310192	E
Nearest Town	Hyden (canola)				
Trial Site #3	5 th & 29 th May	33.798512	S	116.940085	E
Nearest Town	Kojonup (wheat & barley)				
Trial Site #4	5 th & 29 th May	33.801477	S	116.946477	E
Nearest Town	Kojonup (canola)				
Trial Site #5	2 nd May & 26 th June	33.95145	S	118.96931	E
Nearest Town	Jerramungup (wheat & barley)				
Trial Site #6	1 st May & 15 th June	34.04481	S	118.9557	E
Nearest Town	Jerramungup (canola)				
Trial Site #7	26 th Apr & 13 th June	34.594781	S	118.3246697	E
Nearest Town	South Stirling (wheat & barley)				
Trial Site #8	26 th Apr & 14 th June	34.567376	S	118.3175291	E
Nearest Town	South Stirling (canola)				
Trial Site #9	3 rd May & 4 th June	33.39705	S	119.61823	E
Nearest Town	Mt Madden (wheat and barley)				
Trial Site #10	5 th May & 4 th June	33.121884	S	119.9671308	E
Nearest Town	Mt Madden (canola)				
Trial Site #11	4 th May & 20 th June	33.759212	S	121.180166	E
Nearest Town	Munglinup (wheat & barley)				
Trial Site #12	4 th May & 20 th June	33.67848	S	120.800765	E
Nearest Town	Munglinup (canola)				
Trial Site #13	2 nd May & 6 th June	33.611594	S	121.7739182	E
Nearest Town	Gibson (wheat & barley)				
Trial Site #14	2 nd May & 6 th June	33.601897	S	121.787181	E
Nearest Town	Gibson (canola)				
Trial Site #15	3 rd May & 8 th June	33.42411	S	121.6385827	E
Nearest Town	Scadden (wheat & barley)				
Trial Site #16	3 rd May & 19 th June	33.383562	S	121.3985338	E
Nearest Town	Scadden (canola)				

Growing Season Rainfall (2018)

Site	Autumn rainfall total (Jan-Apr) (mm)	Growing season monthly rainfall (mm)						2018 GSR (mm)	Average GSR (mm)
		May	Jun	Jul	Aug	Sep	Oct		
Hyden	68	9.7	28.2	60.8	75.4	3.0	22.8	200	226
Kojonup	77	33.0	90.4	105.6	87.0	20.3	38.2	375	405
Jerramungup	54	10.9	28.4	46.4	52.4	7.8	28.7	175	280
South Stirling	56	16.5	64.9	42.3	97.1	37.4	39.2	297	425
Mt Madden	68	12.8	29.2	24.6	38.8	3.0	38.2	147	196
Munglinup	140	8.4	39.6	51.2	150.6	33.4	38.4	322	334
Gibson	158	33.8	52.4	64.8	158.0	46.6	54.2	410	385
Scadden	175	8.5	30.9	14.9	62.1	8.6	29.7	155	232

Major Frost Events and Heat Shock

The table below lists the dates of spring (August, September) minimum temperatures below 0°C and maximum temperatures above 30°C, determined from on-site Tiny Tag temperature sensors.

Site	Daily min temperature below 0°C	Daily max temperature above 30°C
Hyden (wheat and barley)	18, 14-15 Aug	21-23 Sept
Hyden (canola)	11, 17-18, 24-25 Aug; 6, 14-15, 18 Sept	21-24 Sept
Kojonup (wheat & barley)	11-12, 18-19, 25 Aug; 3, 6, 14-16, 27 Sept	11 Oct
Kojonup (canola)	11-12, 18-19 Aug; 11-12, 14-16, 20, 27 Sept	11, 17 Oct
Jerramungup (wheat & barley)	18 Aug; 6, 15-16 Sept	nil
Jerramungup (canola)	18 Aug; 6, 15-16 Sept	nil
South Stirling (wheat & barley)	17-19 Aug; 14-16 Sept	16-17 Oct
South Stirling (canola)	17-19 Aug; 14-16 Sept	16-17 Oct
Mt Madden (wheat and barley)	8, 10-13, 15-19 Aug; 5-7, 11-12, 14-16, 18 Sept	11, 18 Aug; 22-24 Sept
Mt Madden (canola)	11-12, 15, 17-19, Aug; 5-6, 12, 14-16, 18 Sept	15, 20 Aug; 19-25 Sept
Munglinup (wheat & barley)	nil	3, 9-10, 12-13, 15-16, 23-24, 27-28 Sept
Munglinup (canola)	nil	15, 18-19 Aug; 23 Sept
Gibson (wheat & barley)	nil	nil
Gibson (canola)	nil	21, 23-24 Sept
Scadden (wheat & barley)	nil	21-24 Sept
Scadden (canola)	15-16, 27-29 Sept	21-24 Sept

Results

Grain yield and grain quality for each site is shown in the Results section whilst growth parameters of establishment, vigour, tiller density and NDVI for each site are shown in the Appendix.

Wheat and barley at Hyden

The wheat and barley were sown into an acidic sandy gravel. Total nitrate and ammonium levels of 27 units at 0-10cm suggested this would be a N responsive site however this is mitigated by increasing acidity (4.3) and Al⁺⁺⁺ (24.3 mg/kg) at depth which may impede growth and rooting depth of barley.

Consistent but below average winter rains were followed by a dry September and a mild finish with only one instance of maximum temperature above 30°C; 21-23rd September. One major frost event was recorded, between 14th and 15th of September with minimum temperatures dropping to -2.7°C.

Time of seeding one was sown dry followed by a second sowing five days after the opening rains of 25-28th May.

BOM records show opening rains at the end of May for Hyden however this site received earlier rain that allowed the crops to germinate on early moisture and provide a clear comparison for time of sowing. Yield results at this site clearly show that early seeding was important for high yield. The two sowing times could not be analysed directly owing to the trial layout however there was a consistent trend for higher yield. Early sowing also resulted in no yield difference between the two wheat and barley varieties chosen whilst variety choice became important for wheat at the later sowing.

The influence of fertiliser regime on yield depended on sowing time and crop. Wheat yield remained unaffected under the higher yield potential from an early sowing with the Decile 1 inputs of 15 units of N and 4 units of P being adequate to achieve 3.5 t/ha. Nutrient inputs were more important following a delay in sowing with the Decile 6 treatment of 60 units of N and 16 units of P increasing yield significantly compared to all other mixes of N and P. Yield of barley remained relatively inelastic with no yield improvement above the Decile 1 rates of N and P at either sowing time.

The lack of any significant interaction in both crops show that yield of both varieties responded in a similar manner to increasing rates of N and P.

Tiller density was unaffected by variety choice or nutrition for either crop.

NDVI measurements may be indicative of biomass but there was no evidence that NDVI was consistently associated with yield under the growing conditions experienced at this site.

Wheat varieties differed significantly in grain protein, hectolitre weight and thousand grain weights however the results were not consistent over sowing times. Protein tended to be a little low whilst hectolitre weight was above delivery specifications. Both varieties returned low levels of screenings. Grain protein was the only grain quality attribute to respond to nutrition with protein increases of 0.5 to 0.7% associated with the Decile 6 level of 60 units of N.

Grain quality of barley was also quite consistent between varieties and nutrition treatments at each sowing time with very little improvement to increasing levels of N. Grain protein tended to be highest at the Decile 6 N rate of 60 units however it was only significant at sowing time one.

The lack of any significant interaction for most grain quality measures suggests that varieties in both crops responded in a similar manner to increasing rates of N and P. Grain protein in barley was an exception at TOS1 with Spartacus recording a significant increase in protein percent at Decile 6 whilst protein in Planet was relatively stable.

Table 1. Wheat yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost %	Lodging	Grain shatter	Yield t/ha	Frost %	Lodging	Grain shatter
Wheat variety								
Scepter	3.423	-	2		3.301	a	2	
Cutlass	3.623	-	2		3.076	b	2	
LSD					0.186	.		
F pr.	0.091	.	nil	nil	0.021	.	nil	nil
Nutrition								
Decile 1	3.542	-	2		2.928	b	2	
Decile 3	3.461	-	2		3.177	b	2	
Decile 6	3.542	-	2		3.466	a	2	
Play	3.547	-	2		3.183	b	2	
LSD		.			0.263	.		
F pr.	0.933	.	nil	nil	0.006	.	nil	nil
Variety x Nutrition								
F pr.	0.524	.	nil	nil	0.693	.	nil	nil

Table 2. Wheat grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein %	HLW Kg/hL	1000 Grain weight g	Screens %	Protein %	HLW Kg/hL	1000 Grain weight g	Screens %
Wheat variety								
Scepter	10.2	a	86.37	-	42.19	b	0.733	-
Cutlass	9.7	b	86.14	-	45.36	a	0.783	-
LSD	0.2489		1.626				0.309	
F pr.	<.001	0.794	<.001	0.684	0.054	<.001	<.001	0.577
Nutrition								
Decile 1	9.7	b	85.75	-	44.54	-	0.750	-
Decile 3	10.2	a	85.88	-	42.29	-	0.717	-
Decile 6	10.2	a	87.65	-	44.02	-	0.700	-
Play	9.8	b	85.73	-	44.24	-	0.867	-
LSD	0.352						0.51	
F pr.	0.016	0.338	0.197	0.761	0.032	0.275	0.263	0.477
Variety x Nutrition								
F pr.	0.336	0.404	0.999	0.378	0.841	0.796	0.166	0.995

Table 3. Barley yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost %	Lodging	Grain shatter	Yield t/ha	Frost %	Lodging	Grain shatter
Barley variety								
Planet	2.734 -	1.6 -			2.676 -	1.8 -		
Spartacus	2.776 -	1.3 -			2.701 -	1.4 -		
LSD								
F pr.	0.751	0.259	nil	nil	0.816	0.112	nil	nil
Nutrition								
Decile 1	2.699 -	1.7 -			2.611 -	1.3 -		
Decile 3	2.806 -	1.5 -			2.718 -	1.3 -		
Decile 6	2.805 -	1.3 -			2.630 -	2.2 -		
Play	2.708 -	1.2 -			2.796 -	1.7 -		
LSD								
F pr.	0.888	0.640	nil	nil	0.609	0.096	nil	nil
Variety x Nutrition								
F pr.	0.680	0.572	nil	nil	0.126	0.741	nil	nil

Table 4. Barley grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein	HLW	Grain Retent	Screens	Protein	HLW	Grain Retent	Screens
	%	Kg/hL	%	%	%	Kg/hL	%	%
Barley variety								
Planet	9.54 b	73.4 -	90.5 -	0.35 -	10.13 -	74.3 -	93.0 -	0.28 -
Spartacus	10.03 a	77.4 -	90.2 -	0.48 -	10.37 -	73.1 -	94.0 -	.25 -
LSD	0.316							
F pr.	0.005	0.146	0.839	0.306	0.317	0.308	0.358	0.688
Nutrition								
Decile 1	9.68 b	75.5 -	90.0 -	0.26 -	9.82 -	70.3 b	93.7 -	0.30 -
Decile 3	9.45 b	75.8 -	92.3 -	0.48 -	10.17 -	73.4 b	93.8 -	0.38 -
Decile 6	10.25 a	75.5 -	89.5 -	0.52 -	10.80 -	78.0 a	93.6 -	0.22 -
Play	9.77 b	74.8 -	89.6 -	0.40 -	10.22 -	73.2 b	92.8 -	0.17 -
LSD	0.447					3.32		
F pr.	0.013	0.994	0.615	0.411	0.052	0.002	0.895	0.291
Variety x Nutrition								
F pr.	0.004	0.994	0.313	0.600	0.413	0.575	0.981	0.343

Table 5. Interaction of barley grain protein percent between variety and nutrition.

Factor	Traits assessed TOS1 Grain protein %	
	Planet	Spartacus
Decile 1	9.53 -	9.83 b
Decile 3	9.43 -	9.45 b
Decile 6	9.43 -	11.07 a
Play	9.77 -	9.77 b
LSD	0.63	
F pr.	0.004	

Canola at Hyden

Canola was sown into a sandy gravel with an acceptable pH of 5.2 (CaCl₂) and AL⁺⁺⁺ of less than 2 mg/kg at 10-30cm. 21 units of nitrate at 0-10cm along with negligible ammonium suggested the site should be N responsive.

The canola site received below average winter rains followed by a dry September with several major frost events with temperature below 0°C on three occasions in each of August and September. The site did not experience a hot finish with only one recording of maximum temperature above 30°C; 21-24th September.

Canola yield was quite low at this site although the results clearly show that canola was still very responsive to sowing time. Variety choice was important with the yield of T4510 significantly higher than Bonito at both sowing times.

The low site yield most likely accounts for the lack of a yield response to increasing levels of N and P. Increasing N and P above Decile 1 levels gave no further increase in yield and only a slight increase in oil percent.

Whilst T4510 recorded higher NDVI than Bonito, increases in nutrition had no significant effect on NDVI.

Oil content was relatively high with each variety recording greater than 46%. There was a significant trend for oil percent to increase with N at early sowing although the improvement was slight. A significant interaction for oil percent indicates that varieties responded differently to increasing N and P. These interactions were observed in a low yielding site yet there is a suggestion that oil content of Bonito is more likely to respond to increasing N than T4510.

Table 1. Canola yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Wheat variety								
Bonito	0.39 b				0.26 b			
T4510	0.65 a				0.48 a			
LSD	0.17				0.04			
F pr.	0.007	nil	nil	nil	<.001	nil	nil	nil
Nutrition								
Decile 1	0.49 -				0.30 b			
Decile 3	0.51 -				0.39 a			
Decile 6	0.55 -				0.40 a			
Play	0.54 -				0.39 a			
LSD					0.06			
F pr.	0.929	nil	nil	nil	0.007	nil	nil	nil
Variety x Nutrition								
F pr.	0.334	nil	nil	nil	0.200	nil	nil	nil

Table 2. Canola grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1		Traits assessed TOS2	
	Oil %		Oil %	
Wheat variety				
Bonito	47.5	a	50.1	a
T4510	46.5	b	47.1	b
LSD	0.44		0.98	
F pr.	0.001		<.001	
Nutrition				
Decile 1	46.7	c	49.2	-
Decile 3	47.4	b	48.5	-
Decile 6	48.3	a	48.2	-
Play	45.6	d	48.5	-
LSD	0.62			
F pr.	<.001		0.519	
Variety x Nutrition				
F pr.	0.001		0.789	

Table 3. Interaction of canola oil percent between variety and nutrition.

Factor	Traits assessed TOS1		Traits assessed TOS2	
	Oil %		Oil %	
	Bonito	T4510	Bonito	T4510
Decile 1	46.4 cde	47.0 cd	50.6	47.8
Decile 3	48.4 b	46.3 de	49.9	47.1
Decile 6	49.4 a	47.2 c	50.1	46.3
Play	45.6 e	45.6 e	49.9	47.2
LSD	0.88			
F pr.	<.001		0.79	

Wheat and barley at Kojonup

Total nitrate and ammonium levels of 27.5 units at 0-10cm suggest the sandy loam site at Kojonup would be N responsive although it also contained high levels of P (74 units at 0-10cm) that may indicate high PBI. The site tended towards acidity at depth as pH dropped to 5.0 and, along with an increase in Al^{+++} to 14.4 mg/kg, this may possibly affect growth of barley.

Opening rains of 32mm were recording over 5 days between 25-29th of May. Higher than average rain through July and August was followed by a mild finish with rain in September, October and November. Several frost events were recorded with below 0°C temperatures; on three occasions in August and four in September. One heat shock was recorded during grain fill with maximum temperature above 30°C; 11th October.

The Kojonup cereal site was affected by several frost events through spring with wheat yield in the first time of sowing reduced to an average of 1.76 t/ha, accompanied by low tiller density. The impact of frost was demonstrated in the nearby wheat NVT where there was a 2 t/ha differential between Emu Rock and Yitpi varieties. Environmental conditions were the overwhelming influence on yield and increasing nutrition above the Decile 1 rates offered no improvement in yield or quality. Low yields were accompanied by poor grain quality with low protein, thousand grain weight and high screenings. The later sowing appears to have escaped some frosts at critical developmental times and averaged 2.27 t/ha. Variety choice was important at this sowing time with significant yield differences between wheat varieties. Nutrition was also important at sowing time two with significant improvements in plant growth (vigour, tiller density and NDVI) and grain yield as N and P were increased. At this site Decile 6 proved to be the most productive. However, grain quality remained poor with low protein, thousand grain weight and greater than 5% screenings. Leaching of nitrogen may have played a role in the poor grain quality at this site and the “play the season” treatment may have improved yield and quality if N and P rates were higher. Timing nitrogen application with rainfall events may be one approach that needs further investigation.

The lack of significant interactions for tiller density, NDVI, yield and quality suggest that the two wheat varieties responded in a similar way to increasing nutrition.

Barley was able to better cope with the growing season conditions with higher yields than wheat at both early and later sowing times. The later sowing again appeared to escape frosts at critical developmental times and along with a higher yield, varieties also differed significantly in yield. Nutrition was important for yield performance in barley with significant responses to increasing N and P at both sowing times. Decile 6 was the most productive nutritional regime with the highest tiller density, NDVI and yield at both sowing times.

The lack of significant interactions for tiller density, NDVI and yield suggest that the two barley varieties responded in a similar way to increasing nutrition of N and P.

Despite low levels of grain protein in both barley varieties the data shows that Spartacus consistently recorded higher protein and hectolitre weight and lower screenings than Planet. Grain protein also increased significantly as nutrition reached Decile 6 inputs of N. There were however very few significant interactions between variety and nutrition for barley grain quality traits. The only difference between varieties was seen for screenings at TOS2 where screenings of Spartacus were relatively stable whilst Planet tended to increase screenings as N rate was raised.

Table 1. Wheat flowering date and yield for variety and nutrition main effects.

Factor	Traits assessed TOS1					Traits assessed TOS2				
	50% flowering year/day	Yield t/ha	Frost	Lodging	Grain shatter	50% flowering Year/day	Yield t/ha	Frost	Lodging	Grain shatter
Wheat variety										
Scepter	272 -	1.901 -				273 B	2.464 a			
Zen	274 -	1.630 -				275 A	2.083 b			
LSD						1.9	0.2217			
F pr.	0.131	0.133	nil	nil	nil	0.029	0.002	nil	nil	nil
Nutrition										
Decile 1	272 -	1.548 -				274 -	1.912 c			
Decile 3	273 -	1.495 -				275 -	2.275 b			
Decile 6	272 -	2.017 -				272 -	2.976 a			
Play	274 -	2.004 -				275 -	1.932 c			
LSD							0.3135			
F pr.	0.765	0.079	nil	nil	nil	0.079	<.001	nil	nil	nil
Variety x Nutrition										
F pr.	0.380	0.732	nil	nil	nil	0.998	0.076	nil	nil	nil

Table 2. Wheat grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein	HLW	1000 Grain weight g	Screens	Protein	HLW	1000 Grain weight g	Screens
	%	Kg/hL		%	%	Kg/hL		%
Wheat variety								
Scepter	8.96 b	78.08 -	31.1 a	12.16 a	8.30 b	80.37 -	34.5 -	10.15 a
Zen	9.81 a	78.49 -	30.1 b	5.99 b	9.33 a	80.85 -	34.1 -	5.44 b
LSD	0.439			0.856	0.32			1.591
F pr.	<.001	0.713	0.489	<.001	<.001	0.770	0.792	<.001
Nutrition								
Decile 1	9.22 -	77.35 -	27.9 d	8.83 -	8.53 b	78.93 -	32.3 -	8.33 -
Decile 3	9.28 -	77.50 -	30.7 b	8.28 -	8.77 b	82.80 -	33.7 -	7.90 -
Decile 6	9.72 -	79.37 -	29.7 c	9.38 -	9.35 a	81.85 -	37.2 -	6.98 -
Play	9.32 -	78.92 -	34.1 a	9.80 -	8.62 b	78.85 -	34.2 -	7.97 -
LSD					0.45			
F pr.	0.340	0.501	0.047	0.083	0.007	0.246	0.150	0.626
Variety x Nutrition								
F pr.	0.551	0.582	0.056	0.875	0.614	0.969	0.274	0.793

Table 3. Barley yield for variety and nutrition main effects.

Factor	Traits assessed TOS1					Traits assessed TOS2				
	50% flowering BBCH	Yield t/ha	Frost	Lodging	Grain shatter	50% flowering BBCH	Yield t/ha	Frost	Lodging	Grain shatter
Barley variety										
Planet	56.6 b	3.439 -				57.3 b	3.872 a			
Spartacus	72.2 a	3.228 -				73.0 a	3.380 b			
LSD	1.08					1.0	0.293			
F pr.	<.001	0.094	nil	nil	nil	<.001	0.003	nil	nil	nil
Nutrition										
Decile 1	64.8 -	2.923 c				65.7 -	3.360 b			
Decile 3	63.7 -	3.287 b				65.3 -	3.558 b			
Decile 6	64.2 -	3.730 a				64.8 -	4.279 a			
Play	64.8 -	3.393 ab				64.8 -	3.307 b			
LSD		0.357					0.415			
F pr.	0.319	0.002	nil	nil	nil	0.533	<.001	nil	nil	nil
Variety x Nutrition										
F pr.	0.099	0.233	nil	nil	nil	0.533	0.320	nil	nil	nil

Table 4. Barley grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein	HLW	Grain retent	Screens	Protein	HLW	Grain retent	Screens
Barley variety								
Planet	7.51 b	72.32 b	88.32 b	1.50 a	7.76 b	71.28 b	82.03 b	2.47 a
Spartacus	8.88 a	74.18 a	92.41 a	1.01 b	8.43 a	74.86 a	90.93 a	1.16 b
LSD	0.369	1.664	2.697	0.376	0.413	1.719	2.589	0.417
F pr.	0.0001	0.0311	0.0058	0.0141	0.0038	0.0005	0.0001	0.0001
Nutrition								
Decile 1	7.58 c	73.47 -	88.17 -	1.63 -	7.68 b	72.40 -	85.05 -	1.65 ab
Decile 3	8.00 bc	72.55 -	91.73 -	0.95 -	7.82 b	74.07 -	89.27 -	1.38 b
Decile 6	8.95 a	73.42 -	91.02 -	1.22 -	9.02 a	73.30 -	85.33 -	2.23 a
Play	8.23 b	73.55 -	90.53 -	1.22 -	7.85 b	72.52 -	86.28 -	1.98 a
LSD	0.522				0.585			0.590
F pr.	0.0005	0.7809	0.2557	0.0943	0.0007	0.4498	0.0972	0.0384
Variety x Nutrition								
F pr.	0.7850	0.9374	0.9639	0.1015	0.3870	0.4266	0.4688	0.0281

Table 5. Interaction of barley screenings between variety and nutrition.

Factor	Traits assessed TOS2 Screenings %	
	Planet	Spartacus
Decile 1	2.13 bc	1.17 d
Decile 3	1.57 cd	1.20 d
Decile 6	3.27 a	1.20 d
Play	2.90 ab	1.07 d
LSD	0.834	
F pr.	0.0281	

Canola at Kojonup

The canola site at Kojonup recorded a pH of 5.75 at 0-10cm and low levels of Al⁺⁺⁺. The soil consisted of a sandy loam with gravel increasing at depth. Soil N levels were reasonably high at 47 mg/kg at 0-10cm although a high yield potential should still make the site N responsive for canola.

Opening rains were recording between 25-29th of May followed by higher than average falls in July and August. Several frost events were recorded with two periods in August and four occasions in September when the temperature dropped below 0°C. Pod maturation occurred under cool conditions with temperatures above 30°C recorded only on 11th and 17th October.

Crop density averaged 49 plants /m² at GS31 with no statistical effect of variety or nutritional regime.

Frost at this site may have impacted TOS1 with an average yield of 2.21 t/ha however TOS2 appears to have escaped any major impact with an average yield of 2.48 t/ha. Sowing time two appeared to better match the crop maturity of the test varieties to the growing season.

There was a clear variety response at this site with T4510 recording significantly higher yield than Bonito at each sowing time.

N and P nutrition was also important for yield at this site and the lack of significant interactions show that each variety responded in a similar way to increasing N and P. Decile 6 proved to be the most productive under the higher yield at sowing time two and the smaller input of Decile 3 was adequate for sowing time one. Delaying N application proved to be the most useful at this site with “play the season”, with equal inputs to Decile 3 but with post-emergent N, the best compromise for high yield at both sowing times.

Oil content was relatively high with significant variety differences. Oil content was not increased by increasing nutrition.

Table 1. Canola yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Canola variety								
Bonito	1.932 b				2.312 b			
T4510	2.489 a				2.652 a			
LSD	0.234				0.116			
F pr.	<.001	nil	nil	nil	<.001	nil	nil	nil
Nutrition								
Decile 1	1.852 b				2.343 b			
Decile 3	2.269 a				2.411 b			
Decile 6	2.427 a				2.581 a			
Play	2.293 a				2.593 a			
LSD	0.332				0.164			
F pr.	0.013	nil	nil	nil	0.012	nil	nil	nil
Variety x Nutrition								
F pr.	0.439	nil	nil	nil	0.964	nil	nil	nil

Table 3. Canola grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1	Traits assessed TOS2
	Oil %	Oil %
Canola variety		
Bonito	47.8 a	48.8 a
T4510	44.8 b	44.6 b
LSD	0.84	2.1
F pr.	<.001	<.001
Nutrition		
Decile 1	46.7 -	47.4 -
Decile 3	46.2 -	46.5 -
Decile 6	46.0 -	45.6 -
Play	46.3 -	47.4 -
LSD		
F pr.	0.672	0.546
Variety x Nutrition		
F pr.	0.713	0.298

Wheat and barley at Jerramungup

Total nitrate and ammonium levels of 34.1 units at 0-10cm suggest the sandy loam site at Jerramungup would be N responsive although the pH of 4.53 at 10-30cm along with Al^{+++} of 8 may affect the growth of barley.

Opening rains of 11mm were recording between 26-28th of May followed by a dry June. July and August were close to average, following by a dry but mild September. Several frost events were recorded with below 0°C temperatures recorded 18th August and 6, 15-16th September. Mild temperatures persisted through grain fill with no maximums greater than 30°C.

The first time of sowing was sown in early May however the cereal site at Jerramungup was afflicted with strong pre-frontal winds that accompanied the late May cold front resulting in extensive sandblasting of wheat and barley plots and almost complete furrow in-fill. Sowing time two was delayed until 26th June however it too was exposed to sandblasting. No reliable growth data could be collected (establishment, early vigour, tiller counts and NDVI). The site did improve and was harvested however it never fully recovered and grain yield was relatively low in both wheat and barley.

N and P nutrition was not the main determinant for grain yield or quality and increasing N and P nutrition above Decile 1 inputs did not improve yield or grain quality of wheat or barley. The only quality parameters to show a response to better nutrition was a significant reduction in screenings for barley at TOS1 and an increase in protein in both crops at TOS2.

The lack of significant differences for main effects of variety and nutrition was reflected in a lack of significant interactions for yield and grain quality of wheat and barley at both sowing times. The only significant interaction was recorded for yield of barley at TOS1 and showed that there was a difference between varieties in how they responded to increasing N and P. Yield of Planet was significantly higher at Decile 3 than all other Nutrition regimes compared with LaTrobe which showed no response to increasing N and P above Decile 1.

Table 1. Wheat yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Wheat variety								
Scepter	1.730 a				1.696 -			
Cutlass	1.366 b				1.730 -			
LSD	0.208							
F pr.	0.002	nil	nil	nil	0.653	nil	nil	nil
Nutrition								
Decile 1	1.499 -				1.597 -			
Decile 3	1.551 -				1.696 -			
Decile 6	1.401 -				1.852 -			
Play	1.742 -				1.707 -			
LSD					0.332			
F pr.	0.135	nil	nil	nil	0.171	nil	nil	nil
Variety x Nutrition								
F pr.	0.223	nil	nil	nil	0.150	nil	nil	nil

Table 2. Wheat grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein	HLW	1000 Grain weight	Screens	Protein	HLW	1000 Grain weight	Screens
	%	Kg/hL	g	%	%	Kg/hL	g	%
Wheat variety								
Scepter	11.0 -	79.3 -	40.9 a	0.97 b	12.4 -	81.2 a	50.2 a	0.52 b
Cutlass	11.3 -	75.0 -	37.2 b	1.57 a	12.0 -	77.2 b	35.6 b	2.29 a
LSD			2.32	0.436		1.6	1.7	0.79
F pr.	0.138	0.145	0.004	0.011	0.084	<.001	<.001	<.001
Nutrition								
Decile 1	11.1 b	79.3 -	38.8 -	1.15 -	11.7 c	78.8	42.0 -	1.50 -
Decile 3	10.9 b	76.4 -	39.6 -	1.32 -	12.2 b	79.3	43.3 -	1.37 -
Decile 6	11.9 a	76.4 -	38.0 -	1.73 -	13.1 a	77.8	41.7 -	1.68 -
Play	10.7 b	76.5 -	39.8 -	0.87 -	11.8 bc	80.9	44.5 -	1.07 -
LSD	0.658				0.63			
F pr.	0.011	0.846	0.641	0.059	<.001	0.067	0.081	0.686
Variety x Nutrition								
F pr.	0.584	0.831	0.106	0.143	0.990	0.373	0.098	0.655

Table 3. Barley yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Barley variety								
Planet	1.395 -				1.539 -			
LaTrobe	1.560 -				1.403 -			
LSD								
F pr.	0.137	nil	nil	nil	0.065	nil	nil	nil
Nutrition								
Decile 1	1.418 -				1.557 -			
Decile 3	1.487 -				1.458 -			
Decile 6	1.597 -				1.458 -			
Play	1.406 -				1.412 -			
LSD								
F pr.	0.566	nil	nil	nil	0.512	nil	nil	nil
Variety x Nutrition								
F pr.	0.041	nil	nil	nil	0.412	nil	nil	nil

Table 4. Interaction of barley grain yield between variety and nutrition.

Factor	Traits assessed TOS1 Grain yield t/ha	
	Planet	Spartacus
Decile 1	1.273 c	1.562 abc
Decile 3	1.331 c	1.644 ab
Decile 6	1.806 a	1.389 c
Play	1.169 c	1.644 ab
LSD	0.4495	
F pr.	0.041	

Table 5. Barley grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein	HLW	Grain Retent	Screens	Protein	HLW	Grain Retent	Screens
	%	Kg/hL	%	%	%	Kg/hL	%	%
Barley variety								
Planet	11.2 -	67.55 -	84.5 a	2.53 b	12.3 -	69.42 -	83.47 -	4.10 a
LaTrobe	11.5 -	68.77 -	73.4 b	3.30 a	12.5 -	70.77 -	81.67 -	2.49 b
LSD			4.78	0.626				1.34
F pr.	0.435	0.345	<.001	0.020	0.604	0.141	0.221	0.022
Nutrition								
Decile 1	11.2 -	66.73 -	76.7 -	3.52 a	11.5 b	70.97 -	82.97 -	3.40 -
Decile 3	11.1 -	68.08 -	80.5 -	2.47 b	12.3 b	69.65 -	83.13 -	2.98 -
Decile 6	11.8 -	69.33 -	80.3 -	2.43 b	13.5 a	70.18 -	82.58 -	3.07 -
Play	11.2 -	68.48 -	78.4 -	3.25 ab	12.2 b	69.57 -	81.60 -	3.73 -
LSD				0.885	0.954			
F pr.	0.583	0.537	0.597	0.042	0.005	0.654	0.869	0.825
Variety x Nutrition								
F pr.	0.746	0.499	0.882	0.296	0.312	0.559	0.376	0.873

Canola at Jerramungup

The canola site at Jerramungup was acidic with a pH of 4.4 at 0-10cm and Al⁺⁺⁺ of 7.2 mg/kg. Low N levels suggested it would be N responsive.

Opening rains of 11mm occurred between 26-28th of May. This was followed by a dry June and average rainfall in July and August. September was dry yet mild. Spring temperatures did not dip below 0°C.

The canola trial site at Jerramungup also experienced strong pre-frontal winds on several occasions with emerged plants sandblasted at both sowing times. No reliable growth data could be collected (establishment, early vigour and NDVI) and plots never recovered. The site was abandoned.

Wheat and barley at South Stirling

The soil test for the wheat and barley site at South Stirling recorded a slightly acidic pH and low levels of Al⁺⁺⁺ which may affect the growth of barley. Nitrate levels were quite high at 81 mg/kg at the surface and 33 mg/kg at 10-20cm.

TOS1 was seeded in front of a cold front in early May. The site then received little rain until 10-11 June which provided an opportunity to seed TOS2. Regular cold fronts brought lower than average rainfall for June and July followed by higher than average August rain. The site experienced a mild finish with two frost events (17-19th August and 14-16th September).

The trial site experienced strong pre-frontal winds that sandblasted the wheat and barley plots and no reliable yield or grain quality data could be collected from TOS1. Grain yield of TOS2 was in keeping with district averages for both crops.

Variety choice had no impact on yield in wheat or barley at TOS2. NDVI measurements may be indicative of crop biomass and significant differences existed between barley varieties however there was no evidence that NDVI was associated with yield under the growing conditions experienced at this site.

Whilst N and P nutrition was not the main determinant for plant growth of wheat it was a driver for yield with the highest yield attained at Decile 6. Nutrition regimes did not however have a significant effect on yield of barley and increasing inputs above Decile 1 inputs did not improve yield above the 4.3 t/ha recorded at Decile 1.

Grain protein of wheat was increased by improved nutrition above Decile 1 with an increase of about 0.6%. A significant interaction showed that wheat varieties also responded differently with protein increasing in Scepter as nutrition improved from Decile 1 to 6.

Significant differences in grain quality existed between barley varieties with Rosalind recording higher protein, hectolitre weight and grain retention and lower screenings than Planet. There were however few differences in quality with improved nutrition. Other than improved grain protein with increasing N other traits were unaffected with hectolitre weight, and screening remained stable.

A significant interaction between variety and nutrition for grain protein showed barley varieties responded differently with protein increasing more rapidly in Rosalind as nutrition improved from Decile 1 to 6 compared to Planet.

Table 1. Wheat yield for variety and nutrition main effects.

Factor	Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter
Wheat variety				
Scepter	3.745 -			
Zen	3.714 -			
LSD				
F pr.	0.781	nil	nil	nil
Nutrition				
Decile 1	3.271 c			
Decile 3	3.718 b			
Decile 6	4.139 a			
Play	3.792 b			
LSD	0.332			
F pr.	<.001	nil	nil	nil
Variety x Nutrition				
F pr.	0.434	nil	nil	nil

Table 2. Wheat grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS2			
	Protein	HLW	1000 Grain weight	Screens
	%	Kg/hL	g	%
Wheat variety				
Scepter	10.71 -	77.09 -	39.1 -	14.51 a
Zen	10.95 -	77.69 -	40.1 -	5.86 b
LSD				2.52
F pr.	0.17	0.643	0.336	<.001
Nutrition				
Decile 1	10.42 b	78.43 -	41.7 -	8.35 -
Decile 3	10.72 ab	76.85 -	38.8 -	9.33 -
Decile 6	11.17 a	75.7 -	38.4 -	12.59 -
Play	11.02 a	78.58 -	39.4 -	10.47 -
LSD	0.506			
F pr.	0.031	0.3542	0.132	0.111
Variety x Nutrition				
F pr.	0.043	0.6954	0.167	0.185

Table 3. Interaction of wheat grain protein between variety and nutrition.

Factor	Traits assessed TOS2	
	Grain protein %	
	Scepter	Zen
Decile 1	10.367 c	10.467 c
Decile 3	10.233 c	11.200 ab
Decile 6	11.433 a	10.900 ab
Play	10.800 abc	11.233 ab
LSD	0.7159	
F pr.	0.043	

Table 4. Barley yield for variety and nutrition main effects.

Factor	Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter
Barley variety				
Planet	4.31 -			
Rosalind	4.358 -			
LSD				
F pr.	0.723	nil	nil	nil
Nutrition				
Decile 1	4.072 -			
Decile 3	4.42 -			
Decile 6	4.491 -			
Play	4.352 -			
LSD				
F pr.	0.174	nil	nil	nil
Variety x Nutrition				
F pr.	0.615	nil	nil	nil

Table 5. Barley grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS2			
	Protein	HLW	Grain Retent	Screens
	%	Kg/hL	%	%
Barley variety				
Planet	10.6 b	63.82 b	79.58 b	4.37 a
Rosalind	11.88 a	66.42 a	89.39 a	2.1 b
LSD	0.42	1.127	5.305	1.635
F pr.	0.0001	0.0002	0.0014	0.0101
Nutrition				
Decile 1	10.23 c	64.98 -	85.8 -	3.37 -
Decile 3	11 b	65.35 -	87.02 -	2.67 -
Decile 6	11.98 a	64.98 -	81.15 -	3.6 -
Play	11.73 a	65.15 -	83.98 -	3.3 -
LSD	0.594			
F pr.	0.0001	0.9528	0.3961	0.843
Variety x Nutrition				
F pr.	0.0294	0.7161	0.6846	0.7689

Table 6. Interaction of barley grain yield between variety and nutrition.

Factor	Traits assessed TOS2	
	Grain protein %	
	Planet	Rosalind
Decile 1	9.93 e	10.53 de
Decile 3	10.20 de	11.80 b
Decile 6	10.87 cd	13.10 a
Play	11.40 bc	12.07 b
LSD	0.84	
F pr.	0.0294	

Canola at South Stirling

The canola site at South Stirling was situated on a sandy loam with 25% gravel. The soil test indicated an N responsive site with adequate pH in the 5.6-5.8 range and low level of AL⁺⁺⁺.

The canola site experienced similar seasonal rainfall to the cereal site with cold fronts in early May and mid-June providing seeding opportunities for both sowing times. Regular cold fronts brought lower than average rainfall for June and July followed by higher than average August rain. The site experienced a mild finish with two frost events (17-19th August and 14-16th September).

The canola trial site experienced strong pre-frontal winds that resulted in sandblasting. Reliable yield or grain quality data could not be collected from TOS1.

In TOS2 the crop established well and plant density for the canola averaged 67 plants /m² at GS31 with no statistical differences due to variety or nutritional regime.

Sowing time two matched with the crop maturity of the two varieties tested with an average yield of 1.61 t/ha. There was a slight yet significant variety response with Wahoo recording higher vigour, NDVI and a yield advantage of 0.15 t/ha over Thumper.

N and P nutrition was also important for yield at this site with Decile 3 the most productive for vigour NDVI and yield. Delaying N application through "playing the season" did not demonstrate any yield benefit compared to all N applied at seeding under the growing conditions experienced at this site. The lack of significant interactions show that each variety responded in a similar way to increasing N and P.

Oil content averaged 44.7% and was not increased by nutrition above a Decile 1.

Table 1. Canola yield and oil content for variety and nutrition main effects.

Factor	Traits assessed TOS2				
	Yield t/ha	Frost	Lodging	Grain shatter	Oil %
Canola variety					
Wahoo	1.687 a				44.5 -
Thumper	1.541 b				44.9 -
LSD	0.103				
F pr.	0.009	nil	nil	nil	ns
Nutrition					
Decile 1	1.375 b				45.4 -
Decile 3	1.68 a				44.7 -
Decile 6	1.746 a				44.1 -
Play	1.653 a				44.7 -
LSD	0.146				
F pr.	<.001	nil	nil	nil	ns
Variety x Nutrition					
F pr.	0.891	nil	nil	nil	ns

Wheat and barley at Mt Madden

The Mt Madden site was a sandy loam tending to alkaline with a pH of 5.9. There were low levels of AL⁺⁺⁺ and the soil test indicated an N responsive site.

Autumn and winter rainfall were below the long-term average in 2018. Opening rains were recorded 26-29th May and this was followed by regular cold fronts through June, July and August and a very dry September. The site experienced severe frost with three frost events in August and four in September where the temperature dropped below 0°C, for a total of 13 days.

Mount Madden was very dry following sowing of TOS1 and this led to patchy establishment in wheat and barley. Establishment at TOS2 was better and emergence did improve but early growing conditions for both sowing times were still considered marginal. Below average winter rainfall was followed by severe spring frosts. The wheat plots were harvested but the yield was not considered reliable with large variations for both sowing times.

Barley yields were very low with a site average of just 1.11 t/ha. LaTrobe recorded a consistent and significant yield advantage over Planet although grain quality tended to be poorer with lower protein, hectolitre weight, grain retention and higher screenings.

Marginal growing conditions and severe frosts restricted the impact of increasing fertiliser regime on barley yield with no yield improvement above the Decile 1 rates of N and P at either sowing time.

The lack of any significant interaction also indicated that yield of barley varieties responded in a similar manner to increasing rates of N and P under the growing conditions experienced at this site.

Increasing nutrition had very little effect on quality. It was only at the highest N and P rates at Decile 6 that significant responses were expressed; with an increase in protein and screenings and reduction in grain retention. Both varieties also responded in a similar manner to increasing rates of N and P with no significant interaction for any grain quality traits.

Table 1. Barley yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Barley variety								
Planet	1.007 b				1.039 b			
LaTrobe	1.134 a				1.256 a			
LSD	0.1171				0.1086			
F pr.	0.035	nil	nil	nil	<.001	nil	nil	nil
Nutrition								
Decile 1	0.955 -				1.117 -			
Decile 3	1.140 -				1.152 -			
Decile 6	1.088 -				1.244 -			
Play	1.099 -				1.076 -			
LSD								
F pr.	0.138	nil	nil	nil	0.161	nil	nil	nil
Variety x Nutrition								
F pr.	0.678	nil	nil	nil	0.401	nil	nil	nil

Table 2. Barley grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein	HLW	Grain Retent	Screens	Protein	HLW	Grain Retent	Screens
	%	Kg/hL	%	%	%	Kg/hL	%	%
Barley variety								
Planet	9.1 -	69.82 a	82.63 a	2.09 b	9.5 a	72.17 a	91.22 a	1.06 b
LaTrobe	8.7 -	66.29 b	65.93 b	6.30 a	8.7 b	68.72 b	82.45 b	1.76 a
LSD		1.655	3.52	1.14	0.556	1.726	3.863	0.436
F pr.	0.116	<.001	<.001	<.001	0.006	<.001	<.001	0.004
Nutrition								
Decile 1	8.2 b	67.28 -	76.97 a	3.38 b	8.9 -	70.13 -	89.60 -	1.38 -
Decile 3	8.8 b	67.92 -	76.65 a	3.40 b	9.3 -	70.33 -	84.60 -	1.62 -
Decile 6	9.8 a	69.62 -	67.85 b	6.43 a	9.0 -	69.73 -	86.85 -	1.17 -
Play	8.9 b	67.40 -	75.65 a	3.57 b	9.2 -	71.58 -	86.28 -	1.47 -
LSD	0.815		4.98	1.61				
F pr.	0.008	0.168	0.004	0.002	0.785	0.428	0.304	0.487
Variety x Nutrition								
F pr.	0.381	0.709	0.792	0.697	0.613	0.792	0.658	0.331

Canola at Mt Madden

The canola site at Mt Madden site was a sandy loam tending to alkaline with a pH of 6.1 at depth. There was a high level of N with nitrate measured at 46 mg/kg in 0-10cm.

The canola site experienced similar weather to the cereal site with late opening rains followed by regular cold fronts through June, July and August and a dry September. This site also experienced severe frost with three frost events in August and four in September where the temperature dropped below 0°C, for a total of 16 days.

The Mount Madden canola site also experienced marginal growing conditions and this resulted in very low yields of 0.05 to 0.13 t/ha. Plots were harvested however the poor yields resulted in no yield or oil response to increasing levels of N and P above the Decile 1.

Table 1. Canola yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Canola variety								
Bonito	0.1066 -				0.134 a			
T4510	0.0878 -				0.049 b			
LSD					0.0453			
F pr.	0.190	nil	nil	nil	0.001	nil	nil	nil
Nutrition								
Decile 1	0.0806 -				0.080 -			
Decile 3	0.0948 -				0.100 -			
Decile 6	0.1170 -				0.095 -			
Play	0.0963 -				0.091 -			
LSD								
F pr.	0.344	nil	nil	nil	0.926	nil	nil	nil
Variety x Nutrition								
F pr.	0.639	nil	nil	nil	0.796	nil	nil	nil

Table 2. Canola grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1	Traits assessed TOS2
	Oil %	Oil %
Canola variety		
Bonito	43.74 -	41.81 -
T4510	43.67 -	42.75 -
LSD		
F pr.	0.945	0.151
Nutrition		
Decile 1	45.32 -	42.26 -
Decile 3	44.01 -	43.32 -
Decile 6	42.67 -	43.31 -
Play	42.81 -	40.24 -
LSD		
F pr.	0.444	0.055
Variety x Nutrition		
F pr.	0.606	0.067

Wheat and barley at Munglinup

The wheat and barley were sown onto an acidic sandy gravel at Munglinup with pH dropping to 4.4 at 10-30cm. The site was thought to be N responsive although the soil test did record high levels of nitrate at 79 mg/kg. The increasing acidity at depth was associated with AL⁺⁺⁺ of 14.4 mg/kg which may impede growth and rooting depth of barley.

The first seasonal rains occurred at the end of May with 6mm recorded. Regular cold fronts but below average rain in June was followed by well above average August rainfall and drier than average September with regular hot days where the maximum temperature rose above 30°C for a total of 11 days. No frost events were recorded for August and September.

Mean yield was not greatly influenced by sowing time in either wheat or barley at Munglinup whilst variety choice was only important for maximising yield of early sown barley.

The influence of fertiliser regime on yield depended on sowing time and crop. For example, earlier sowing maximised wheat yield at Decile 3 (50N and 12P). Yield of barley at TOS1 responded to higher inputs with yield was maximised at Decile 6 whilst barley at TOS2 recorded no further yield increase above Decile 3.

The lack of any significant interaction for yield in both crops showed that there was no evidence to show varieties differed in their response to increasing nutrition under the growing conditions and inputs tested at this site.

Tiller density was unaffected by variety choice or nutrition for either crop and was not necessarily associated with higher yield.

NDVI measurements tended to increase with improved nutrition but there was no evidence that NDVI was consistently associated with yield under the growing conditions experienced at this site.

Grain quality in wheat tended to be unchanged by increasing nutrition with only protein of later sown wheat increased by nutrition above the Decile 1 level of 25N and 6P. There was no evidence to suggest the grain protein of wheat varieties Scepter and Cutlass respond differently to increasing N.

Whilst Planet barley tended to record lower protein, hectolitre weight and screenings than LaTrobe significant differences were only apparent at the early sowing. Grain protein was the most responsive quality trait to increasing nutrition in barley yet the lack of significant interactions for any grain quality trait suggests that the barley varieties tested responded in a similar manner to increasing rates of N and P for all traits.

Table 1. Wheat yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Wheat variety								
Scepter	3.286 -				3.234 -			
Cutlass	3.043 -				3.197 -			
LSD								
F pr.	0.067	nil	nil	nil	0.607	nil	nil	nil
Nutrition								
Decile 1	2.900 b				3.082 b			
Decile 3	3.266 ab				3.153 b			
Decile 6	3.537 a				3.392 a			
Play	2.955 b				3.235 ab			
LSD	0.3712				0.2150			
F pr.	0.009	nil	nil	nil	0.043	nil	nil	nil
Variety x Nutrition								
F pr.	0.933	nil	nil	nil	0.444	nil	nil	nil

Table 2. Wheat grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein	HLW	1000 Grain weight	Screens	Protein	HLW	1000 Grain weight	Screens
	%	Kg/hL	g	%	%	Kg/hL	g	%
Wheat variety								
Scepter	11.1 a	79.58 -		0.408 -	10.7 b	81.73 -		0.183 -
Cutlass	10.7 b	80.33 -		0.392 -	11.0 a	81.48 -		0.192 -
LSD	0.43				0.1498			
F pr.	0.030	0.154		0.855	<.001	0.528		0.887
Nutrition								
Decile 1	10.8 ab	80.32 -		0.333 -	10.2 c	81.48 -		0.167 -
Decile 3	10.3 b	80.62 -		0.250 -	10.8 b	81.77 -		0.150 -
Decile 6	11.4 a	79.88 -		0.517 -	11.6 a	81.42 -		0.317 -
Play	11.1 a	79.02 -		0.500 -	10.8 b	81.75 -		0.117 -
LSD	0.61				0.2119			
F pr.	0.014	0.167		0.147	<.001	0.892		0.117
Variety x Nutrition								
F pr.	0.528	0.758		0.412	0.180	0.879		0.489

Table 3. Barley yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Barley variety								
Planet	3.940 a				3.670 -			
LaTrobe	3.726 b				3.578 -			
LSD	0.1531							
F pr.	0.010	nil	nil	nil	0.270	nil	nil	nil
Nutrition								
Decile 1	3.571 b				3.456 b			
Decile 3	3.842 b				3.803 a			
Decile 6	4.154 a				3.478 b			
Play	3.763 b				3.760 a			
LSD	0.2165				0.2434			
F pr.	<.001	nil	nil	nil	0.013	nil	nil	nil
Variety x Nutrition								
F pr.	0.815	nil	nil	nil	0.394	nil	nil	nil

Table 4. Barley grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein %	HLW Kg/hL	Grain Retent %	Screens %	Protein %	HLW Kg/hL	Grain Retent %	Screens %
Barley variety								
Planet	9.8 b	67.87 b	94.07 a	1.02 b	9.0 -	67.60 b	90.74 -	1.41 -
LaTrobe	10.9 a	69.53 a	89.51 b	1.96 a	10.4 -	68.92 a	89.66 -	1.78 -
LSD	0.635	0.588	3.277	0.677		0.808		
F pr.	0.003	0.0001	0.0099	0.0098	0.092	0.0036	0.2204	0.0640
Nutrition								
Decile 1	9.4 b	68.18 -	93.12 -	1.43 -	8.8 b	67.85 -	92.68 a	1.18 b
Decile 3	10.4 a	68.73 -	91.48 -	1.48 -	8.6 b	68.27 -	90.40 a	1.50 b
Decile 6	11.2 a	68.92 -	89.73 -	1.80 -	12.4 a	68.75 -	86.62 b	2.12 a
Play	10.3 a	68.97 -	92.82 -	1.23 -	9.2 b	68.17 -	91.10 a	1.58 ab
LSD	0.898				2.323		2.562	0.566
F pr.	0.005	0.2104	0.4137	0.6542	0.012	0.4303	0.0012	0.0236
Variety x Nutrition								
F pr.	0.607	0.4147	0.5212	0.4599	0.171	0.5615	0.8415	0.7725

Canola at Munglinup

The canola site at Munglinup was more acid at depth than the wheat site and contained a higher level of Al⁺⁺⁺ at 30.6 mg/kg which may impede growth and rooting depth.

The canola site experienced similar weather to the wheat and barley site. TOS1 was sown into moisture in early May and this was followed by regular cold fronts but below average rain in June and well above average August rainfall. The site recorded no frost events and only a few days where the maximum temperature rose above 30°C.

The farmer crop, canola NVT and this trial became infested with Green Peach Aphid in 2018. Three applications of Transform insecticide were unable to control aphids in TOS2. TOS1 was able to recover somewhat and was continued through to harvest. Only harvest yield and oil content were considered reliable and have been included.

Variety choice had no effect on yield or oil in this trial. The impact on Green Peach Aphid could not be measured and so it is not clear if the similarity in yield is a reliable genetic comparison.

Increasing N and P nutrition to Decile 3 levels of 50N and 12P increased yield. Increasing N and P above Decile 1 levels gave no increase in oil percent.

No significant interactions were recorded for yield or oil percent, indicating that varieties responded similarly to increasing N and P.

Table 1. Canola yield and oil content for variety and nutrition main effects.

Factor	Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Oil %
Canola variety				
Bonito	1.454 -			43.43 -
T4510	1.699 -			43.98 -
LSD				
F pr.	0.142	nil	nil	0.616
Nutrition				
Decile 1	1.137 b			43.23 -
Decile 3	1.625 a			43.35 -
Decile 6	1.983 a			43.80 -
Play	1.562 ab			44.45 -
LSD	0.4792			
F pr.	0.016	nil	nil	0.850
Variety x Nutrition				
F pr.	0.487	nil	nil	0.505

Wheat and barley at Gibson

The wheat and barley were sown into a sandy loam with good pH and low levels of Al+++ at depth. Total nitrate and ammonium levels did however reach 55 units at 0-10cm.

April and May rainfall was well below the long-term average in 2018. Regular fronts in June and July were followed by well above average August rainfall and spring rainfall similar to the long-term average. The site experienced no frost and only a few days in late September when the maximum temperature rose above 30°C.

TOS1 was sown into moisture 2nd May followed by TOS2 about 4 weeks later. The two sowing times could not be analysed directly owing to the trial layout however yield results at this site clearly show a consistent trend for higher yield with early seeding in the 2018 growing season with yield improvements in both wheat and barley. Early sowing may have also allowed TOS1 to better access stored moisture from Autumn rainfall.

Variety choice was also important for wheat and barley to maximise yield at TOS1.

The influence of fertiliser regime on yield depended on sowing time and crop. The Decile 3 inputs of 50N and 12P all applied at sowing maximised yield under the higher yield potential from an early sowing, with the Decile 1 inputs of 25N and 6P adequate to maximise yield in wheat and barley at sowing time two.

A significant interaction in wheat suggests Scepter and Cutlass differ in responsiveness to increasing rates of N and P with yield of Cutlass more responsive to increasing N. This was only present at the higher yielding early sowing of wheat. Barley varieties Planet and LaTrobe recorded no significant interaction for yield, suggesting yield of both varieties respond similarly to increasing rates of N and P.

NDVI measurements may be indicative of biomass, and there was a general trend for higher yield associated with higher NDVI when comparing sowing times, however there was no evidence that NDVI was consistently associated with yield within each sowing time or crop type under the growing conditions experienced at this site.

Wheat variety Scepter tended to record higher protein, hectolitre weight and thousand grain weight and lower screenings than Cutlass. Protein was highest at sowing time one and responded to improved nutrition however there was again no difference between wheat varieties in how grain quality responded to increasing rates of N and P.

Grain protein of barley was quite consistent with increasing nutrition until inputs were increased to Decile 6. LaTrobe barley tended to record higher protein, hectolitre weight and also higher screenings than Planet barley. There were again no differences between barley varieties in how grain quality responded to increasing rates of N and P.

Table 1. Wheat yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Wheat variety								
Scepter	4.546 b				3.608 -			
Cutlass	4.872 a				3.787 -			
LSD	0.233							
F pr.	0.010	nil	nil	nil	0.156	nil	nil	nil
Nutrition								
Decile 1	4.286 c				3.621 -			
Decile 3	4.807 ab				3.513 -			
Decile 6	5.111 a				3.944 -			
Play	4.632 b				3.711 -			
LSD	0.330							
F pr.	<.001	nil	nil	nil	0.114	nil	nil	nil
Variety x Nutrition								
F pr.	0.038	nil	nil	nil	0.062	nil	nil	nil

Table 2. Interaction of wheat grain yield between variety and nutrition.

Factor	Traits assessed TOS1 Grain yield t/ha	
	Scepter	Cutlass
Decile 1	4.418 e	4.154 e
Decile 3	4.479 cde	5.134 ab
Decile 6	4.945 abc	5.277 a
Play	4.341 e	4.924 abcd
LSD	0.4663	
F pr.	0.038	

Table 3. Wheat grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein	HLW	1000 Grain weight	Screens	Protein	HLW	1000 Grain weight	Screens
	%	Kg/hL	g	%	%	Kg/hL	g	%
Wheat variety								
Scepter	11.9 a	79.43 a	45.27 a	0.892 -	10.6 -	78.54 -	39.41 a	1.17 b
Cutlass	11.4 b	76.48 b	39.32 b	1.217 -	10.6 -	76.85 -	32.98 b	2.28 a
LSD	0.296	2.364	3.459				3.745	0.589
F pr.	0.003	0.018	0.002	0.097	0.708	0.039	0.002	0.001
Nutrition								
Decile 1	11.4 b	76.98 --	40.57 -	1.083 -	10.4 -	78.50 -	37.18 -	1.40 -
Decile 3	11.6 b	78.05 -	42.57 -	1.017 -	10.4 -	78.03 -	37.19 -	1.60 -
Decile 6	12.0 a	77.32 -	41.94 -	1.100 -	10.8 -	76.37 -	33.22 -	2.38 -
Play	11.5 b	79.47 -	44.10 -	1.017 -	10.7 -	77.88 -	37.21 -	1.52 -
LSD	0.418							
F pr.	0.024	0.422	0.502	0.981	0.125	0.247	0.316	0.090
Variety x Nutrition								
F pr.	0.318	0.290	0.774	0.859	0.722	0.551	0.993	0.293

Table 4. Barley yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Barley variety								
Planet	5.599 a				3.71 -			
LaTrobe	4.354 b				3.02 -			
LSD	0.268							
F pr.	<.001	nil	nil	nil	0.186	nil	nil	nil
Nutrition								
Decile 1	4.620 c				2.91 -			
Decile 3	5.102 ab				2.84 -			
Decile 6	5.286 a				3.90 -			
Play	4.898 bc				3.80 -			
LSD	0.379							
F pr.	0.013	nil	nil	nil	0.310	nil	nil	nil
Variety x Nutrition								
F pr.	0.379	nil	nil	nil	0.513	nil	nil	nil

Table 4. Barley grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein	HLW	Grain Retent	Screens	Protein	HLW	Grain Retent	Screens
	%	Kg/hL	%	%	%	Kg/hL	%	%
Barley variety								
Planet	10.5 -	67.23 b	91.22 -	0.367 b	9.7 b	67.54 b	88.96 a	0.88 b
LaTrobe	10.8 -	70.30 a	89.56 -	0.922 a	10.4 a	71.76 a	82.23 b	1.94 a
LSD		0.730		0.284	0.503	1.642	3.234	0.793
F pr.	0.059	<.001	0.309	0.001	0.014	<.001	<.001	0.012
Nutrition								
Decile 1	10.4 b	68.07 -	92.45 -	0.618 -	9.8 -	68.80 -	88.23 a	1.08 -
Decile 3	10.7 ab	69.29 -	91.53 -	0.609 -	10.0 -	69.13 -	85.05 ab	1.33 -
Decile 6	11.1 a	68.65 -	87.08 -	0.683 -	10.5 -	69.57 -	81.73 b	1.87 -
Play	10.5 b	69.05 -	90.50 -	0.667 -	9.8 -	71.10 -	87.37 a	1.35 -
LSD	0.474						4.574	
F pr.	0.038	0.105	0.135	0.971	0.238	0.200	0.037	0.519
Variety x Nutrition								
F pr.	0.233	0.385	0.929	0.488	0.356	0.196	0.250	0.869

Canola at Gibson

The canola site at Gibson was an acidic sandy gravel. Total nitrate was recorded at 39 units at 0-10cm however the N responsiveness of this site is mitigated by pH decreasing to 4.5 and Al⁺⁺⁺ increasing to 9.9 mg/kg with 50% gravel at 10-30cm.

The canola site experienced similar weather to the Gibson cereal site with TOS1 sown into moisture in early May. The site received regular winter cold fronts and well above average August rainfall. Spring rainfall was similar to the long-term average and the site recorded no frost events.

Canola at Gibson showed a strong response to early sowing with an average yield of 2.3 t/ha versus 1.3 t/ha. Early sowing may have also allowed TOS1 to better access stored moisture from Autumn rainfall. Variety choice was important with a significant yield advantage of T4510 over Bonito.

Each sowing time recorded a response to increasing N and P with the later sowing also recording a significant interaction between variety and nutrition that showed yield of T4510 was more responsive to increasing N than Bonito.

Increasing N and P above Decile 1 inputs gave no increase in oil percent. No significant interaction was recorded for oil percent.

Table 1. Canola yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Canola variety								
Bonito	2.038 b				1.150 b			
T4510	2.501 a				1.354 a			
LSD	0.1536				0.145			
F pr.	<.001	nil	nil	nil	0.009	nil	nil	nil
Nutrition								
Decile 1	2.101 c				0.985 c			
Decile 3	2.349 ab				1.080 bc			
Decile 6	2.481 a				1.742 a			
Play	2.148 bc				1.201 b			
LSD	0.2172				0.206			
F pr.	0.007	nil	nil	nil	<.001	nil	nil	nil
Variety x Nutrition								
F pr.	0.944	nil	nil	nil	0.006	nil	nil	nil

Table 2. Interaction of canola grain yield between variety and nutrition.

Factor	Traits assessed TOS2 Grain yield t/ha	
	Bonito	T4510
Decile 1	0.959 d	1.011 cd
Decile 3	1.136 bcd	1.023 cd
Decile 6	1.398 b	2.086 a
Play	1.105 cd	1.297 bc
LSD	0.2906	
F pr.	0.006	

Table 3. Canola grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1	Traits assessed TOS2
	Oil %	Oil %
Canola variety		
Bonito	46.83 -	46.74 a
T4510	46.01 -	42.69 b
LSD		0.929
F pr.	ns	<.001
Nutrition		
Decile 1	46.37 -	44.50 -
Decile 3	46.47 -	44.40 -
Decile 6	46.25 -	45.47 -
Play	46.60 -	44.50 -
LSD		
F pr.	ns	0.300
Variety x Nutrition		
F pr.	ns	0.328

Wheat and barley at Scadden

The cereal site at Scadden was a N responsive alkaline clay with nitrate levels of 19 mg/kg at 0-10cm.

The first seasonal rains occurred at the end of May with 8mm recorded, followed by below average winter rainfall and a drier than average September. No frost events were recorded in August and September. The site experienced no frost and only one period in late September where the temperature rose above 30°C for 3 days.

Emergence was patchy in both wheat and barley in TOS1. This can be seen in the ratings for establishment of wheat. However final yields of 4.1 t/ha for wheat and 4.6 t/ha for barley indicate crops were able to utilise stored moisture from February rains and later growing conditions were more favourable for cereals.

Seeding before the opening rains was not important for high yield on this alkaline clay in the 2018 growing season and variety choice was of limited importance for maximising yield.

Whilst the site was chosen to be N responsive, low winter rains impacted fertiliser response and the fertiliser regimes employed in treatments had no impact on yield of both wheat and barley with no yield increase beyond that recorded for the Decile 1 treatment of 20N and 5P. The lack of response to improved nutrition was also reflected in a lack of any significant interactions between variety and nutrition for yield of both wheat and barley.

Variety and nutrition had no significant effect on tiller density for wheat and barley and increasing N and P had no significant effect on NDVI measurements in wheat or barley.

Varietal differences in protein and grain weight for the wheats and protein for barley were the only significant changes in grain quality. Increasing nutrition regimes above the Decile 1 rates of 20N and 5P offered no statistical change in any grain quality trait in wheat or barley. The lack of response to improved nutrition for quality traits of both crops was also reflected in a lack of any significant interactions between variety and nutrition.

Table 1. Wheat yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Wheat variety								
Scepter	3.975 -				4.400 a			
Cutlass	4.017 -				3.992 b			
LSD					0.2652			
F pr.	0.804	nil	nil	nil	0.005	nil	nil	nil
Nutrition								
Decile 1	3.683 -				4.000 -			
Decile 3	4.117 -				4.200 -			
Decile 6	4.200 -				4.350 -			
Play	3.983 -				4.233 -			
LSD								
F pr.	0.177	nil	nil	nil	0.288	nil	nil	nil
Variety x Nutrition								
F pr.	0.675	nil	nil	nil	0.302	nil	nil	nil

Table 2. Wheat grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein	HLW	1000 Grain weight	Screens	Protein	HLW	1000 Grain weight	Screens
	%	Kg/hL	g	%	%	Kg/hL	g	%
Wheat variety								
Scepter	10.95 -	78.07 -	46.96 a	0.850 -	10.60 b	81.59 -	45.11 a	0.575 -
Cutlass	11.13 -	77.94 -	42.49 b	0.583 -	11.11 a	78.50 -	40.05 b	0.558 -
LSD			2.614		0.303		2.716	
F pr.	0.336	0.886	0.003	0.079	0.003	0.062	0.001	0.795
Nutrition								
Decile 1	11.03 -	77.62 -	45.53 -	0.983 -	10.65 -	80.40 -	44.16 -	0.567
Decile 3	10.82 -	78.40 -	44.41 -	0.483 -	11.08 -	79.82 -	40.27 -	0.567 -
Decile 6	11.10 -	78.97 -	44.17 -	0.800 -	10.78 -	80.28 -	41.85 -	0.583 -
Play	11.22 -	77.03 -	44.78 -	0.600 -	10.90 -	79.68 -	44.04 -	0.550 -
LSD								
F pr.	0.498	0.429	0.867	0.105	0.213	0.983	0.136	0.986
Variety x Nutrition								
F pr.	0.579	0.256	0.845	0.631	0.119	0.235	0.638	0.529

Table 3. Barley yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Barley variety								
Planet	4.20 -				4.887 -			
LaTrobe	4.57 -				4.849 -			
LSD								
F pr.	0.180	nil	nil	nil	0.813	nil	nil	nil
Nutrition								
Decile 1	4.33 -				4.890 -			
Decile 3	4.54 -				4.839 -			
Decile 6	4.30 -				5.085 -			
Play	4.36 -				4.659 -			
LSD								
F pr.	0.913	nil	nil	nil	0.317	nil	nil	nil
Variety x Nutrition								
F pr.	0.736	nil	nil	nil	0.214	nil	nil	nil

Table 4. Barley grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Protein	HLW	Grain Retent	Screens	Protein	HLW	Grain Retent	Screens
	%	Kg/hL	%	%	%	Kg/hL	%	%
Barley variety								
Planet	10.44 a	73.88 -	87.8 -	1.66 -	9.50 -	72.73 -	83.10 -	2.13 -
LaTrobe	9.59 b	72.04 -	89.5 -	1.16 -	9.57 -	71.56 -	80.52 -	2.65 -
LSD	0.825							
F pr.	0.044	0.086	0.471	0.213	0.690	0.272	0.060	0.155
Nutrition								
Decile 1	10.27 -	72.23 -	88.1 -	1.35 -	9.63 -	71.77 -	83.05 -	2.73 -
Decile 3	9.80 -	72.98 -	90.9 -	1.19 -	9.32 -	72.60 -	82.17 -	2.40 -
Decile 6	10.20 -	72.75 -	86.8 -	1.78 -	9.82 -	72.60 -	81.45 -	2.28 -
Play	9.80 -	73.88 -	88.9 -	1.32 -	9.37 -	71.62 -	80.57 -	2.13 -
LSD								
F pr.	0.736	0.703	0.672	0.714	0.152	0.850	0.567	0.667
Variety x Nutrition								
F pr.	0.636	0.563	0.467	0.551	0.136	0.585	0.123	0.833

Canola at Scadden

The canola site was similar to the cereal site with pH of 6.8 at depth and low levels of Al^{+++} , but on a loam descending to a sandy clay. Total N at 0-10cm of 18 mg/kg should result in a N responsive site.

The canola site experienced a similar rainfall pattern to the wheat and barley site with opening rains at the end of May followed by below average winter rainfall and a drier than average September. Two severe frosts occurred in September with temperatures below 0°C for two days between 15-16th September and below 0°C for three days between 27-29th September. Maximum daily temperature rose above 30°C for 3 days in late September.

Site yield for canola averaged 1.2 t/ha in 2018. Low rainfall after seeding meant TOS1 suffered poor emergence in the 3-4 weeks after seeding and TOS2 was seeded relatively late for canola; on the 19th June following 11mm rain over the previous 7 days. TOS2 was seeded at a similar time to the farmer crop and growth was comparable over the growing season.

Delayed emergence, late sowing, low rainfall in July and September and frost contributed to limit yield of canola.

Variety choice was important with a significant yield advantage of T4510 over Bonito. Whilst increasing nutrition improved yield at TOS1, with maximum yield recorded at Decile 6, the periods of low rainfall potentially limited yield responsiveness to fertiliser treatments. The interaction between variety and nutrition was not significant at either sowing time.

Increasing N and P above Decile 1 inputs gave no further increase in oil percent and the interaction between variety and nutrition for oil content was not significant at either sowing time.

Table 1. Canola yield for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Yield t/ha	Frost	Lodging	Grain shatter	Yield t/ha	Frost	Lodging	Grain shatter
Canola variety								
Bonito	1.115 b				0.929 b			
T4510	1.478 a				1.117 a			
LSD	0.0839							
F pr.	<.001	nil	nil	nil	0.001	nil	nil	nil
Nutrition								
Decile 1	1.046 c				0.964 -			
Decile 3	1.284 b				1.038 -			
Decile 6	1.544 a				1.038 -			
Play	1.313 b				1.054 -			
LSD	0.1186							
F pr.	<.001	nil	nil	nil	0.555	nil	nil	nil
Variety x Nutrition								
F pr.	0.679	nil	nil	nil	0.644	nil	nil	nil

Table 2. Canola grain quality for variety and nutrition main effects.

Factor	Traits assessed TOS1		Traits assessed TOS2	
	Oil %		Oil %	
Canola variety				
Bonito	49.20	a	48.30	a
T4510	45.84	b	45.20	b
LSD	0.457		0.524	
F pr.	<.001		<.001	
Nutrition				
Decile 1	47.58	a	47.33	-
Decile 3	48.23	a	46.63	-
Decile 6	46.35	b	46.32	-
Play	47.92	a	46.72	-
LSD	0.646			
F pr.	<.001		0.065	
Variety x Nutrition				
F pr.	0.473		0.229	

Conclusions

True time of sowing comparisons were difficult to examine in 2018 because of seasonal conditions. Hyden and Gibson were two sites that benefited from early emergence of TOS1 and both sites showed yield benefits. Yield from early sowing at other sites was restricted by adverse weather conditions such as damaging pre-frontal winds at Jerramungup and South Stirling and severe frost at Kojonup.

Increasing N and P rates tended to increase grain yield at Hyden, Munglinup, Gibson and Scadden when averaged across varieties however there was no clear take home message. Yield improvement was contingent on sowing time and a specific wheat, barley or canola crop at each site. Significant yield increases from N and P inputs above Decile 1 rates were also recorded in wheat and canola TOS2 crops at South Stirling and wheat, barley and canola at Kojonup.

Increasing N and P generally increased grain protein in wheat and barley.

There was little consistent evidence across the trials in wheat, barley and canola to support the idea that varieties differ in their response to increasing N and P nutritional inputs such that it could be exploitable by growers. In fact, the opposite was true for most parameters measured at most sites with both varieties of wheat, barley and canola responding in similar ways for yield and grain quality.

The lack of strong evidence of a variety x fertiliser interaction in these environments indicates growers need only consider a crop and not specific varieties. However, interpreting trial results from a single site in one season needs to be done with caution. The results of this trial series are really only pertinent to the 2018 growing season and to the choice of varieties used.

The choice of varieties is important in understanding interaction terms. Varieties were selected as latest releases with high yield potential yet we have little data on phasic development of these varieties and how the two test varieties in each crop differ.

One possible avenue of further investigation could be greater emphasis put on the timing of nutrition treatments in relation to crop phenology. This could be the commencement of stem elongation in addition to flowering time as these events change the rate of dry accumulation of plants and development of yield potential and then realisation of that potential.

Appendix

Growth parameters of establishment, vigour, tiller density and NDVI are shown in this Appendix.

Wheat and barley at Hyden

Table 1. Wheat growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2	
	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1	Tiller Count #/m ²	NDVI 0-1
Wheat variety						
Scepter	9 -	8.5 -	380 -	0.597 -	400 -	0.4817 b
Cutlass	9 -	8.7 -	385 -	0.608 -	407 -	0.5317 a
LSD						0.0278
F pr.	.	0.495	0.801	0.575	0.783	0.002
Nutrition						
Decile 1	9 -	8.8 -	387 -	0.603 -	371 -	0.4500 c
Decile 3	9 -	8.8 -	385 -	0.622 -	402 -	0.4967 b
Decile 6	9 -	8.0 -	387 -	0.580 -	419 -	0.5733 a
Play	9 -	8.7 -	371 -	0.605 -	422 -	0.5067 b
LSD						0.0393
F pr.	.	0.080	0.907	0.562	0.517	<.001
Variety x Nutrition						
F pr.	.	0.264	0.838	0.782	0.968	0.953

Table 2. Barley growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2		
	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1	Estab' Ment 0-9	Tiller Count #/m ²	NDVI 0-1
Barley variety							
Planet	9	8.5 -	588 -	0.737 a	8.8 -	613 -	0.454 a
Spartacus	9	8.2 -	613 -	0.660 b	8.5 -	633 -	0.364 b
LSD				0.0135			0.034
F pr.	.	0.06	0.473	<.001	0.573	0.841	<.001
Nutrition							
Decile 1	9	8.2 -	538 -	0.667 c	8.5 -	558 -	0.373 b
Decile 3	9	8.3 -	617 -	0.718 a	8.0 -	596 -	0.400 b
Decile 6	9	8.3 -	658 -	0.715 a	9.0 -	542 -	0.470 a
Play	9	8.5 -	583 -	0.693 b	9.0 -	792 -	0.393 b
LSD				0.0191			0.056
F pr.	.	0.59	0.096	<.001	0.338	0.331	0.013
Variety x Nutrition							
F pr.	.	0.05	0.095	0.007	0.801	0.150	0.259

Canola at Hyden

Table 1. Canola growth for variety and nutrition main effects.

Factor	Traits assessed TOS1			Traits assessed TOS2
	Estab' Ment 0-9	Vigour 0-9	NDVI 0-1	Estab' Ment 0-9
Canola variety				
Bonito	5.0 -	8.6 -	0.567 b	9 -
T4510	5.8 -	8.7 -	0.651 a	9 -
LSD			0.078	
F pr.	0.657	0.696	0.038	.
Nutrition				
Decile 1	6.7 -	8.1 -	0.613 -	9 -
Decile 3	5.8 -	8.6 -	0.607 -	9 -
Decile 6	4.5 -	9.0 -	0.595 -	9 -
Play	4.5 -	8.8 -	0.620 -	9 -
LSD				
F pr.	0.745	0.078	0.958	.
Variety x Nutrition				
F pr.	0.810	0.120	0.753	.

Wheat and barley at Kojonup

Table 1. Wheat growth for variety and nutrition main effects.

Factor	Traits assessed TOS1					Traits assessed TOS2				
	Estab' Ment 0-9	Vigour 9 Jul 0-9	Vigour 2 Aug 0-9	Tiller Count #/m ²	NDVI 0-1	Estab' Ment 0-9	Vigour 9 Jul 0-9	Vigour 2 Aug 0-9	Tiller Count #/m ²	NDVI 0-1
Wheat variety										
Scepter	8.0 -	6.8 -	6.8 -	166 -	0.5392 -	8.5 -	8.1 -	7.8 -	247 b	0.6050 -
Zen	7.8 -	6.7 -	6.4 -	176 -	0.5342 -	8.3 -	7.8 -	7.7 -	286 a	0.6150 -
LSD									33.43	
F pr.	0.193	0.288	0.08	0.510	0.601	0.462	0.163	0.631	0.026	0.362
Nutrition										
Decile 1	8.0 -	6.7 -	6.3 -	151 -	0.5183 b	8.5 -	8.0 -	7.7 ab	229 b	0.6117 b
Decile 3	7.8 -	6.5 -	6.5 -	167 -	0.5167 b	8.2 -	7.8 -	7.3 b	224 b	0.5917 b
Decile 6	7.8 -	7.0 -	6.8 -	185 -	0.5517 a	8.7 -	8.0 -	8.2 a	356 a	0.6567 a
Play	8.0 -	6.8 -	6.8 -	183 -	0.5600 a	8.3 -	8.0 -	7.7 ab	257 b	0.5800 b
LSD					0.0283			0.51	47.28	0.0322
F pr.	0.612	0.156	0.318	0.323	0.009	0.442	0.866	0.028	<.001	<.001
Variety x Nutrition										
F pr.	0.612	0.156	0.933	0.300	0.306	0.901	0.473	0.001	0.152	0.267

Table 3. Barley growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1
Barley variety								
Planet	7.3 -	7.2 -	249 b	0.6242 a	8.3 -	7.8 -	318 -	0.6742 a
Spartacus	7.7 -	7.5 -	327 a	0.5700 b	7.8 -	7.9 -	331 -	0.6275 b
LSD		0.41	46.9	0.0208				0.0183
F pr.	0.053	0.087	0.003	<.001	0.080	0.744	0.599	<.001
Nutrition								
Decile 1	7.2 -	7.2 -	247 b	0.5633 b	8.3 -	8.0 -	287 c	0.6317 b
Decile 3	7.7 -	7.2 -	255 b	0.5800 b	7.8 -	7.7 -	312 b	0.6500 b
Decile 6	7.3 -	7.3 -	343 a	0.6317 a	8.0 -	7.8 -	389 a	0.6917 a
Play	7.7 -	7.7 -	308 ab	0.6133 a	8.0 -	8.0 -	311 b	0.6300 b
LSD			66.3	0.0295			73.0	0.0259
F pr.	0.231	0.213	0.024	<.001	0.713	0.750	0.049	<.001
Variety x Nutrition								
F pr.	0.591	0.647	0.402	0.019	0.713	0.952	0.177	0.145

Canola at Kojonup

Table 1. Canola growth for variety and nutrition main effects.

Factor	Traits assessed TOS1			Traits assessed TOS2		
	Estab' Ment 0-9	Vigour 0-9	NDVI 0-1	Estab' Ment 0-9	Vigour 0-9	NDVI 0-1
Canola variety						
Bonito	7.1 -	7.5 -	0.4375 b	8.3 -	8.6 -	0.5200 b
T4510	7.2 -	7.7 -	0.5017 a	8.6 -	8.5 -	0.5583 a
LSD			0.0279			0.0259
F pr.	0.781	0.245	<.001	0.133	0.705	0.007
Nutrition						
Decile 1	7.2 -	7.7 -	0.4383 b	8.2 -	8.2 -	0.5317 b
Decile 3	7.0 -	7.7 -	0.4517 b	8.3 -	8.7 -	0.5117 b
Decile 6	7.0 -	8.0 -	0.5133 a	8.7 -	8.8 -	0.5900 a
Play	7.3 -	7.3 -	0.4750 ab	8.5 -	8.5 -	0.5233 b
LSD			0.0394			0.0366
F pr.	0.828	0.106	0.006	0.397	0.205	0.002
Variety x Nutrition						
F pr.	0.970	0.106	0.614	0.068	0.659	0.305

Wheat and barley at South Stirling

Table 1. Wheat growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1
Wheat variety								
Scepter	6.5 -	6.0 -	100 b	0.3200 -	7.3 -	7.1 -	166 b	0.373 -
Zen	6.3 -	5.9 -	116 a	0.3350 -	7.6 -	6.8 -	204 a	0.387 -
LSD			15.7				31.8	
F pr.	0.201	0.334	0.046	0.074	0.307	0.163	0.022	0.562
Nutrition								
Decile 1	6.3 -	5.8 -	109 -	0.3333 -	7.5 -	7.0 -	167 -	0.352 -
Decile 3	6.5 -	6.0 -	95 -	0.3200 -	7.5 -	7.0 -	184 -	0.388 -
Decile 6	6.2 -	6.0 -	120 -	0.3233 -	7.5 -	7.0 -	213 -	0.423 -
Play	6.5 -	6.0 -	110 -	0.3333 -	7.3 -	6.8 -	176 -	0.357 -
LSD								
F pr.	0.549	0.422	0.169	0.524	0.944	0.866	0.204	0.136
Variety x Nutrition								
F pr.	0.895	0.422	0.081	0.092	0.268	0.473	0.308	0.412

Table 2. Barley growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1
Barley variety								
Planet	6.4 -	4.3 -	144 -	0.3425 a	7.3 -	7.000 -	215 -	0.479 a
Rosalind	6.1 -	4.1 -	132 -	0.2925 b	7.3 -	6.833 -	199 -	0.375 b
LSD				0.02127				0.0469
F pr.	0.070	0.207	0.309	<.001	1.000	0.334	0.349	<.001
Nutrition								
Decile 1	6.3 -	4.2 -	144 -	0.3217 -	7.2 -	7.0 -	204 -	0.417 -
Decile 3	6.3 -	4.3 -	120 -	0.3083 -	7.7 -	6.8 -	199 -	0.425 -
Decile 6	6.3 -	4.0 -	140 -	0.3350 -	7.7 -	7.0 -	226 -	0.477 -
Play	6.0 -	4.2 -	148 -	0.3050 -	7.0 -	6.8 -	198 -	0.390 -
LSD								
F pr.	0.436	0.357	0.346	0.174	0.150	0.801	0.599	0.082
Variety x Nutrition								
F pr.	0.317	0.636	0.630	0.430	0.745	0.220	0.681	0.253

Canola at South Stirling

Table 1. Canola growth for variety and nutrition main effects.

Factor	Traits assessed TOS1			Traits assessed TOS2		
	Estab' Ment 0-9	Vigour 0-9	NDVI 0-1	Estab' Ment 0-9	Vigour 0-9	NDVI 0-1
Canola variety						
Wahoo	1.1 -	1.4 -	0.333 -	7.8 -	8.4 a	0.5017 a
Thumper	1.0 -	1.0 -	0.312 -	7.5 -	7.8 b	0.4658 b
LSD					0.36	0.0322
F pr.	0.334	0.334	0.333	0.501	0.004	0.032
Nutrition						
Decile 1	1.0 -	1.0 -	0.310 -	7.0 -	7.7 b	0.4283 b
Decile 3	1.0 -	1.0 -	0.312 -	7.8 -	8.2 ab	0.4833 a
Decile 6	1.0 -	1.0 -	0.330 -	7.8 -	8.5 a	0.5267 a
Play	1.2 -	1.8 -	0.337 -	7.8 -	8.2 ab	0.4967 a
LSD					0.51	0.0456
F pr.	0.422	0.422	0.749	0.306	0.025	0.003
Variety x Nutrition						
F pr.	0.422	0.422	0.878	0.983	0.128	0.953

Wheat and barley at Mt Madden

Table 1. Wheat growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2		
	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²
Wheat variety							
Scepter	8.3 -	8.8 -	232 b	0.482 -	7.4 -	8.1 -	167 -
Ninja	8.1 -	8.6 -	286 a	0.531 -	8.1 -	8.6 -	189 -
LSD			30				
F pr.	0.54	0.164	0.002	0.085	0.334	0.533	0.196
Nutrition							
Decile 1	8.5 -	8.5 -	241 -	0.480 -	8.2 -	8.5 -	168 -
Decile 3	8.0 -	8.7 -	256 -	0.497 -	6.7 -	7.3 -	163 -
Decile 6	7.8 -	8.7 -	276 -	0.572 -	8.0 -	8.8 -	182 -
Play	8.3 -	8.8 -	263 -	0.477 -	8.2 -	8.7 -	199 -
LSD							
F pr.	0.309	0.274	0.380	0.077	0.349	0.537	0.415
Variety x Nutrition							
F pr.	0.352	0.558	0.315	0.763	0.404	0.484	0.233

Table 2. Barley growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2		
	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²
Barley variety							
Planet	8.58 -	8.6 -	345 -	0.537 a	8.5 -	8.2 -	245 -
LaTrobe	8.42 -	8.4 -	378 -	0.477 b	8.8 -	8.6 -	279 -
LSD				0.0175			
F pr.	0.443	0.487	0.081	<.001	0.156	0.069	0.078
Nutrition							
Decile 1	8.50 -	8.3 -	333 -	0.463 c	8.5 -	8.5 -	254 -
Decile 3	8.33 -	8.7 -	345 -	0.497 b	8.5 -	8.3 -	269 -
Decile 6	8.83 -	8.5 -	360 -	0.563 a	8.8 -	8.3 -	273 -
Play	8.33 -	8.5 -	407 -	0.503 b	8.7 -	8.3 -	251 -
LSD				0.0247			
F pr.	0.331	0.487	0.050	<.001	0.458	0.924	0.782
Variety x Nutrition							
F pr.	0.406	0.915	0.738	0.159	0.071	0.644	0.701

Canola at Mt Madden

Table 1. Canola growth for variety and nutrition main effects.

Factor	Traits assessed TOS1		Traits assessed TOS2	
	Vigour	NDVI	Vigour	NDVI
	0-9	0-1	0-9	0-1
Canola variety				
Bonito	7.0	0.3767 -	9 -	0.3750 -
T4510	7.0	0.3800 -	9 -	0.3608 -
LSD				
F pr.	.	0.695	.	0.149
Nutrition				
Decile 1	7.0	0.3717 -	9 -	0.3500 -
Decile 3	7.0	0.3900 -	9 -	0.3883 -
Decile 6	7.0	0.3717 -	9 -	0.3700 -
Play	7.0	0.3800 -	9 -	0.3633 -
LSD				
F pr.	.	0.384	.	0.069
Variety x Nutrition				
F pr.	.	0.057	.	0.156

Wheat and barley at Munglinup

Table 1. Wheat growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1
Wheat variety								
Scepter	8 -	9 -	371 -	0.575 -	9 -	9 -	480 -	0.5933 b
Cutlass	8 -	9 -	359 -	0.610 -	9 -	9 -	529 -	0.6300 a
LSD								0.03226
F pr.	.	.	0.623	0.109	.	.	0.137	0.029
Nutrition								
Decile 1	8 -	9 -	347 -	0.523 c	9 -	9 -	474 -	0.5550 c
Decile 3	8 -	9 -	399 -	0.592 b	9 -	9 -	483 -	0.6100 b
Decile 6	8 -	9 -	371 -	0.662 a	9 -	9 -	523 -	0.6800 a
Play	8 -	9 -	344 -	0.593 b	9 -	9 -	538 -	0.6017 b
LSD				0.0620				0.04563
F pr.	.	.	0.402	0.003	.	.	0.420	<.001
Variety x Nutrition								
F pr.	.	.	0.950	0.684	.	.	0.467	0.945

Table 2. Barley growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1
Barley variety								
Planet	8 -	9 -	495 b	0.6333 a	9 -	9 -	600 -	0.6167 a
LaTrobe	8 -	9 -	591 a	0.5300 b	9 -	9 -	660 -	0.5433 b
LSD			77.8	0.0346				0.03256
F pr.	.	.	0.019	<.001	.	.	0.087	<.001
Nutrition								
Decile 1	8 -	9 -	515 -	0.5333 b	9 -	9 -	608 -	0.5100 c
Decile 3	8 -	9 -	528 -	0.5767 b	9 -	9 -	634 -	0.5800 b
Decile 6	8 -	9 -	608 -	0.6517 a	9 -	9 -	654 -	0.6550 a
Play	8 -	9 -	521 -	0.5650 b	9 -	9 -	623 -	0.5750 b
LSD				0.0489				0.04605
F pr.	.	.	0.272	0.001	.	.	0.788	<.001
Variety x Nutrition								
F pr.	.	.	0.627	0.438	.	.	0.449	0.849

Wheat and barley at Gibson

Table 1. Wheat growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2		
	Estab' Ment	Vigour	Tiller Count	NDVI	Estab' Ment	Vigour	NDVI
	0-9	0-9	#/m ²	0-1	0-9	0-9	0-1
Wheat variety							
Scepter	9 -	9 -	267 b	0.7308 -	9 -	9 -	0.590 -
Cutlass	9 -	9 -	294 a	0.7400 -	9 -	9 -	0.647 -
LSD			11.2				
F pr.	.	.	0.002	0.48	.	.	0.095
Nutrition							
Decile 1	9 -	9 -	278 -	0.6900 c	9 -	9 -	0.600 -
Decile 3	9 -	9 -	278 -	0.7250 bc	9 -	9 -	0.590 -
Decile 6	9 -	9 -	293 -	0.7833 a	9 -	9 -	0.683 -
Play	9 -	9 -	275 -	0.7433 b	9 -	9 -	0.602 -
LSD				0.0384			
F pr.	.	.	0.332	0.001	.	.	0.189
Variety x Nutrition							
F pr.	.	.	0.961	0.074	.	.	0.71

Table 2. Barley growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2		
	Estab' Ment	Vigour	Tiller Count	NDVI	Estab' Ment	Vigour	NDVI
	0-9	0-9	#/m ²	0-1	0-9	0-9	0-1
Barley variety							
Planet	9 -	9 -	579 b	0.7883 a	9 -	9 -	0.673 -
LaTrobe	9 -	9 -	638 a	0.7625 b	9 -	9 -	0.589 -
LSD			51.5	0.0193			
F pr.	.	.	0.026	0.012	.	.	0.457
Nutrition							
Decile 1	9 -	9 -	572 b	0.7367 c	9 -	9 -	0.577 -
Decile 3	9 -	9 -	668 a	0.7917 ab	9 -	9 -	0.553 -
Decile 6	9 -	9 -	618 ab	0.8017 a	9 -	9 -	0.655 -
Play	9 -	9 -	576 b	0.7717 b	9 -	9 -	0.74 -
LSD			72.8	0.0272			
F pr.	.	.	0.043	<.001	.	.	0.631
Variety x Nutrition							
F pr.	.	.	0.478	0.037	.	.	0.392

Canola at Gibson

Table 1. Canola growth for variety and nutrition main effects.

Factor	Traits assessed TOS1			Traits assessed TOS2		
	Estab' Ment 0-9	Vigour 0-9	NDVI 0-1	Estab' Ment 0-9	Vigour 0-9	NDVI 0-1
Canola variety						
Bonito	9 -	9 -	0.4808 -	9 -	9 -	0.651 -
T4510	9 -	9 -	0.4633 -	9 -	9 -	0.626 -
LSD						
F pr.	.	.	0.280	.	.	0.299
Nutrition						
Decile 1	9 -	9 -	0.4733 -	9 -	9 -	0.602 b
Decile 3	9 -	9 -	0.4600 -	9 -	9 -	0.607 b
Decile 6	9 -	9 -	0.4900 -	9 -	9 -	0.720 a
Play	9 -	9 -	0.4650 -	9 -	9 -	0.625 b
LSD	.	.		.	.	0.0703
F pr.	.	.	0.560	.	.	0.009
Variety x Nutrition						
F pr.	.	.	0.974	.	.	0.479

Wheat and barley at Scadden

Table 1. Wheat growth for variety and nutrition main effects.

Factor	Traits assessed TOS1				Traits assessed TOS2			
	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1	Estab' Ment 0-9	Vigour 0-9	Tiller Count #/m ²	NDVI 0-1
Wheat variety								
Scepter	7.1 -	7.3 -	339. -	0.5683 b	7.3 -	7.4 -	344. -	0.6675 b
Cutlass	6.2 -	6.6 -	302. -	0.6150 a	6.9 -	7.1 -	319. -	0.7083 a
LSD				0.03598				0.01617
F pr.	0.465	0.550	0.196	0.015	0.742	0.713	0.353	<.001
Nutrition								
Decile 1	5.2 -	5.5 -	312. -	0.5717 -	5.8 -	6.2 -	295. -	0.6750 -
Decile 3	7.2 -	7.5 -	343. -	0.6033 -	7.8 -	7.8 -	357. -	0.6950 -
Decile 6	6.8 -	7.2 -	302. -	0.5767 -	7.0 -	7.2 -	339. -	0.6967 -
Play	7.3 -	7.5 -	327. -	0.6150 -	7.7 -	7.8 -	334. -	0.6850 -
LSD								
F pr.	0.587	0.527	0.738	0.247	0.497	0.522	0.437	0.199
Variety x Nutrition								
F pr.	0.624	0.629	0.312	0.837	0.253	0.151	0.632	0.867

Table 2. Barley growth for variety and nutrition main effects.

Factor	Traits assessed TOS1		Traits assessed TOS2	
	Tiller Count #/m ²	NDVI 0-1	Tiller Count #/m ²	NDVI 0-1
Barley variety				
Planet	436 -	0.557 -	509 -	0.611 -
LaTrobe	491 -	0.533 -	556 -	0.633 -
LSD				s
F pr.	0.071	0.381	0.113	0.349
Nutrition				
Decile 1	461 -	0.603 a	486 -	0.605 -
Decile 3	493 -	0.475 b	537 -	0.617 -
Decile 6	456 -	0.543 ab	567 -	0.632 -
Play	445 -	0.558 ab	540 -	0.635 -
LSD		0.0838		
F pr.	0.662	0.038	0.254	0.784
Variety x Nutrition				
F pr.	0.032	0.147	0.098	0.512

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