MANAGING EARLY SOWN WHEAT

Kelly Angel and Genevieve Clarke (BCG), Ash Wallace (Agriculture Victoria), Kenton Porker (SARDI), James Hunt (La Trobe University)

TAKE HOME MESSAGES

- March to April sown winter wheats performed comparably to main season spring wheats. Optimal time of sowing for winter wheats was late March to mid April.
- Early sowing may present opportunities to increase overall farm profitability by spreading the sowing window without excessive risk of frost and heat.
- Longsword (RAC2341) failed to perform at both sites due to unexplained sterility.

BACKGROUND

A declining trend in April to May rainfall in the Wimmera and Mallee can cause difficulty in establishing spring wheat crops in their optimal sowing window (late April to early May). An increase in farm sizes and more diverse cropping programs is putting pressure on the wheat sowing window. Sowing earlier could be a useful tool to increase whole-farm wheat yield and capture value from late summer rains. Early sowing of spring varieties commonly grown in the region increases the risk of frost during flowering due to flowering occurring earlier than optimal. Winter wheats however, can provide a wider sowing window while offering a more stable and suitable flowering period. This is due to one of the key drivers of maturity in winter wheat varieties - vernalisation. Vernalisation is a genetically determined requirement for a variety to experience a certain amount of low temperatures (4-18^{o}C) before a switch from vegetative to reproductive growth is made.

Winter wheats provide an opportunity to cash in on an early break, give flexibility to a sowing program, and on mixed farms can provide a dual purpose option for livestock. Traditionally, winter wheats, with their longer maturity have not had a good fit in the mid to low rainfall zones where seasons can be cut off early due to heat or lack of rainfall.

Previous BCG research has shown promise for some early sown winter wheat varieties sown early, with the ability to out-yield the later sown spring cultivars (Ick et al. 2014, Angel et al. 2015, Frischke et al. 2015). The adaptation of many of these lines to some regions, particularly the low rainfall zone has been a shortcoming and meant widespread adoption has been limited. However, after a long hiatus, Australian wheat breeders are breeding and releasing winter varieties once again, and some of these are showing promising adaptation to the Mallee.

AIM

To investigate the suitability of new and pre-release winter wheat varieties to the Wimmera and Mallee, and define their optimal time of sowing.

PADDOCK DETAILS

Site 1

Location:	Curyo
Annual rainfall:	297mm
GSR (Apr-Oct):	215mm
Soil type:	Sandy clay loam
Paddock history:	2016 – fallow, cultivated

Site 2

Location:	Longerenong
Annual rainfall:	424mm
GSR (Apr-Oct):	303mm
Soil type:	Clay
Paddock history:	2016 – lentil, harrowed and burnt

TRIAL DETAILS

Crop type:	Refer to Table 1
Treatments:	Refer to Table 1
Target plant density:	150 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	Refer to Table 1
Replicates:	Four
Harvest date:	Curyo: 25 November 2017 Longerenong: 11 December 2017

TRIAL INPUTS

Fertiliser:	Curyo: Granulock® Z + flutriafol @ 50kg/ha at sowing, topdressing June 22 urea @ 120kg/ha on June 22. Longerenong: at sowing Granulock Z + flutriafol @ 50kg/ha, topdressing 21 June urea @ 170kg/ha, 28 July urea @ 100kg/ha
Herbicide:	Curyo: Sowing: Sakura® @ 118g/ha, Avadex® Xtra @ 2L/ha, Trifluralin @ 1.5L/ha, Glyphosate @ 2L/ha, 18 April: Velocity® @ 1L/ha and Hasten @ 1% Longerenong: Sowing: Sakura @ 118g/ha, Avadex Xtra @ 2L/ha, Trifluralin @ 1.5L/ha, Glyphosate @ 2L/ha, 12 April: Lontrel @ 150mL/ha, 19 April: Velocity @ 670mL/ha and Hasten @ 1%
Insecticide:	Curyo: 14 May: Talstar® @ 500mL/ha, Lorsban™ @ 1.2L/ha Longerenong: 29 July: Lorsban @ 400mL/ha
Fungicide:	Curyo: 22 June, 21 July and 25 August: Prosaro® @ 300mL/ha Longerenong: 29 July, 26 August, 26 September: Prosaro @ 300mL/ha

METHOD

A replicated field trial was sown at two sites using a split plot design with time of sowing as the main plot and variety as the sub plot. Where soil moisture was not adequate to allow for establishment, 10mm of water was applied via dripline irrigation to ensure establishment close to the target dates.

Assessments included establishment counts, growth staging to identify end of tillering, head emergence and anthesis, frost assessment, plant height, harvest index, and harvest of plots for grain yield and quality analysis.

This report focuses on the key assessments of establishment, and the grain yield and quality parameters, taking into account seasonal influences such as frost. Other data will be made available at a later date.

Table 1. Varieties and sowing dates for trials at Curyo and Longerenong.

Varieties	Maturity	Winter/Spring	Sowing dates Curyo	Sowing dates Longerenong
Longsword (RAC2341)	Fast	Winter	15 March 29 March 18 April 4 May	16 March 29 March 14 April 28 April
Kittyhawk	Mid	Winter		
ADV11.9419	Long	Winter		
ADV08.0008	Mid	Winter		
LPB14-0392	Very slow	Spring		
V09150-01	Fast-Mid	Winter		
Cutlass	Mid	Spring		
Scepter	Fast	Spring		
Trojan	Mid-fast	Spring		

RESULTS AND INTERPRETATION

Crop establishment and development

Plant establishment counts conducted in both trials showed a significant effect on time of sowing (TOS), but no varietal affects. TOS1 at Curyo had much lower plant numbers than the other TOS, and at Longerenong it was lowest although not significantly lower than TOS2 or 4 (Table 2). The significant rain event around April 20 caused some short-term pre-emergent herbicide damage at Curyo, but this was transient and the crop recovered quickly. TOS3 at Longerenong had the best establishment, believed to be a result of additional rainfall after irrigation that kept the seedbed moist through the germination process. TOS3 was not irrigated further as there was adequate moisture in the seedbed.

Low establishment from a very early time of sowing is believed to be a result of high soil temperatures and possibly some low-level dormancy present from sowing seed a relatively short time after harvest, as some varieties were only harvested in January on the back of a soft season finish in 2016. High soil temperatures can result in the shortening of the coleoptile of the wheat seedling. To ensure good crop establishment more precise seed placement may be required.

Where crops are sown early into soil with adequate moisture and nutrition, plant numbers are less critical as the crop has time to compensate through the production of additional tillers.

Table 2. Plant establishment plants/m², as influenced by time of sowing.

Curyo	Plants/m²	Longerenong	Plants/m²
15 March	125[b]	16 March	147[b]
29 March	157[a]	29 March	154[b]
18 April	179[a]	14 April	205[a]
4 May	175[a]	28 April	160[b]
Sig. diff.	P=0.003		P<0.001
LSD (P=0.05)	25		15
CV%	17.9		12.7

Grain yield and quality at Curyo

At a relatively frost-free site at Curyo, Trojan and Scepter flowering mid-September produced the highest yields of 7.2t/ha and 6.6t/ha respectively (Figure 1). This occurred from sowing Trojan in mid-April, and Scepter in early May. Remaining winter types performed best when sown late March to mid-April. The highest yielding winter line was ADV11.9419 sown 18 April (6.6t/ha), which took advantage of late rains and mild conditions to complete grain fill even though it flowered later than what would be considered the ideal window (mid-September) at Curyo. This would not be expected in drier or hotter seasons, and therefore its performance should be treated with the understanding it is later maturing than Wedgetail – which is not considered adapted to the low rainfall region.

Longsword was the poorest overall performer which suffered a large amount of unexplained sterility in the top half of the spike where it appeared to be infertile and did not set grain. Given the lack of significant frost events at this site, pollen sterility due to chilling in the meiosis stage is considered to be the cause but has not been confirmed.

Poor yields in early sown Scepter was due to mice damage which appeared to have a preference for the early maturing Scepter over other varieties. In the absence of mice, and as observed in Trojan and Cutlass, sowing spring varieties too early does result in reduced yields. This is partly due to frost as well as lack of time to set up biomass/tillers to drive yield. These varieties are driven by thermal time accumulation (Scepter) with some influence of photoperiod/day length (Cutlass and Trojan) and as such, they progress through the growth stages too quickly to set good yield potential.

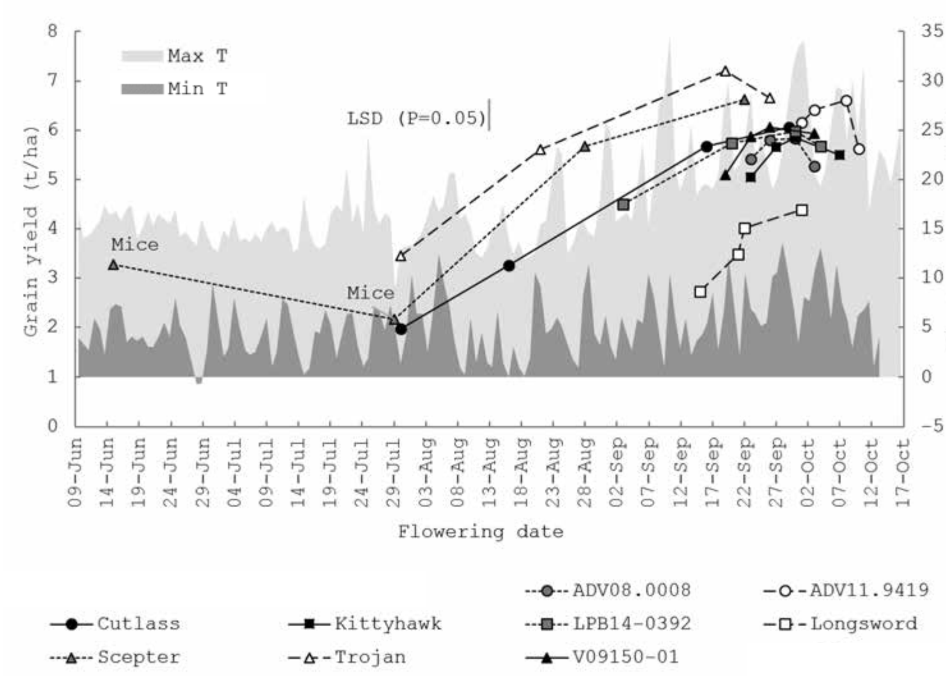

Figure 1. Temperature, flowering date and yield for four times of sowing at Curyo. Note: four positions on a single line indicate the four times of sowing in sequence. Stats: Cultivar x TOS P<0.001, LSD=0.62t/ha, CV=7.8%.

Grain quality at Curyo showed an inversely proportional yield-protein response with higher yielding plots having lower protein (data not presented). This would be a result of protein dilution which commonly occurs under high yielding situations. Average protein over all varieties was 13.5%, meeting the highest quality specifications for grain receival. Test weight was higher with later TOS, with Kittyhawk and ADV11.9419 the only varieties that achieved above 76kg/hL test weight from TOS1. Longsword struggled with test weight at all times of sowing, however at this stage this variety is only classified as feed and as less reliant on test weight as a grain quality measure (Table 3). Screenings for most varieties were below 5%, with only ADV08.0008 having consistently higher screenings than other varieties (Table 4).

Grain yield and quality at Longerenong

At Longerenong, the best performing winter lines (ADV11.9419, ADV08.0008 and V09150-01) achieved yields that were not significantly different to Trojan and Scepter sown in late April (7.2t/ha and 7.4t/ha - Figure 2). Yield of the best winter cultivars was relatively stable, reflecting stable flowering dates close to the environmental optimum of early October (Flohr et al. 2017). Springs lines Scepter, Trojan and Cutlass sown early suffered significant frost damage (>90%) at early times of sowing, and yield came primarily from secondary tillers.

Longsword again performed poorly compared to other winter lines and had similar sterility issues to what was seen at Curyo. The reason for the sterility is difficult to identify given it flowered consistently with Trojan TOS3 and TOS4, Scepter TOS4, Kittyhawk TOS3 and TOS4, as well as some of the other winter lines.

All lines managed to complete flowering and the early stages of grain fill prior to the significant frost event on 4 November (not presented in this data), as such there was little evidence of damage from this event in terms of grain yield or quality.

Grain protein at Longerenong followed the same trend as Curyo, with higher yields resulting in lower protein (data not presented). Test weight in general was a lot lower at Longerenong and was quite varied, although Kittyhawk again appeared to have more consistent test weights across all times of sowing (Table 3). There were no treatment differences noted in screenings, again suggesting that the frost from early November has minimal impact on grain size particularly in the later maturing varieties (Table 4).

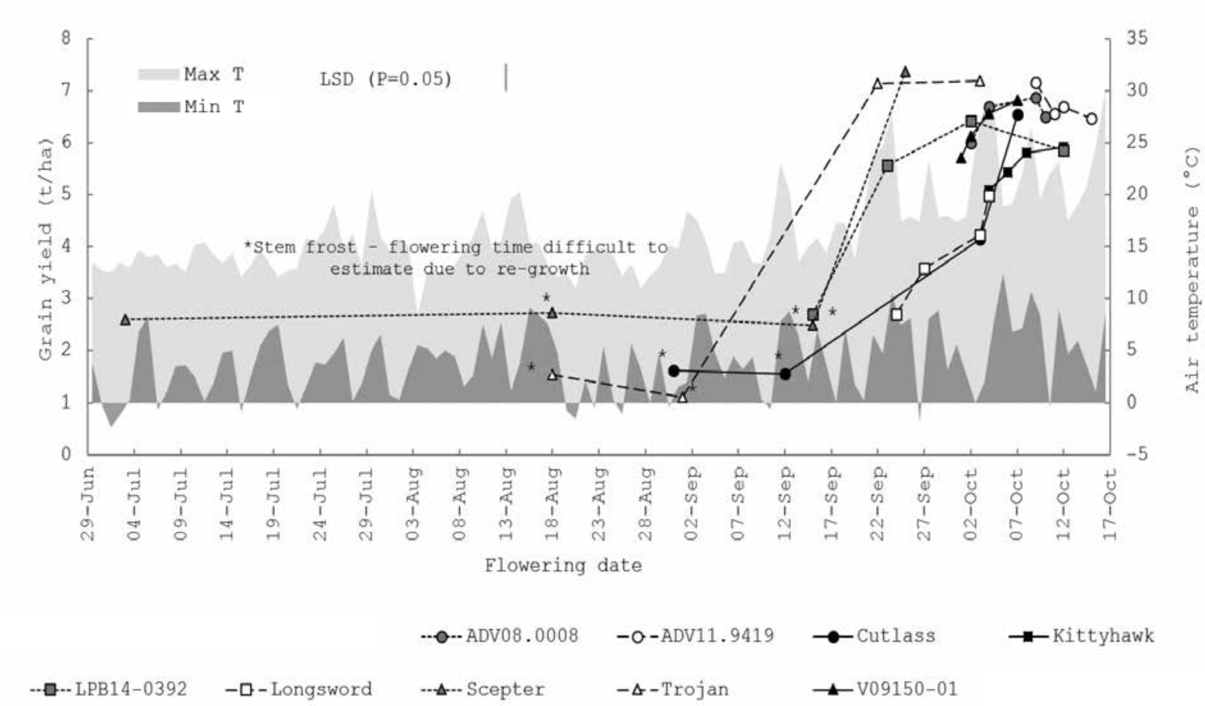

Figure 2. Temperature, flowering date and yield for four times of sowing at Longerenong. Note: four positions on a single line indicate the four times of sowing in sequence. Stats: Cultivar x TOS P<0.001, LSD=0.71t/ha, CV=9.3%

Table 3. Test weight kg/hL of all cultivars at all TOS at Curyo and Longerenong.

Cultivar	Curyo				Longerenong			
	15 Mar	29 Mar	18 Apr	4 May	16 Mar	29 Mar	14 Apr	28 Apr
ADV08.0008	74.8	767.0	78.4	79.1	77.3	71.9	71.8	76.7
ADV11.9419	76.8	77.4	79.7	81.1	74.0	73.2	74.6	77.8
Cutlass	73.4	74.3	78.2	80.8	77.4	74.4	73.6	70.83
Kittyhawk	781	79.6	81.32	81.1	77.9	76.8	77.8	76.1
LPB14-0392	73.08	77.7	78.2	79.1	71.3	75.6	77.0	76.8
Longsword	74.9	73.5	72.5	73.9	76.0	76.9	76.2	72.9
Scepter	73.5	72.3	77.8	80.4	76.3	76.0	77.6	76.8
Trojan	68.5	77.8	80.2	81.2	78.0	76.2	77.7	74.4
V09150-01	72.3	74.7	76.3	77.8	75.9	75.9	69.4	78.5
Sig. diff. (Cultivar x TOS)	<0.001				0.023			
LSD (P<0.05)	2.6				5.2			
CV%	2.5				4.8			

Table 4. Screenings percentage of all cultivars at all TOS at Curyo and Longerenong.

Cultivar	Curyo				Longerenong			
	15 Mar	29 Mar	18 Apr	4 May	16 Mar	29 Mar	14 Apr	28 Apr
ADV08.0008	8.1	7.7	7.6	4.5	3.2	2.8	3.9	3.8
ADV11.9419	4.9	4.0	3.6	4.5	4.4	4.5	1.5	4.9
Cutlass	1.5	1.9	3.8	3.5	4.1	25	3.9	2.0
Kittyhawk	4.9	4.7	3.7	3.6	6.0	3.0	4.2	4.4
LPB14-0392	2.5	2.3	3.5	3.3	4.2	5.4	4.6	2.3
Longsword	0.9	1.3	1.7	1.6	5.2	4.2	5.2	3.4
Scepter	4.9	2.5	4.8	5.1	6.3	2.4	3.7	4.0
Trojan	1.5	3.3	5.3	3.9	5.9	4.9	4.8	4.3
V09150-01	3.5	3.8	3.4	3.0	4.7	5.5	5.8	4.0
Sig. diff. (Cultivar x TOS)	P<0.001				0.446			
LSD (P<0.05)	0.9				NS			
CV%	16.5				NS			

COMMERCIAL PRACTICE

The expanding nature of farms and larger sowing programs means the need for varieties that can be sown early in the program is important to maximise whole-farm yields while minimising risk of having crops flowering too early or too late. There are some promising lines under development and if the management packages around them can be refined, may see the pressure being released from the main sowing window when an early sowing opportunity occurs.

Longsword is the fastest developing winter cultivar available, and in previous trials showed excellent adaptation to the Mallee (Angel et al. 2015). Unfortunately, in the BCG trials this season, Longsword struggled to fulfil the high expectations around it with a perplexing high level of sterility. This high level of sterility was not observed in 2017 at warmer, lower rainfall sites within the trial network (Minnipa, Mildura, Loxton) where Longsword performed very well, nor has it been observed in previous years. We suggest that growers adopting Longsword proceed with caution until more years of data are available to determine if this years poor performance was an anomaly. In the meantime, more seasons of data are required to determine the fit of pre-release lines such as V09150-01 and ADV11.9419 may have a fit in the Mallee.

In the Wimmera, pre-release lines ADV11.9419 and V09150-01 were able to flower within the optimal window of that environment from a broad range of sowing dates and achieve yields as good as elite spring cultivars sown later. These cultivars have potential in this environment, but require more seasons of testing to determine their fit.

To see winter wheats sown in their ideal window (early) yield as well as spring wheat sown in the main sowing window emphasises previous research (Ick et al. 2014, Angel et al. 2015). It also highlights the need for varieties that can have both a vernalisation requirement to slow down their development to reduce frost risk, but then flower and fill grain before moisture and heat stress become excessive. This trial also emphasised that early sowing of spring wheats is not an option, and results in large crop losses.

Winter wheats for early sowing will be of greater value to growers with large sowing programs who struggle to finish their wheat program by mid-May. Being able to sow some area early reduces the number of paddocks sown too late. They will also be of greater value to mixed farmers who can graze livestock on them during the vegetative phase with relatively minor yield effects (Frischke et al. 2015). Growers with smaller cropping programs are unlikely to benefit greatly.

REFERENCES

Ick D., Hunt J. and Poole N., 2014, *2014 BCG Season Research Results* 'Early sowing of wheat' pp. 65-70. http://www.bcg.org.au/delayed-harvest-and-sprouting-tolerance-in-barley/

Angel K., Hunt J. and Poole N., 2015, *2015 BCG Season Research Results* 'Early sowing of wheat' pp 23-29. http://www.bcg.org.au/delayed-harvest-and-sprouting-tolerance-in-barley/

Flohr BM., Hunt JR., Kirkegaard JA. And Evans JR., 2017, *Field Crops Research 209*, 'Water and temperature stress define the optimal flowering period for wheat in south-eastern Australia' pp. 108-119.

Frischke A., Hunt J., McMillan D. and Browne C., 2015, *Crop & Pasture Science 66*, 'Forage and grain yield of grazed or defoliated spring and winter cereals in a winter-dominant, low-rainfall environment' pp. 308-317.

ACKNOWLEDGEMENTS

This research was funded by the GRDC as part of the 'Development of Crop Management packages for early sown, slow developing wheats in the southern region' project (ULA9175069).