Managing early sown long season wheats – results from the Mid-North

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Key Findings

- Winter wheats sown early (pre-April 20) were able to yield similar to Scepter sown in its optimal window.
- Different winter wheats are required for different environments.
- At Hart, the fast – mid developing variety Illabo has been the highest yielding winter wheat across two seasons.

Why do the trial?

The time at which wheat flowers is very important in determining yield. Crops that flower too early have increased risk of frost damage and insufficient biomass, while crops which flower too late have increased risk of high temperatures and water stress which can restrict grain formation and grain-filling. As autumn breaks are declining in frequency and magnitude in the southern grains region, and the size of farming enterprises are increasing, getting a wheat crop established so that it flowers during the optimal flowering period for peak yield can be difficult. However, an opportunity exists in South Australia to take advantage of stored moisture over the summer and rain events in March and April to start sowing crops earlier than what is currently practiced.

Over the last few decades wheat breeding efforts have focused on mid-fast developing spring varieties (for example Scepter) that need to be sown in the first half of May to flower during the optimal period (late September for Hart) for grain yield. Sowing earlier than April 20 requires winter varieties that are slower developing. The ability to sow wheat outside our traditional window opens up opportunities to improve whole farm yield and manage risk.

Breeders have responded to this change in farming system and are now developing material suited to earlier sowing. Previous research has shown that winter varieties (e.g. Wedgetail and Rosella) bred for NSW are not suited to SA conditions. This project compares performance of new winter wheats sown early compared to current spring benchmarks sown on time.

How was it done?

Location: Hart *(rainfall refer to page 11)*

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) + 2% Zn @ 75 kg/ha UAN (42:0) @ 60 L/ha on 5th July UAN (42:0) @ 55 L/ha on 2nd Aug
Seeding date	20th March (irrigated) 3rd April (irrigated) 14th April (irrigated) 1st May		

Location: Booleroo Centre *(rainfall refer to page 12)*

Plot size	1.75 m x 10.0 m	**Fertiliser**	DAP (18:20) + 2% Zn @ 75 kg/ha
Seeding date	21st March (irrigated) 4th April (irrigated) 18th April (irrigated) 2nd May (irrigated)		

At each location the trial was a split plot design with four replicates of nine varieties (Table 1) at four times of sowing. Where irrigation was required the equivalent of 10 mm rainfall was applied using dripper line in-furrow post-seeding to ensure germination. Fungicides and herbicides were applied as necessary to keep the canopy free of disease and weeds.

All plots were assessed for plant establishment, heading date, grain yield and quality (except Booleroo due to insufficient grain sample for processing).

Table 1. Summary of winter varieties, including Wheat Australia quality classification and disease based on the 2019 SA Crop Sowing Guide.

Cultivar	Release Year	Company	Development	Quality	Disease Rankings#			
					Stripe Rust	Leaf Rust	Stem Rust	YLS
Kittyhawk	2016	LRPB	Mid winter	AH	MR	MR	R	MRMS
Longsword	2017	AGT	Fast winter	Feed	RMR	MSS	MR	MRMS
Illabo	2018	AGT	Mid-fast winter	AH	RMR	S	MRMS	MRMS
DS Bennett	2018	Dow	Mid – Slow winter	ASW	R	S	MRMS	MRMS
ADV08.0008	?	Dow	Mid winter	?	-	-	-	-
ADV15.9001	?	Dow	Fast winter	?	-	-	-	-
LPB14-0392	?	LRPB	Very slow spring	?	-	-	-	-
Cutlass	2015	AGT	Mid spring	APW	MS	RMR	R	MSS
Trojan	2013	LRPB	Mid-fast spring	APW	MR	MRMS	MRMS	MSS
Scepter	2015	AGT	Fast spring	AH	MSS	MSS	MR	MRMS

Hart

Results and discussion

The trial was sown into marginal soil moisture after low summer and pre-seeding rainfall. To ensure germination would occur, the first three times of sowing were irrigated.

Plant establishment increased with seeding date from 102 plants/m^2 in mid-March to 152 plants/m^2 in early May (data not shown). All varieties performed similarly across the times of sowing, averaging 127 plant/m^2. The only variety to have reduced plant establishment (99 plant/m^2) was ADV15.9001. In other outputs of this project seeding rates of 50 and 150 plants/m^2 were compared. The main finding from this research was 50 plants/m^2 was sufficient to allow maximum yields to be achieved (Porker et al. 2019). In general, there is no yield benefit from having plant densities greater than 50 plant/m^2 for winter wheats.

Flowering time is a key determinant of wheat yield. Winter varieties are very stable in flowering date across a broad range of sowing dates, this has implications for variety choice as flowering time cannot be manipulated with sowing date in winter wheats like spring wheat. This means that different winter varieties are required to target different optimum flowering windows. The flowering time difference between winter varieties are characterised based on their relative development speed into three broad groups fast, mid-fast, mid and mid-slow for medium-low rainfall environments (Table 1 and Figure 1).

Scepter was the fastest developing spring variety, yielding 2.4 t/ha when sown at its optimal time (early May). Slower developing springs (e.g. Trojan and Cutlass) generally performed best from sowing dates after mid-April and yielded less than the best performing winter varieties when sown prior to this date. The numbered line LPB14-0392 (very slow spring) performed well at Hart again this season however has been less stable in yield and flowering date compared to winter varieties in other experiments.

A number of winter wheats sown in mid-early April were able to yield as well as Scepter sown in early May. Both ADV15.9001 and Illabo had consistent grain yields of 2.3-2.4 t/ha (Table 2). Similar to 2017 Longsword flowered earlier compared to Illabo and did not achieve the same yields (Figure 1). Longsword however, has performed well in lower rainfall areas such as Loxton and Minnipa. Both Kittyhawk and DS Bennett performed well at Hart under tough seasonal conditions but based on flowering date are slightly later than required for the Hart environment (Figure 1).

Across all environments in the project (SA and Vic), the highest yields for winter wheats generally came from early – late April establishment and results suggested that the yields may decline from sowing dates earlier than April and these dates may be too early to maximise winter wheat performance.

Grain protein levels range from 8.1 – 13.1% across all varieties and time of sowing. Changes in grain protein were generally attributed to yield dilution effects (lower yield=higher protein). DS Bennet contained the lowest protein level of all varieties, averaging 8.8% across all times of sowing. In general, majority of varieties and times of sowing were able to achieve a minimum test weight of 76 kg/hL (minimum level for AH and APW classification). In particular, Kittyhawk consistently had the highest test weight (>79 kg/hL) across all varieties. There were some exceptions, particularly for treatments sown in mid-March. Screening levels across the trial were low, with all varieties falling below the 5% level (maximum level for maximum grade).

Table 2. Grain yield and quality for all wheat varieties at different times of sowing at Hart in 2018. Treatments shaded in grey and not significantly different from the highest treatment.

Variety	Mar 20th	Apr 3rd	Apr 17th	May 1st	Mar 20th	Apr 3rd	Apr 17th	May 1st
	Grain yield (t/ha)				**Protein (%)**			
Scepter	1.3	1.8	2.1	2.4	12.5	12.2	11.9	9.5
Trojan	1.5	1.9	2.1	2.0	12.8	12.0	11.0	10.5
Cutlass	2.0	2.4	2.4	2.3	11.0	9.8	9.8	10.2
LPB14-0392	2.2	2.4	2.5	2.0	11.1	10.2	10.3	11.0
Longsword	1.8	2.2	2.0	1.9	13.1	11.8	12.2	11.8
ADV15.9001	2.3	2.4	2.3	2.1	9.7	9.3	9.1	9.3
Illabo	2.0	2.3	2.4	1.9	11.8	10.6	10.5	11.1
Kittyhawk	2.0	2.1	2.1	1.6	10.2	10.0	10.5	11.4
DS Bennett	1.9	1.9	2.2	1.5	8.5	8.8	8.1	9.9
LSD (P≤0.05)	0.24				1.1			
	Test weight (kg/hL)				**Screenings (%)**			
Scepter	75.1	75.7	76.9	78.9	2.9	2.6	3.1	3.4
Trojan	75.2	77.1	78.2	79.1	1.0	0.9	1.7	2.2
Cutlass	78.0	78.4	79.1	79.6	1.9	2.3	2.4	2.2
LPB14-0392	76.5	77.3	77.0	78.3	2.8	2.5	2.8	2.9
Longsword	76.5	78.0	77.4	78.6	1.0	0.7	0.8	1.2
ADV15.9001	76.9	77.9	77.7	78.5	3.2	2.7	3.1	2.7
Illabo	75.2	76.7	77.1	77.6	1.6	1.7	1.7	2.1
Kittyhawk	79.6	80.3	80.7	80.6	2.3	1.7	2.0	1.8
DS Bennett	78.0	78.1	79.1	78.7	3.7	3.6	3.7	3.5
LSD (P≤0.05)	1.1				0.5			

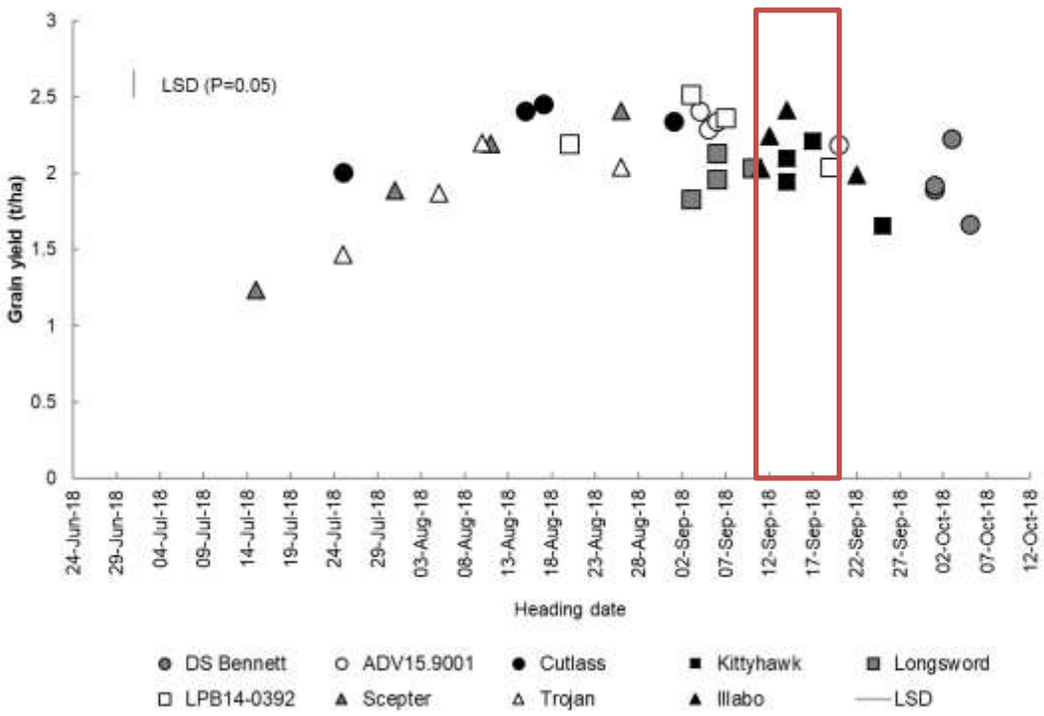

Figure 1. Average yield and heading date for all varieties and times of sowing. The red rectangle highlights the optimal flowering period for Hart.

Booleroo

Achieving good plant establishment has been a challenge at Booleroo, particularly from March sowing dates. All four times of sowing were irrigated to achieve germination. Due to the lack of rainfall and high soil temperatures during March and April, times of sowing one and two appeared dead on the surface by the end of May. However, below the soil surface the coleoptile (section above the seed) remained alive (Figure 2) in the majority of plants. In early June the site received 30 mm across 10 days and many plants regenerated along with a secondary germination. At the final establishment count the plants populations were 67, 84, 111 and 136 plants/m^2 across time of sowing one to four.

Figure 2. Plot of Scepter wheat sown 21st March (left) and plants removed from the plot (right) taken on 22nd May, 2018.

The regeneration of plants and death of the main stem had an interesting impact on phenology. For the spring varieties such as Scepter and Trojan it effectively pushed the 'reset button' due to the fact they were in the reproductive phase when severe moisture stress hit. This meant they restarted their lifecycle at the time of rain in early June. As a result across all times of sowing, Scepter flowered within 10 days of each other which was not expected (Figure 3). As observed in 2017, Scepter was the best performing variety within the trial at Booleroo ranging from 0.6 – 0.8 t/ha (Table 3). Both Trojan and Cutlass sown in early May performed similar to Scepter.

Overall the research project has shown the fastest developing winter wheat Longsword has been the most consistent performing winter wheat in low yielding (<2.5 t/ha) sites such as Booleroo, Minnipa and Loxton. In 2018 Longsword was also the best performing winter wheat and yielded similar to Scepter sown in its optimal window highlighting the need for faster developing winter wheats for environments similar to Booleroo.

Within the current suite of winter wheats there are few varieties well adapted to Booleroo's environment. Across all of the early sown wheat experiments in SA, Booleroo has been the most challenging for winter wheat production. In 2017, Booleroo was the only site where winter wheats did not perform similar to Scepter and yielded 0.7 t/ha less.

Test weight, screenings and protein were not determined due to insufficient grain sample size for processing.

Table 3. Grain yield and quality for all wheat varieties at different times of sowing at Booleroo in 2018. Treatments shaded in grey and not significantly different from the highest treatment.

Variety	March 21st	April 4th	April 18th	May 5th
	Grain yield (t/ha)			
Scepter	0.74	0.79	0.64	0.71
Trojan	0.51	0.71	0.62	0.76
Cutlass	0.51	0.66	0.60	0.70
LPB14-0392	0.19	0.24	0.36	0.23
Longsword	0.42	0.64	0.61	0.57
Illabo	0.37	0.23	0.38	0.28
Kittyhawk	0.35	0.37	0.30	0.30
DS Bennett	0.28	0.27	0.15	0.23
ADV08.0008	0.24	0.30	0.29	0.28
LSD(P≤0.05)	0.15			

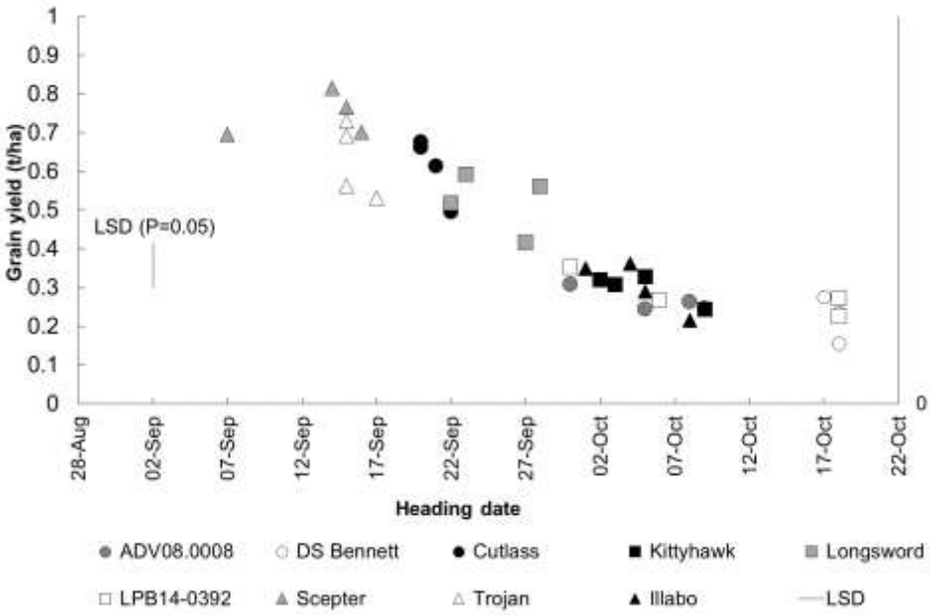

Figure 3. Average yield and heading date for all varieties and times of sowing at Booleroo Centre in 2018.

Summary

Across the entire project (eights sites in SA and VIC) the best performing winter wheat varieties depended upon yield environment, development speed and the severity and timing of frost / heat stress. In over 20 experiments the best performing winter wheat at each site was able to achieve yields similar to Scepter sown in its optimal window. The only exception to this was at Booleroo in 2017 where Scepter outperformed the winter wheats.

In environments greater than 2.5 t/ha, mid-slow developing wheat varieties were favoured for example Illabo at Hart. In environments less than 2.5 t/ha such as Booleroo the faster developing Longsword is favoured. However, the results for Booleroo have not consistently shown that winter wheats are suitable for this environment.

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