

S/UA1021: Characterising the optimal flowering period for the Murray Plains

Project Lead/author: Brendan Kupke (The University of Adelaide/South Australian Research and Development Institute)

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Field trial

- Three germination dates of 20th April, 31st May and 10th June (first two dates had 10mm of in-furrow supplementary irrigation to ensure establishment due to late opening rains).
- Nutrition:
 - 80kg/ha DAP applied at sowing
 - 50kg/ha Urea applied at late tillering
- A range of wheat and barley varieties with different phenologies selected (see Table 1 & 2 below).

Table 1 The wheat varieties tested in the field trial with their respective maturity group and description.

Variety	Maturity Group	Description
Vixen	Quick	Fastest developing spring, good performing under harsh finishes
Ballista	Quick-Mid	New, fast developing spring well suited to low rainfall environments
Scepter	Mid	Mid Maturity staple spring for Murray Plains growers
Rockstar	Mid-Slow	Mid-slow developing spring with opportunity for Late April sowing
Denison	Slow	Slow developing, photoperiod sensitive spring, not tested in Murray Plains with early sowing
Longsword	Quick Winter	Fast developing winter phenology, well suited for early sowing in low rainfall environments and grazing – not tested in Murray Plains
DS Bennett	Mid Winter	Mid maturity winter variety, awnless hay and grazing option, frost avoidance (MESW Loxton) – not tested in Murray Plains
Sheriff CL Plus	Mid-Slow	Slower developing Clearfield spring variety with opportunities for Late April sowing – not tested with early sowing in Murray Plains
Valiant CL Plus	Slow	New, slow developing Clearfield spring variety for early sowing – not tested in Murray Plains or Murray Mallee

Table 2 The barley varieties in the field trial with their respective maturity group and description.

Variety	Maturity Group	Description
Beast	Very Quick	New, quickest maturing spring variety
Compass	Very Quick	Quick maturing staple spring variety for Murray Mallee
Spartacus CL	Very Quick	Quick maturing Clearfield spring, photoperiod sensitive
Maximus CL	Very Quick	New, quick maturing Clearfield spring
Commodus CL	Very Quick	New, quick maturing Clearfield spring with vigorous plant type
RGT Planet	Quick	Quick developing spring with large yield potential in higher rainfall environments – not tested with early sowing in Murray Plains

Growing Season

- Three <math><0^{\circ}\text{C}</math> potential frost events in the flowering window (although no damage observed).
- Two >math>30^{\circ}\text{C}</math> days in early September during flowering.
- Below average rainfall in Autumn causing early drought stress in 20th April sown plots.
- Above average rainfall during early to mid winter and late spring.

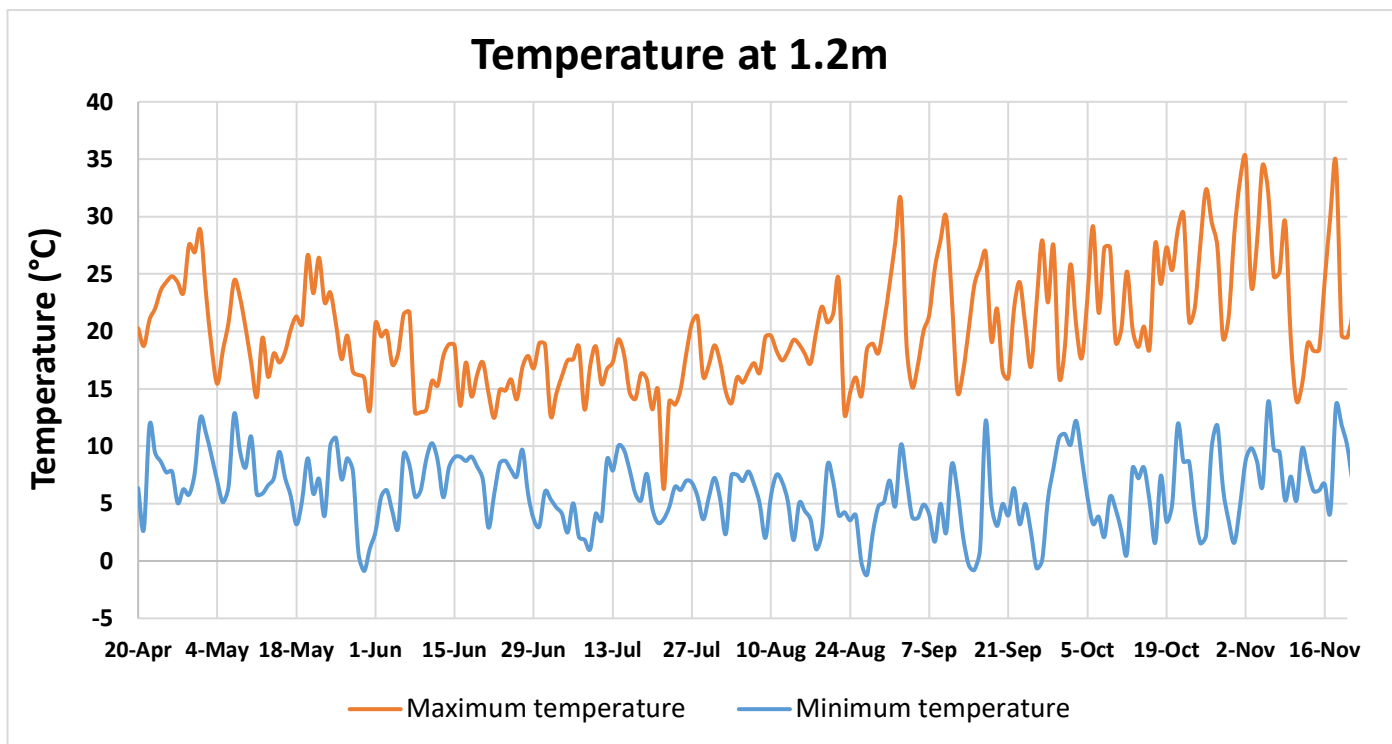


Figure 1 The minimum (blue) and maximum (orange) temperature at 1.2m in the field trial at Palmer recorded with a tiny tag across the growing season from April to November 2021.

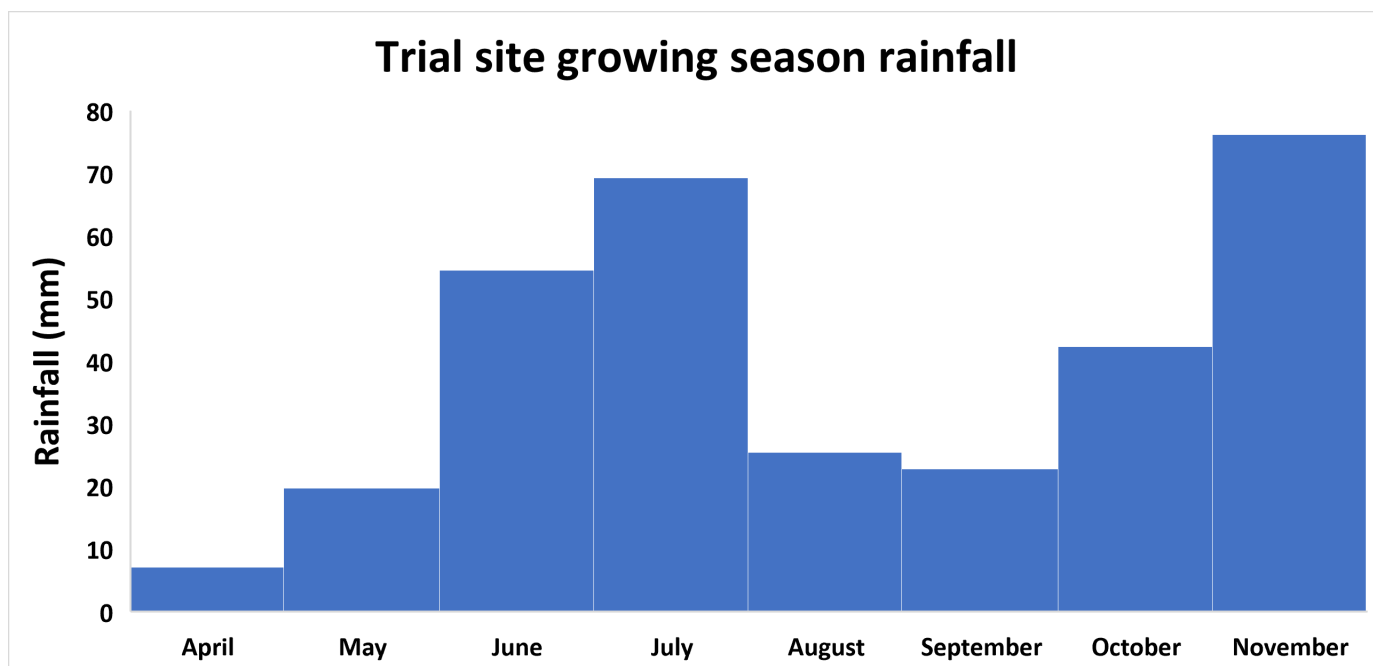


Figure 2 The growing season rainfall recorded for each month at the field site at Palmer with an ATMOS 41 weather station.

Development

- Good spread in development between wheat varieties and across germination dates (8 weeks difference in time to flowering between Vixen and DS Bennett from 20th April germination).

- Slow springs (Denison) and quick winters (Longsword) flowering within the optimal flowering period with 20th April germination.
- April establishment dates getting too early for Quick-Mid spring varieties to flower on time (Vixen, Ballista, Scepter).
- Limited variation in relative development in current elite barley varieties (less than two weeks difference in flowering time between slowest and quickest).
- Opportunity for longer reproductive growth phase with early sowing.

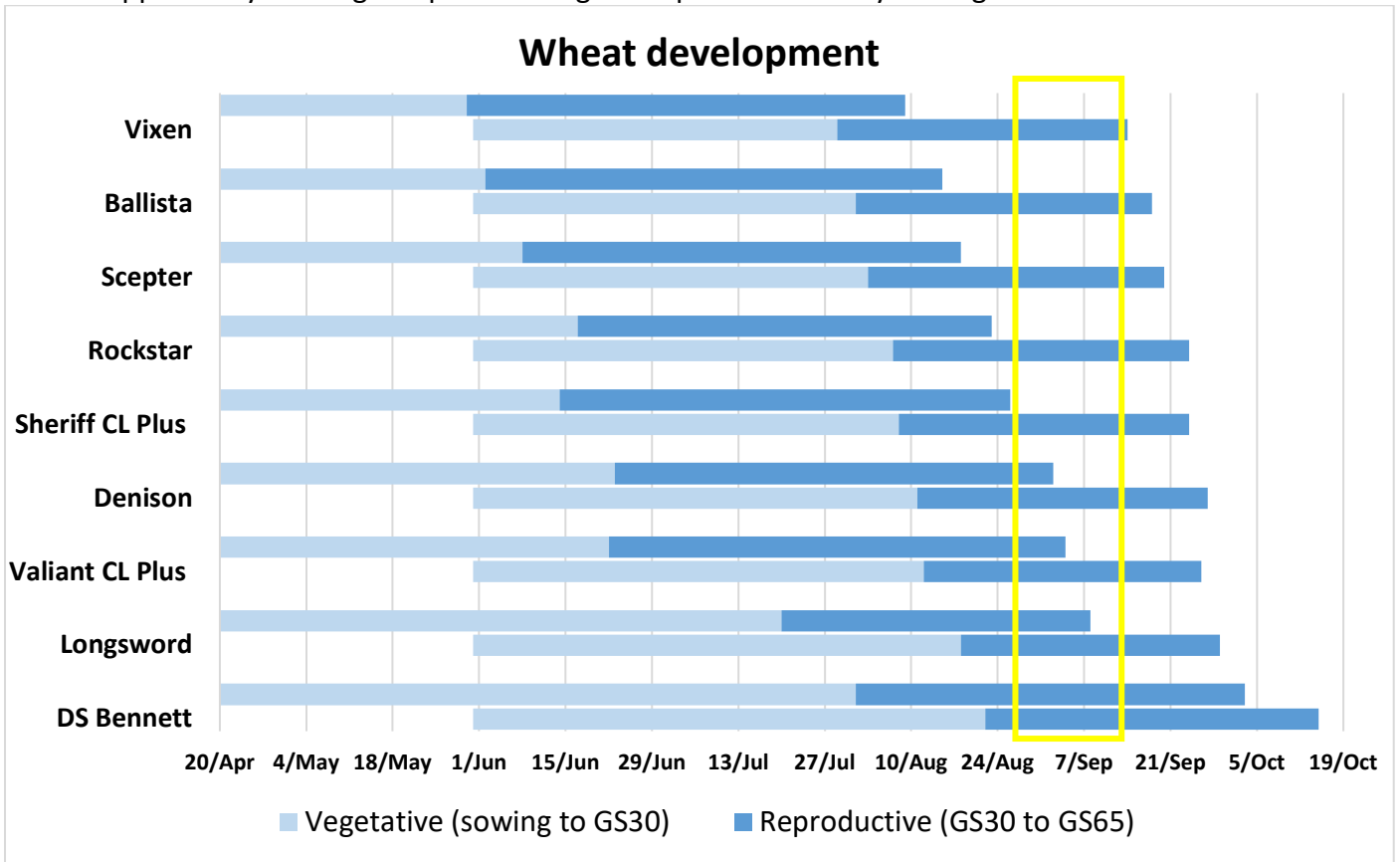


Figure 3 A schematic showing the relative duration of the vegetative (sowing to early stem elongation) and reproductive (stem elongation to flowering) growth stages of each wheat variety at the Palmer field site. The yellow box represents the preliminary optimal flowering period for wheat at Palmer in the Murray Plains from 27th August to 13th September.

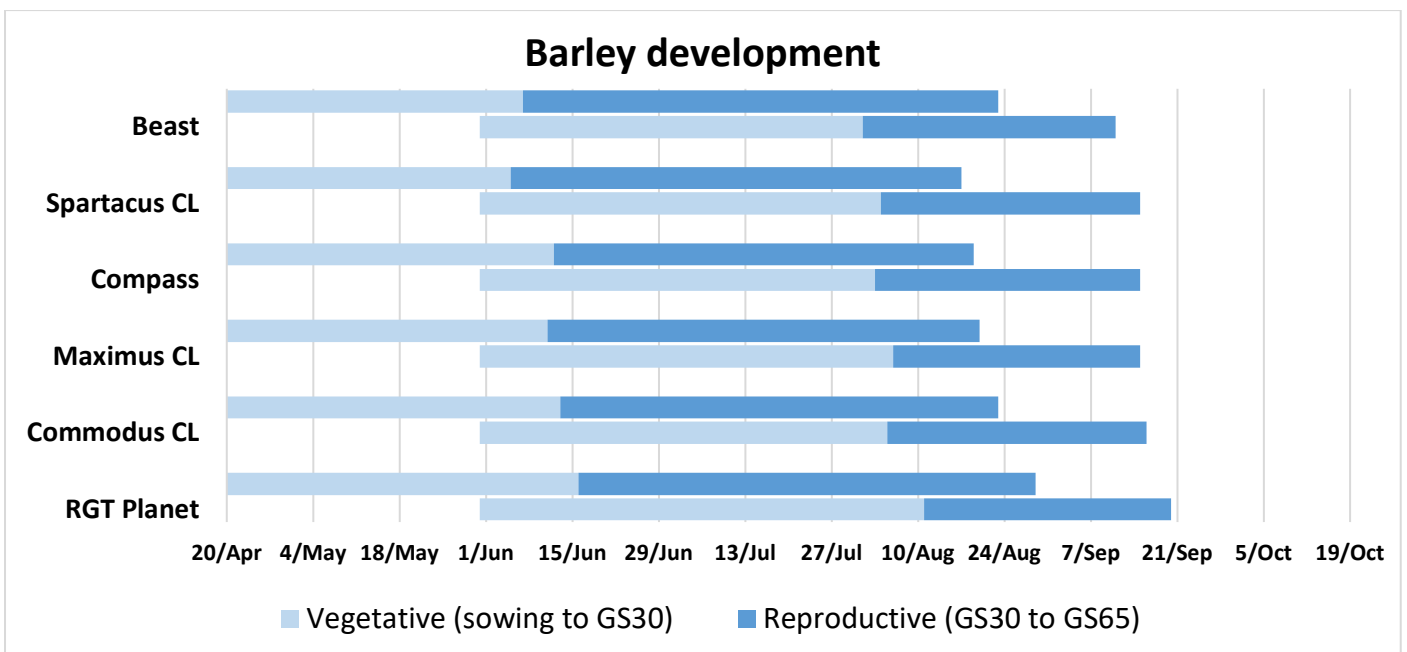


Figure 4 A schematic showing the relative duration of the vegetative (sowing to early stem elongation) and reproductive (stem elongation to flowering) growth stages of each barley variety at the Palmer field site.

Grain Yield and Quality

- Grain Yield
 - Early sowing of barley and wheat resulted in relatively higher grain yields.
 - Some scope for sowing slower developing spring wheats (Denison, Rockstar), however the yield improvement on quick developing varieties Ballista and Scepter was not significant (no frost damage in 2021).
 - Vigorous barley types (Beast, Compass, Commodus) performed well across sowing dates.
 - Early sown barley out-yielded slow spring and winter wheats in first season of trials.
 - The clearfield yield penalty to conventional varieties for both wheat (Sheriff) and barley (Commodus) insignificant in 2021 with early sowing.
- Grain Quality
 - Late spring rainfall enabled good grain filling conditions for many varieties resulting in good grain size.
 - Most wheat achieving good classifications across germination dates.
 - All AH varieties achieved at least H2 classification with greater than 11.5% protein.
 - High test weights and low screenings across varieties and times of sowing.
 - All barley varieties had high protein.
 - No malting varieties achieved a malt classification.
 - High test weights and low screenings across varieties and times of sowing.

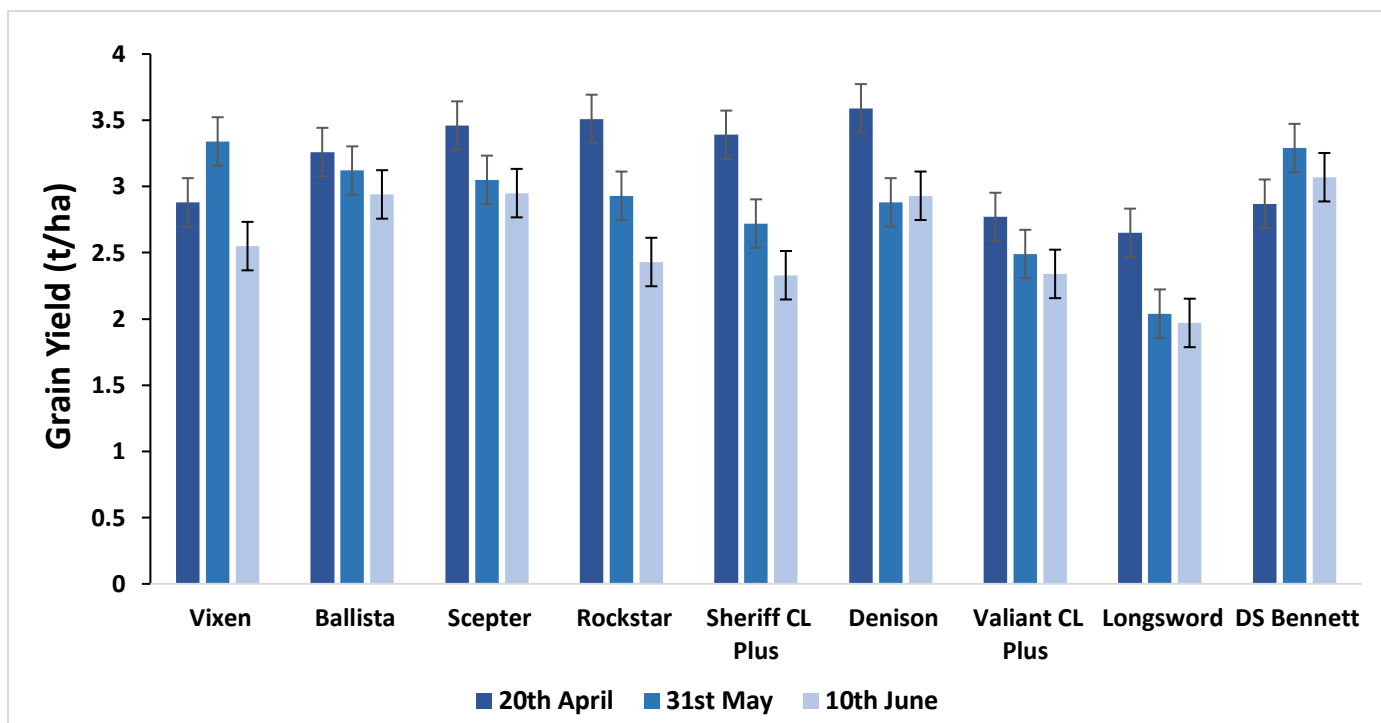


Figure 5 The grain yield of each wheat variety at three germination dates (20th April, 31st May, 10th June) with an LSD ($p < 0.05$) of 0.366.

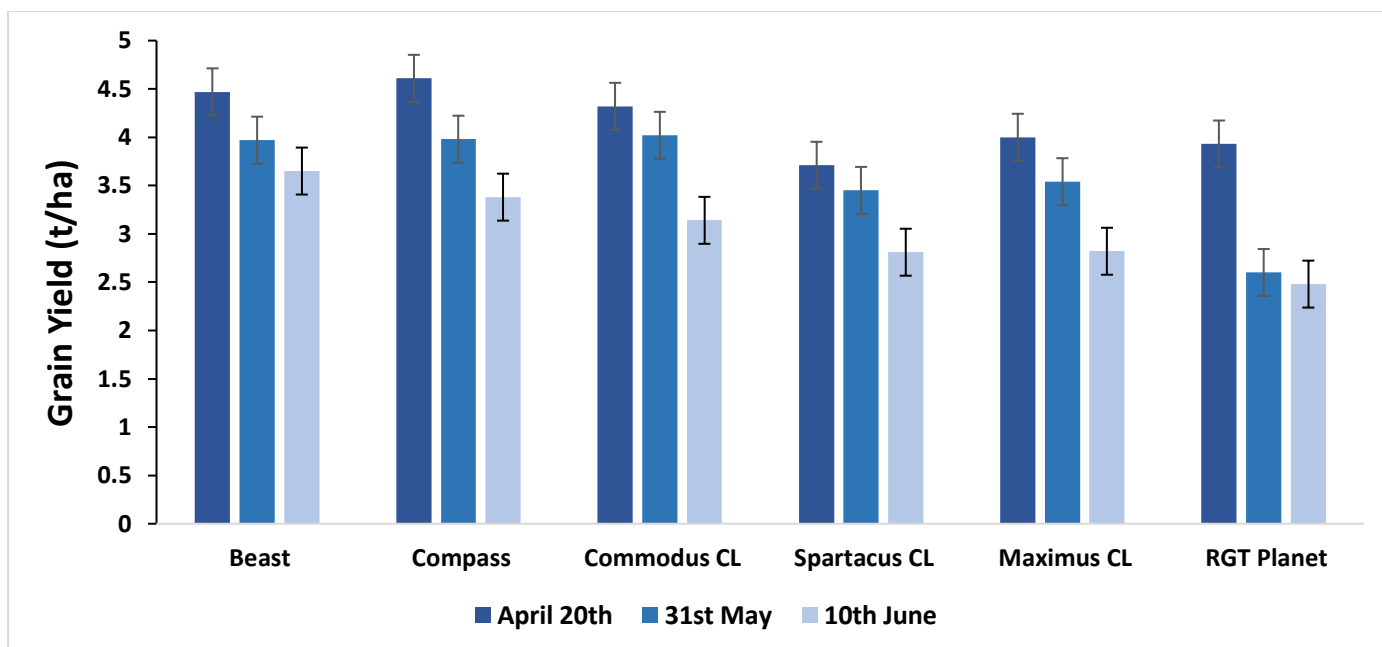


Figure 6 The grain yield of each barley variety at three germination dates (20th April, 31st May, 10th June) with an LSD ($p < 0.05$) of 0.486.

Table 3 The percentage of the site mean grain yield for each variety of (a) wheat and (b) barley at three germination dates (20th April, 31st May, 10th June) with green indicating above average, yellow on average and red below average.

(a)	Site mean yield:	Germination Date		
	2.88 t/ha	20-Apr	31-May	10-Jun
	Vixen	100	116	89
	Ballista	113	108	102
	Scepter	120	106	102
	Rockstar	122	102	84
	Sheriff CL Plus	118	94	81
	Denison	125	100	102
	Valiant CL Plus	96	86	81
	Longsword	92	71	68
	DS Bennett	100	114	107

(b)	Site mean yield:	Germination Date		
	3.6 t/ha	20-Apr	31-May	10-Jun
	Beast	124	110	101
	Compass	128	110	94
	Commodus CL	120	112	87
	Spartacus CL	103	96	78
	Maximus CL	111	98	78
	RGT Planet	109	72	69

Table 4 The wheat grain quality data for Test Weight, Protein and Screenings for different varieties across germination dates at Palmer. ns = not significant

	Test Weight (kg/hl)			Protein (%)			Screenings (%)		
	20-Apr	31-May	10-Jun	20-Apr	31-May	10-Jun	20-Apr	31-May	10-Jun
Vixen	81.3	81.7	80.8	12.5	12.1	13.1	2.4	0.5	0.3
Ballista	81.1	81.5	81.7	12.3	12	12.4	1.9	0.6	0.4
Scepter	83.7	82.9	83.5	11.8	12.2	12.7	1.2	0.4	0.2
Rockstar	82.4	80.5	80.5	12.5	12.7	12.8	1.4	0.7	2.5
Sheriff CL Plus	82.2	82.1	82.2	13.3	13.6	14.5	0.9	0.4	0.9
Denison	83	83.7	84.1	12.8	13.1	13.1	1.3	2.4	2.3
Valiant CL Plus	81.9	84.8	85	13.5	14.5	15	0.3	1.2	0.8
Longsword	79.9	80.2	81.2	14.2	15.8	15.7	0.6	1.3	1.3
DS Bennett	83.1	84.2	84	13.6	12.4	12.6	1.5	3.1	3.8
<i>p</i> -value	<0.001			0.125			<0.001		
LSD ($p \leq 0.05$)	0.91			ns			0.52		

Table 5 The barley grain quality data for Test Weight, Protein and Screenings for different varieties across germination dates at Palmer. ns = not significant

	Test Weight (kg/hl)			Protein (%)			Screenings (%)		
	20-Apr	31-May	10-Jun	20-Apr	31-May	10-Jun	20-Apr	31-May	10-Jun
Beast	73.1	70.7	70.5	14.3	13.2	13.6	0.4	0.1	0.1
Compass	72.8	71.7	71	13.4	13.2	13.9	0.7	0.1	0.3
Commodus CL	72.3	70.5	70.7	14.2	13.6	14.7	1.4	0.3	0.5
Spartacus CL	74.0	72.3	72.3	14.8	13.7	15.3	1.9	0.3	0.5
Maximus CL	74.1	71.5	71.6	14.2	13.3	14	0.9	0.2	0.3
RGT Planet	73.4	71.1	71.1	14.7	15.8	15.6	1.6	1	0.6
<i>p</i> -value	0.155			0.016			0.062		
LSD (<i>p</i> ≤0.05)	ns			0.43			ns		

Sterility

- Below average rainfall in August and September caused drought stress on the heavy soil type resulting in drought tipping in later germination dates.
- No observations of frost induced sterility across wheat and barley varieties.
- Sterility in 2021 season likely driven mainly by drought stress and partially variety genetics.
- DS Bennett with 20th April germination was severely drought stressed pre and post flowering from high early biomass production and long vegetative growth phase, resulting in floret abortion.
- Early sowing improved grain number and significantly reduced sterility in RGT Planet but later germinations resulted in more sterility from drought stress.

Table 6 The sterility percentage across each germination date and variety from 30 randomly selected heads of (a) wheat and (b) barley.

(a)

Sterility (%)	Germination Date		
	20-Apr	31-May	10-Jun
Vixen	13	13	42
Ballista	16	33	40
Scepter	8	30	27
Rockstar	10	29	26
Sheriff CL Plus	12	33	36
Denison	7	15	15
Valiant CL Plus	12	15	20
Longsword	21	37	35
DS Bennett	45	14	17

(b)

Sterility (%)	Germination Date		
	20-Apr	31-May	10-Jun
Beast	9	7	10
Compass	7	13	20
Commodus CL	7	16	17
Spartacus CL	16	8	11
Maximus CL	15	10	11
RGT Planet	12	23	27

Optimal Flowering Period

- Preliminary wheat modelling showing that the OFP occurs between 27th August and 13th September for Palmer in the Murray Plains.
- The field trial had peak grain yield from 2nd September flowering, which was close to peak yield on the modelled curve using APSIM and climatic data.
- Late rain influenced late sown DS Bennett which created outliers to the pattern from its very late phenology being the only variety being able to benefit.
- Peak yield in barley came in mid-August, but more data and modelling still required to determine optimal flowering times.

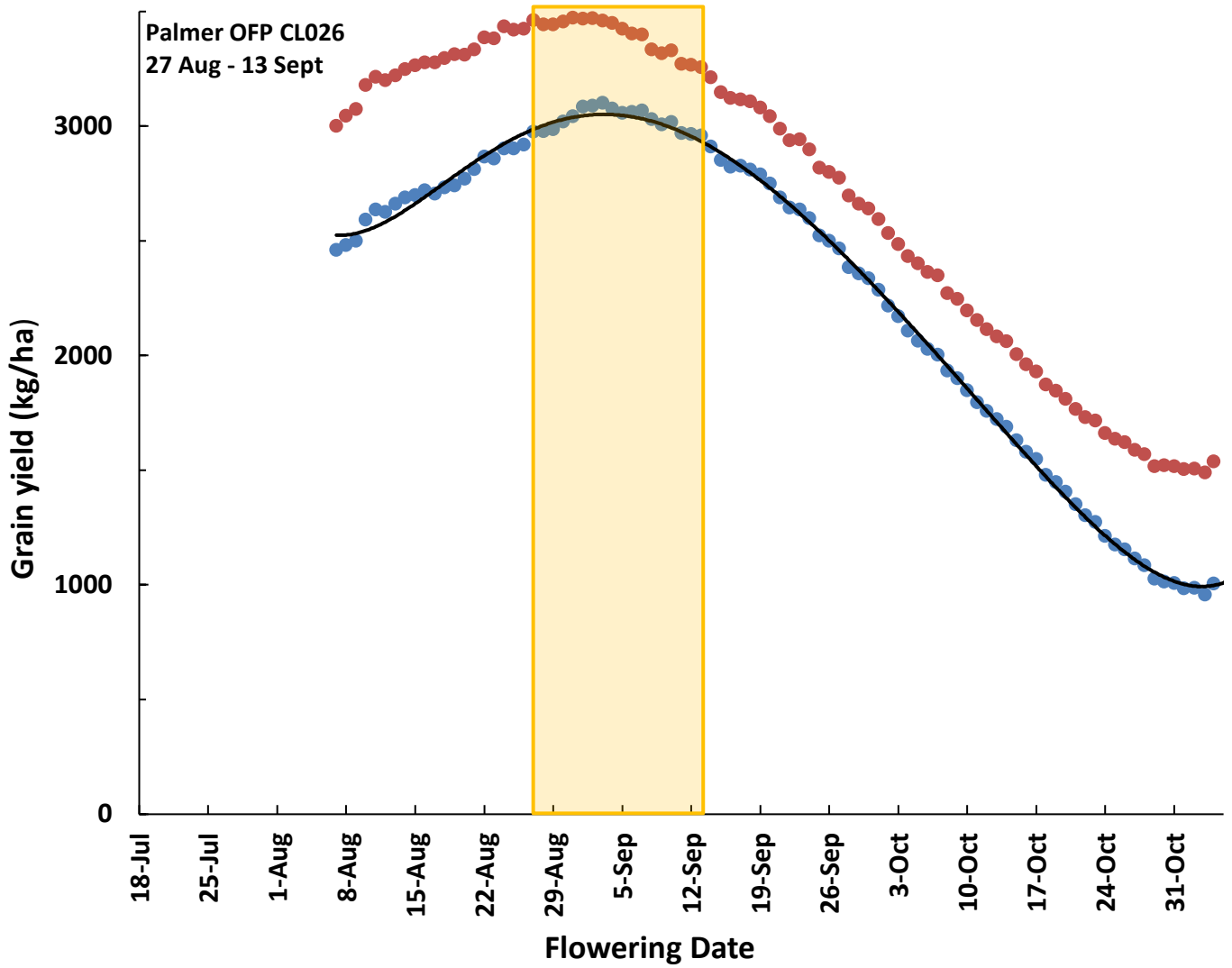


Figure 7 A preliminary draft of the optimal flowering period (OFP) for a mid-fast wheat variety Mace at Palmer in the Murray Plains. The blue dots represent the frost, heat and drought 15 day running mean yield with the red dots showing the water limited maximum potential yield. The yellow highlighted box indicates the duration of the OFP which is determined by 95% of the maximum yield from 40 seasons (1980-2020) and goes from the 27th August to 13th September.

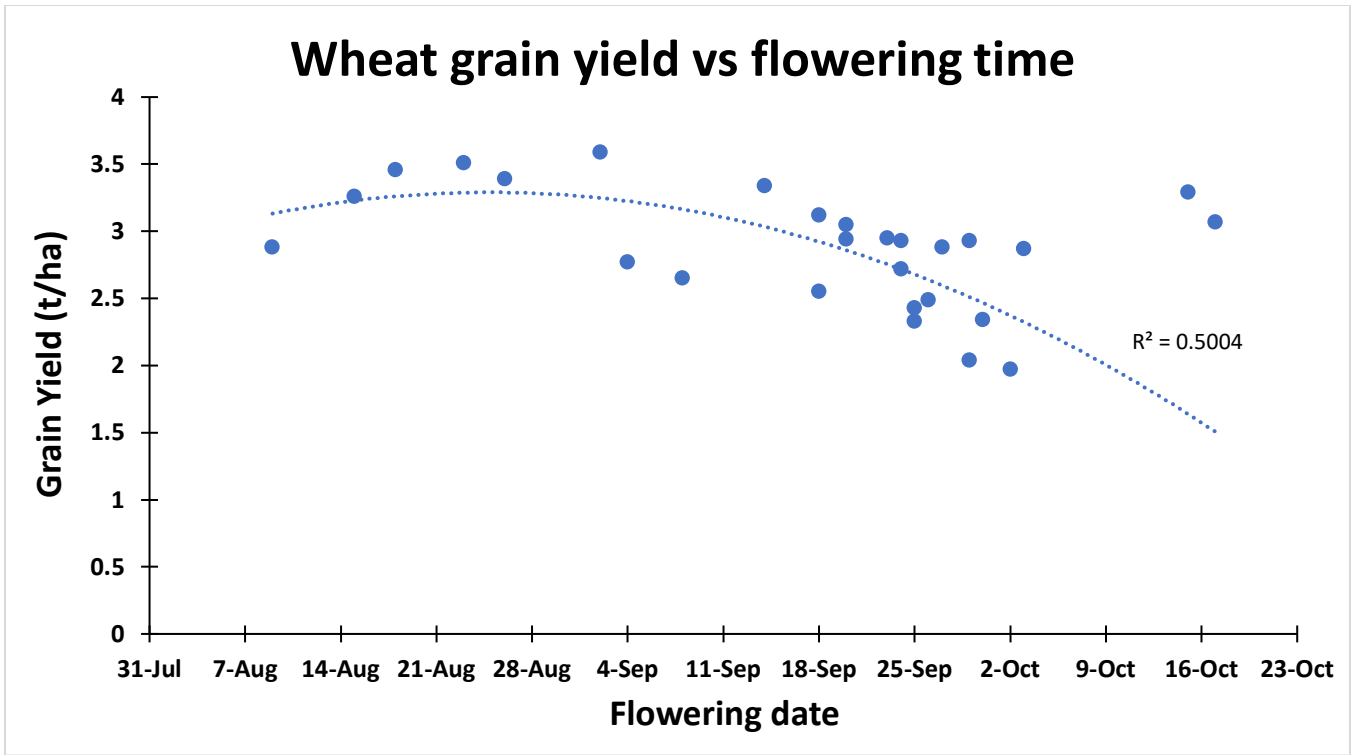


Figure 8 A comparison of the relative wheat grain yield of every variety and their respective flowering dates at Palmer in 2021.

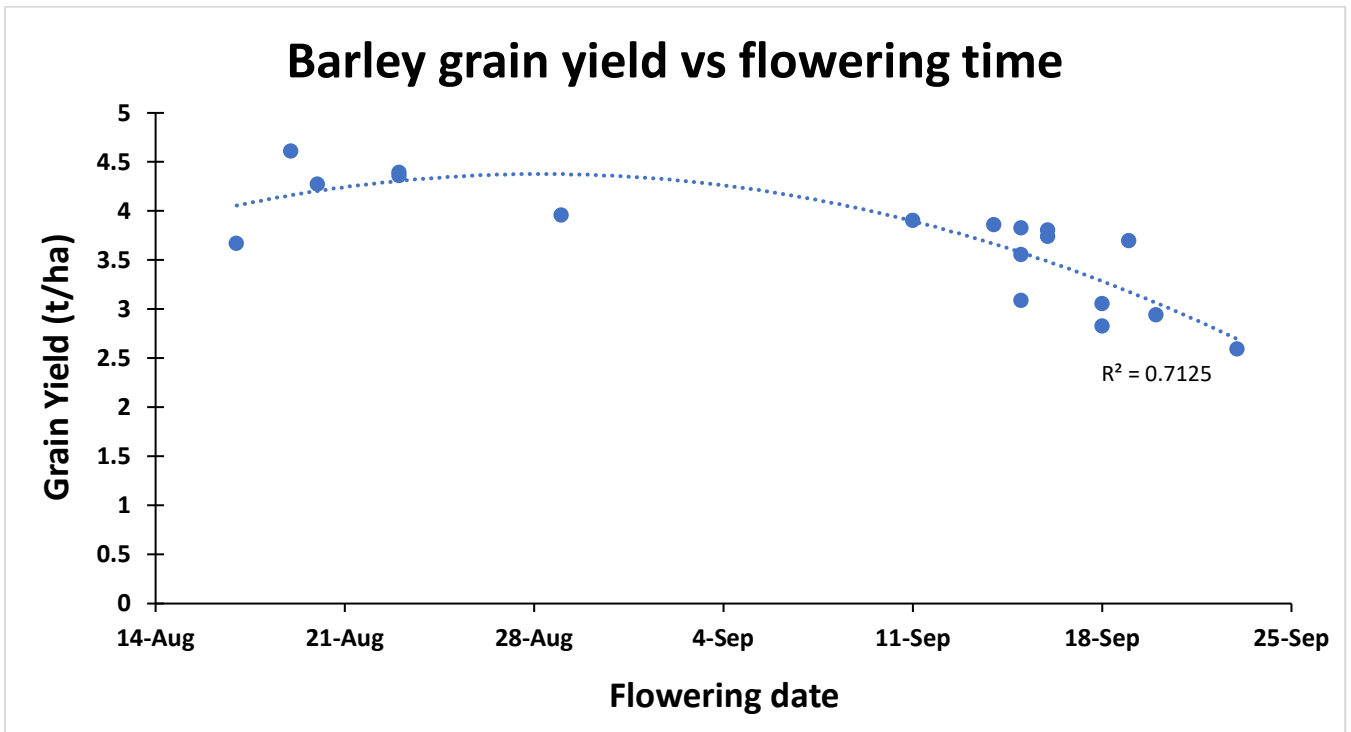


Figure 9 A comparison of the relative barley grain yield of every variety and their respective flowering dates at Palmer in 2021.

Palmer National Variety Trials

Funded by the Grains Research and Development Corporation.



Wheat NVT

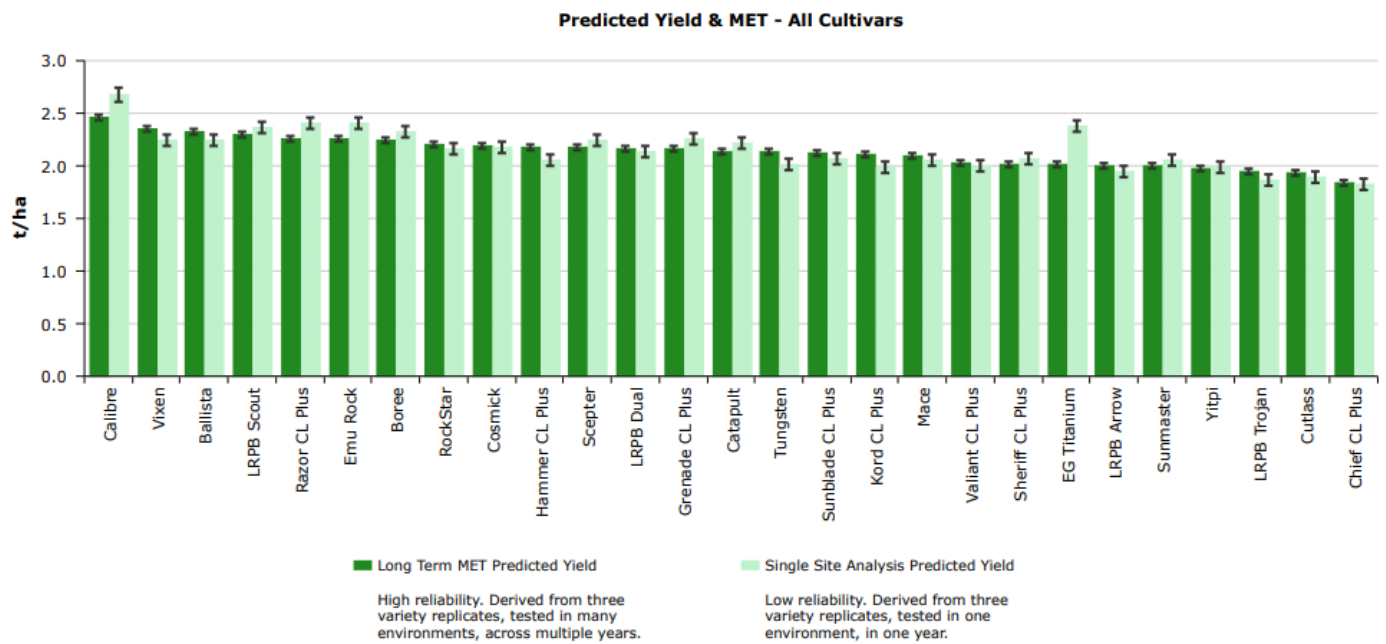


Figure 10 The predicted grain yield for the 2021 Palmer NVT wheat trial across all varieties for both a single site analysis and long term MET data. Source: NVT Online (<https://nvt.grdc.com.au/trial-results>)

Variety	Group	Trials	2017	2018	2019	2020	2021	
			Mean Yield	3.40 t/ha	1.49 t/ha	1.37 t/ha	3.04 t/ha	1.45 t/ha
				1	5	6	6	4
Calibre		10				● 114	● 116	
RockStar	AH	21		● 111	● 115	● 112	● 108	
Ballista	AH	16			● 112	● 112	● 111	
Scepter	AH	22	● 114	● 111	● 111	● 109	● 106	
Catapult	AH	21		● 108	● 112	● 109	● 105	
Vixen	AH	22	● 107	● 112	● 104	● 109	● 111	
Sunblade CL Plus	AH	16			● 109	● 108	● 103	
Razor CL Plus	ASW	22	● 102	● 106	● 100	● 103	● 106	
LRPB Scout	AH	22	● 95	● 100	● 104	● 104	● 106	
Sheriff CL Plus	APW	21		● 101	● 103	● 104	● 99	
LRPB Trojan	APW	22	● 107	● 99	● 105	● 103	● 97	
Mace	AH	22	● 105	● 104	● 99	● 100	● 101	
Cutlass	APW	22	● 104	● 100	● 105	● 100	● 96	
Valiant CL Plus	AH	4					● 98	
LRPB Dual	AH	4					● 101	
Hammer CL Plus	AH	16			● 99	● 98	● 102	
Chief CL Plus	APW	22	● 107	● 98	● 97	● 97	● 92	
Emu Rock	AH	22	● 93	● 100	● 93	● 97	● 103	

Figure 11 The percentage of the site mean yield for different wheat varieties in NVT across the Murray Mallee region of SA for the past 5 seasons. Source: NVT Online (<https://nvt.grdc.com.au/trial-results>)

Barley NVT

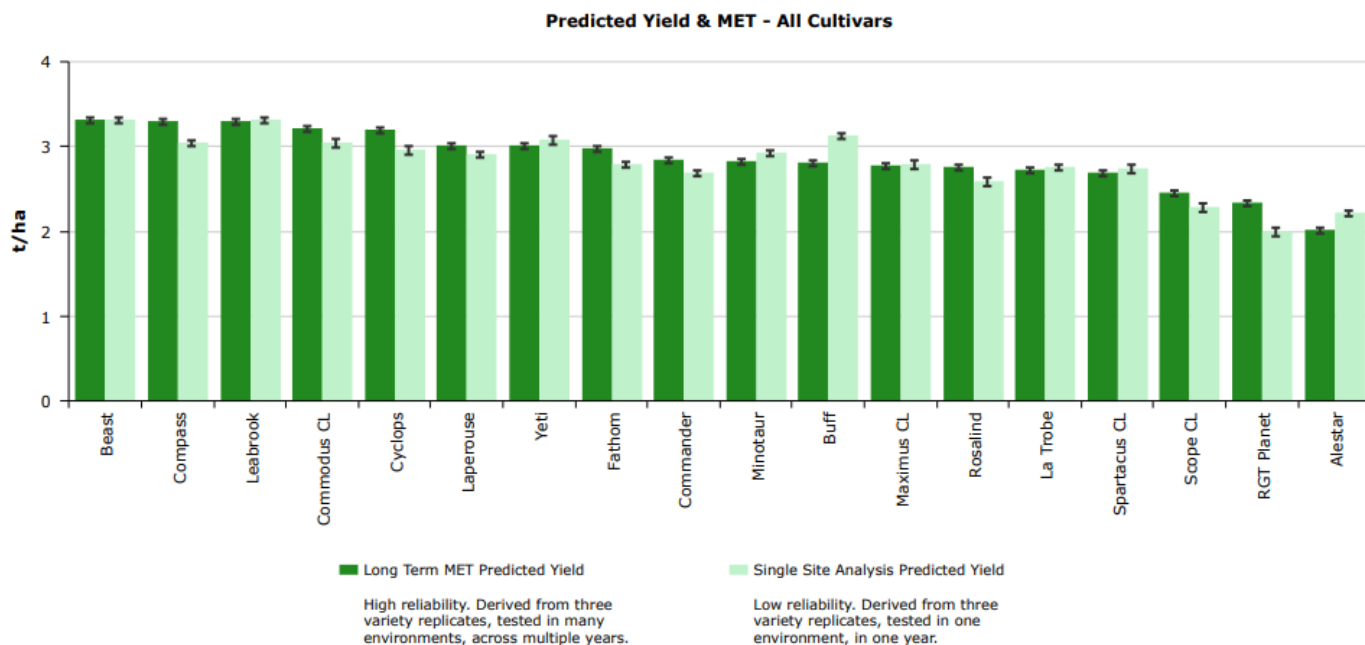


Figure 12 The predicted grain yield for the 2021 Palmer NVT barley trial across all varieties for both a single site analysis and long term MET data. Source: NVT Online (<https://nvt.grdc.com.au/trial-results>)

Group	2017	2018	2019	2020	2021	
Mean Yield	3.65 t/ha	1.98 t/ha	2.64 t/ha	3.64 t/ha	2.09 t/ha	
Variety	Trials	2	2	2	4	4
^/√	^/√	^/√	^/√	^/√	^/√	^/√
Leabrook	14	108	112	122	113	121
Beast	10			122	112	120
Cyclops	8				112	120
Compass	14	104	110	121	109	119
Commodus CL	8				107	117
Rosalind	14	106	106	113	111	106
Minotaur	8				109	110
Yeti	10			113	107	109
Fathom	14	101	107	115	108	111
Laperouse	12		104	104	105	111
Maximus CL	12		101	109	105	103
RGT Planet	14	104	103	101	109	100
La Trobe	14	99	101	105	102	103
Spartacus CL	14	101	99	106	101	99
Commander	14	101	101	92	95	108
Scope CL	14	93	95	90	90	95
Alestar	8				93	84

Figure 13 The percentage of the site mean yield for different barley varieties in NVT across the Murray Mallee region of SA for the past 5 seasons. Source: NVT Online (<https://nvt.grdc.com.au/trial-results>)