Emerging management tips for early sown winter wheats

RESEARCH

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Location
Minnipa Agricultural Centre, Paddock S2/8
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2017 Total: 282 mm
2017 GSR: 155 mm
Yield
Potential: 1.7 t/ha (W)
Actual: Highest yielding treatment, 2.5 t/ha
Paddock History
2016: Grass free pasture
2015: Wheat
2014: Wheat
Soil Type
Sandy loam
Plot Size
5 m x 1.4 m x 4 reps
Yield Limiting Factors
Drought, mice

Key messages

- **Highest yields for winter wheats come from early – late April establishment.**
- **Highest yields of winter wheats sown early are similar to Scepter sown in its optimal window.**
- **Slower developing spring cultivars are not suited to pre 20 April sowing.**
- **Different winter wheats are required for different environments.**
- **Flowering time cannot be manipulated with sowing date in winter wheats like spring wheat.**
- **10 mm of rainfall was needed for establishment on sands, 25 mm on clays - more was not better.**

Why do the trials?

Winter wheat cultivars allow wheat growers in the southern region to sow much earlier than currently practiced, meaning a greater proportion of the farm can be sown on time. The previous GRDC Early Sowing Project (2013-2016) highlighted the yield penalty from delayed sowing. Wheat yield declined at 35 kg/ha for each day sowing was delayed beyond the end of the first week of May using a fast developing spring cultivar.

Sowing earlier requires varieties that are slower developing. For sowing prior to 20 April, winter cultivars are required, particularly in regions of high frost risk. Winter wheats will not progress to flower until their vernalisation requirement is met (cold accumulation) whereas spring cultivars will flower too early when sown early. The longer vegetative period of winter varieties also allows dual-purpose grazing.

The aim of this series of experiments is to determine which of the new generation of winter cultivars have the best yield and adaptation in different environments and what is their optimal sowing window. Prior to the start of the project in 2017 the low–medium rainfall environments of South Australia and Victoria had little exposure to winter cultivars, particularly at really early sowing dates (mid-March). Three different experiments have been conducted in the southern region in low–medium rainfall environments during 2017 and 2018, and one of these has been matched by collaborators in NSW for additional datasets presented in this paper.

How was it done?

Experiment 1

Which wheat cultivar performs best in which environment and when they should be sown?

- Target sowing dates: 15 March, 1 April, 15 April and 1 May (10 mm supplementary irrigation to ensure establishment).
- Locations: SA - Minnipa, Booleroo Centre, Loxton, Hart. Vic - Mildura, Horsham, Birchip and Yarrawonga. NSW - Condobolin, Wongarbon, Wallendbeen.
- Up to ten wheat cultivars - The new winter wheats differ in quality classification, development speed and disease rankings (Table 1).

Experiment 2

How much stored soil water and breaking rain is required for successful establishment of early sown wheat without yield penalty?

- Sowing dates: 15 March, 1 April, 15 April and 1 May.
- Cultivars: Longsword, Kittyhawk and DS Bennett.
- Irrigation: 10 mm, 25 mm and 50 mm applied at sowing.
- Locations: SA - Loxton. Vic - Horsham, Birchip.

Experiment 3

What management factors other than sowing time are required to maximise yields of winter wheats?

- Sowing date: 15 April.
- Cultivars: Longsword, Kittyhawk and DS Bennett.
- Management factors examined: Nitrogen at sowing vs. nitrogen at early stem elongation, defoliation to simulate grazing, plant density 50 plants/m^2 vs. plant density 150 plants/m^2.
- Locations: SA - Loxton. Vic - Yarrawonga.

What happened?

Experiment 1

Development speeds

Flowering time is a key determinant of wheat yield. Winter cultivars have stable flowering dates 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 different winter varieties are required to target the different optimum flowering windows that exist in different environments. The flowering time difference between winter cultivars are characterised based on their relative development speed into four broad groups; fast, mid-fast, mid and mid-slow for medium-low rainfall environments (Table 1 and Figure 1).

Table 1 Summary of winter cultivars, including Wheat Australia quality classification and disease rankings 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/APH*	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/AH*	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

**SNSW only*

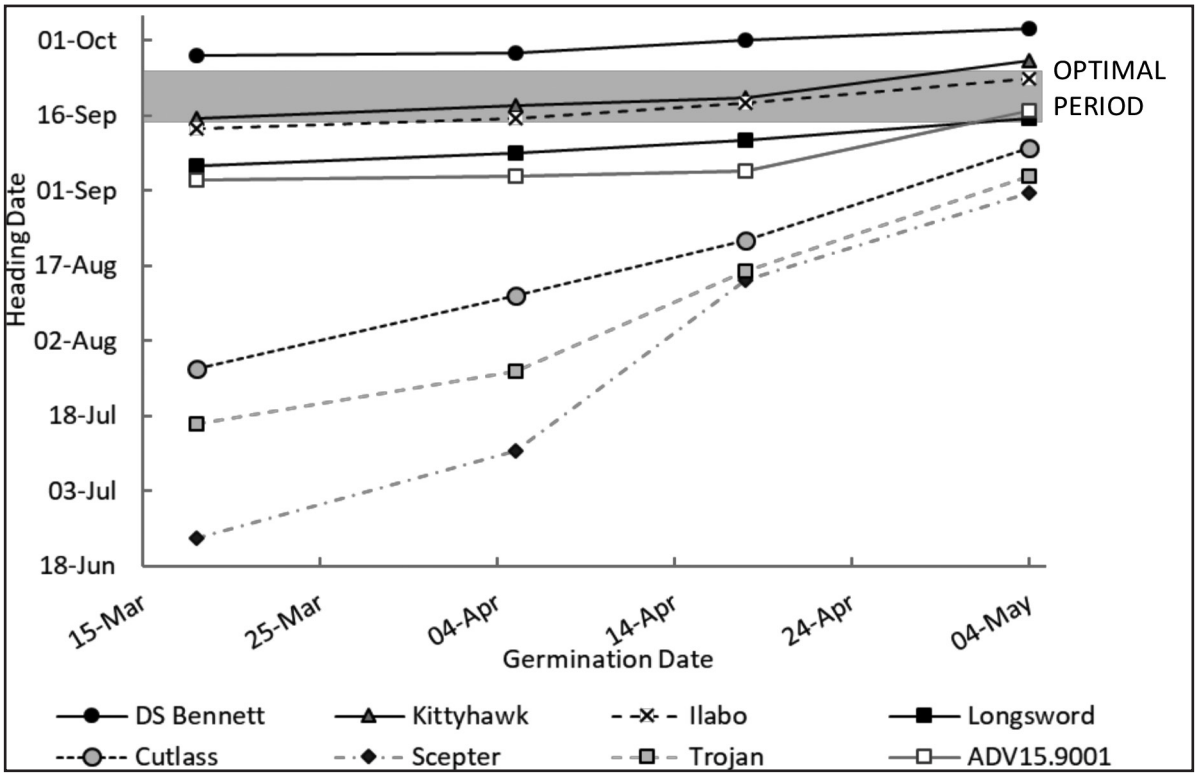

Figure 1 Mean heading date responses from winter and spring cultivars at Hart in 2017 and 2018 across all sowing times, grey box indicates the optimal period for heading at Hart.

For example at Hart in the Mid North of SA each winter variety flowered within a period of 7-10 days across all sowing dates, whereas spring cultivars were unstable and ranged in flowering dates over one month apart (Figure 1). In this Hart example the mid developing winter wheats such as Illabo and Kittyhawk were best suited to achieve the optimum flowering period of 15-25 September for Hart. In other lower yielding environments such as Loxton, Minnipa and Mildura the faster developing winter cultivar Longsword was better suited to achieve flowering times required for the first 10 days in September.

Winter versus spring wheat grain yield

Across all experiments the best performing winter wheat yielded similar to the fast developing spring variety Scepter sown at the optimal time (last few days of April or first few days of May, used as a best practice control) in 16 out of 20 sites, greater in 3 and less than in 1 environment (Figure 2). The best performing winter wheat yielded similar to the best performing slow developing spring variety (alternative development pattern) at 14 sites, greater at 4 and less than at 2 sites.

Sowing time responses

Across all environments the highest yields for winter wheats generally came from early – late April establishment. The results suggested that yields may decline from sowing earlier than April and these dates may be too early to maximise winter wheat performance (Table 2).

Slower developing spring wheats performed best from sowing dates after 20 April, and yielded less than the best performing winter cultivars when sown prior to 20 April. This reiterates slow developing spring varieties are not suited to pre 20 April sowing in low–medium frost prone environments.

Which winter cultivar performed best?

The best performing winter wheat cultivars depended on yield environment, development speed and the severity and timing of frost (Table 2). The rules generally held up that winter cultivars well-adjusted to a region yielded similar to Scepter sown in its optimal window, these results demonstrate that different winter wheats are required for different environments and there is genetic by yield environment interaction.

- In environments less than 2.5 t/ha the faster developing winter wheat Longsword was generally favoured (Table 2, Figure 3).
- In environments greater than 2.5 t/ha the mid–slow developing cultivars were favoured; Illabo in the Mid North of SA, and DS Bennett at the Vic and NSW sites (Table 2, Figure 4).
- The poor relative performance of Longsword in the higher yielding environments was explained by a combination of flowering too early and having inherently greater floret sterility than other cultivars irrespective of flowering date.

Sites defined by severe September frost and October rain included Yarrawonga, Mildura and Horsham in 2018, in these situations the slow developing cultivar DS Bennett was the highest yielding winter wheat and had the least amount of frost induced sterility. The October rains also favoured this cultivar in 2018 and mitigated some of the typical yield loss from terminal drought. Nonetheless the ability to yield well outside the optimal flowering period maybe a useful strategy for extremely high frost prone areas for growers wanting to sow early.

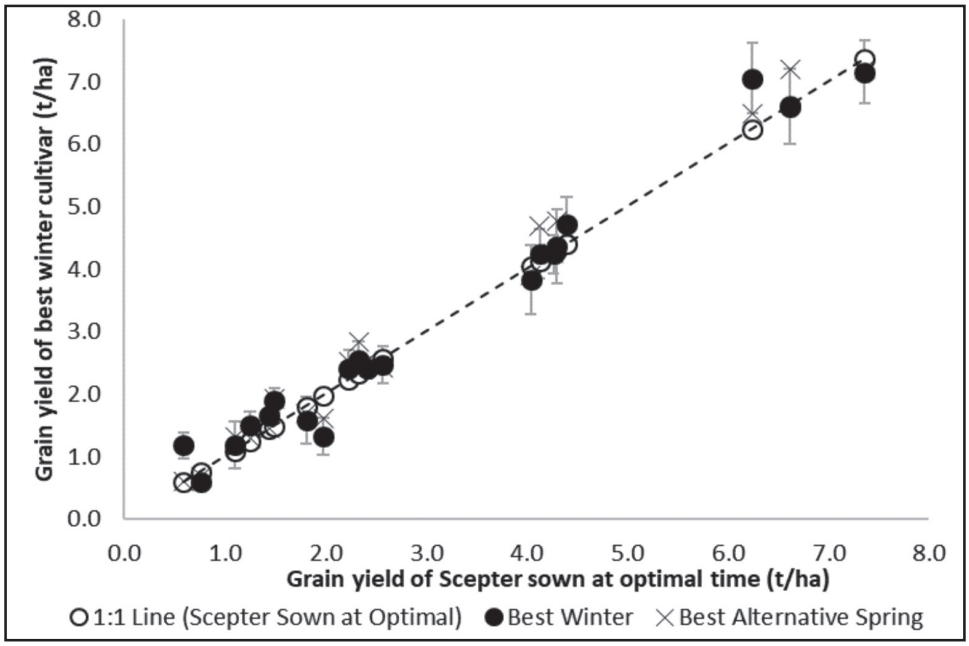

Figure 2 Grain yield performance of Scepter wheat sown at its optimal time (late April-early May) in 20 environments compared to the best performing winter wheat and best alternative spring. Error bars indicate LSD (P<0.05).

Table 2 Summary of grain yield performance of the best performing winter and alternate spring cultivar in comparison to Scepter sown at the optimum time (late April-early May). Different letters within a site indicate significant differences in grain yield.

Site	Year	Scepter sown at optimum grain yield (t/ha)	Best winter performance			Best alternate spring performance		
			Grain yield (t/ha)	Variety	Germ date	Grain yield (t/ha)	Variety	Germ date
Yarrawonga* - VIC	2018	0.59 a	1.18 b	DS Bennett	16-Apr	0.61 a	Cutlass	16-Apr
Booleroo - SA	2018	0.77 a	0.59 a	Longsword	4-Apr	0.69 a	Trojan	2-May
Loxton - SA	2018	1.10 a	1.19 a	Longsword	19-Mar	1.32 a	Cutlass	3-May
Minnipa - SA	2018	1.25 a	1.50 b	Longsword	3-May	1.29 a	Trojan	3-May
Mildura* - VIC	2018	1.44 a	1.66 b	DS Bennett	1-May	1.46 a	LPB14-0293	1-May
Mildura - VIC	2017	1.49 a	1.90 b	Longsword	13-Apr	1.93 b	Cutlass	28-Apr
Horsham* - VIC	2018	1.81 a	1.58 a	DS Bennett	6-Apr	1.70 a	Trojan	2-May
Booleroo - SA	2017	1.98 a	1.33 b	DS Bennett	4-May	1.61 b	Cutlass	4-May
Minnipa - SA	2017	2.23 a	2.42 a	Longsword	18-Apr	2.52 a	Cutlass	5-May
Loxton - SA	2017	2.33 a	2.55 a	Longsword	3-Apr	2.83 b	LPB14-0293	3-Apr
Hart - SA	2018	2.41 a	2.42 a	Illabo	17-Apr	2.52 a	LPB14-0293	17-Apr
Rankins Springs - NSW	2018	2.57 a	2.47 a	DS Bennett	19-Apr	2.42 a	Trojan	7-May
Birchip - VIC	2018	4.04 a	3.83 a	Longsword	30-Apr	3.90 a	Trojan	30-Apr
Hart - SA	2017	4.13 a	4.25 a	Illabo	18-Apr	4.70 b	LPB14-0293	18-Apr
Yarrawonga - VIC	2017	4.27 a	4.24 a	DS Bennett	3-Apr	4.26 a	Cutlass	26-Apr
Wongarbon - NSW	2017	4.30 a	4.37 a	DS Bennett	28-Apr	4.77 a	Trojan	13-Apr
Tarlee - SA	2018	4.40 a	4.71 a	Illabo	17-Apr	4.62 a	LPB14-0293	17-Apr
Wallendbeen - NSW	2017	6.24 a	7.05 b	DS Bennett	28-Mar	6.49 a	Cutlass	1-May
Birchip - VIC	2017	6.62 a	6.60 a	DS Bennett	15-Apr	7.20 a	Trojan	15-Apr
Horsham - VIC	2017	7.36 a	7.15 a	DS Bennett	16-Mar	7.19 a	Trojan	28-Apr

**repeated frost during September followed by October rain*

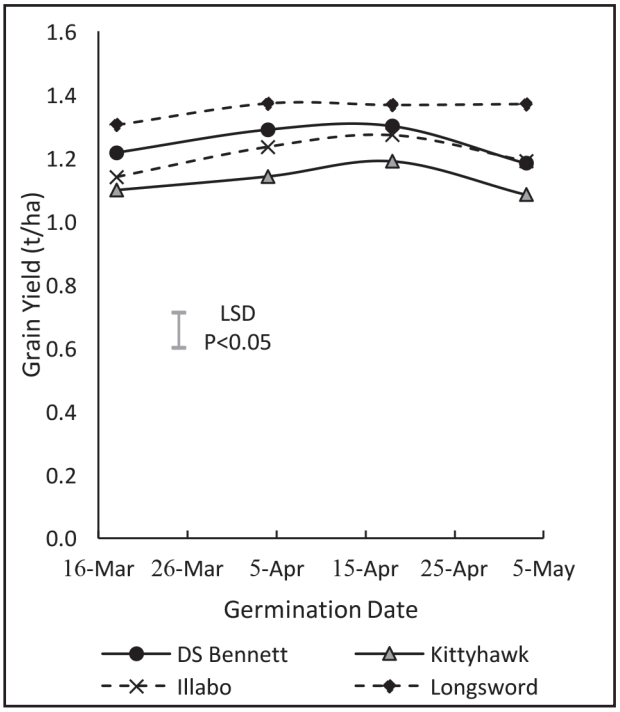

Figure 3. Mean yield performance of winter wheat in yield environments less than 2.5 t/ha (11 sites in SA/Vic)

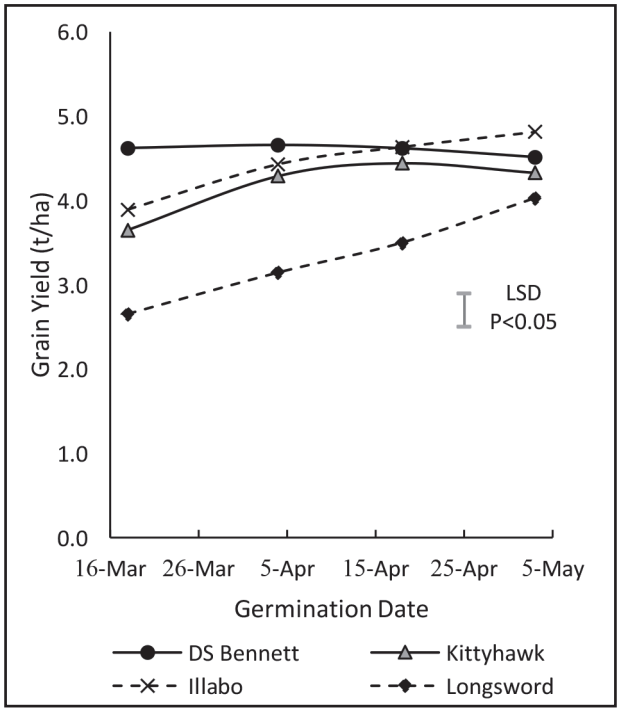

Figure 4. Mean yield performance of winter wheat in yield environments greater than 2.5 t/ha (5 sites in SA/Vic)

Experiment 2

2018 had one of the hottest and driest autumns on record, and provided a good opportunity to test how much stored soil water and/or breaking rain is required to successfully establish winter wheats and carry them through until winter. The 10 mm of irrigation applied at sowing in the sowing furrow was sufficient to establish crops and keep them alive (albeit highly water stressed in most cases) until rains finally came in late May or early June at 7 of the 8 sites at which Experiment 1 was conducted in 2018. The one exception was Horsham, which had very little stored soil water and a heavy, dark clay soil. At this site, plants that emerged following the first time of sowing in mid-March died after establishment and prior to the arrival of winter rains. Plants at all other times of sowing were able to survive. Experiment 2 was also located at this site, and 25 mm of irrigation was sufficient to keep plants alive at the first time of sowing. A minimum value of 25 mm for sowing in March on heavier soil types is supported by results from Minnipa in 2017, which also experienced a very dry autumn. In this case, ~30 mm of combined irrigation, rainfall and stored soil water was sufficient to keep the first time of sowing alive. On lighter soil types, less water was needed and 10 mm irrigation at sowing with 8 mm of stored water plus an accumulated total of 13 mm of rain until June allowed crops to survive on a sandy soil type at Loxton in 2018.

Based on these observations, we conclude that when planting in March on clay soils, at least 25 mm of rainfall and/or accessible soil water are required for successful establishment. Once sowing moves to April, only 10 mm (or enough to germinate seed and allow plants to emerge) is sufficient.

Experiment 3

Yield responses to changes in plant density, N timing and defoliation have been small (Table 3). There have been limited interactions between management factors and cultivars. The results from experiment one and three confirm selecting the correct winter cultivar for the target environment and sowing winter wheats on time (before 20 April) increases the chances of high yields. The target density of 50 plants/m^2 is sufficient to allow maximum yields to be achieved, and there is no yield benefit from having higher densities in winter cultivars. Deferring N until stem elongation had a small positive benefit at Yarrawonga, and a negative effect at Loxton. Grazing typically has a small negative effect in all cultivars, however the mean percentage grain yield recovery from grazing has been higher in Longsword (95%) compared to DS Bennett (87%) and Kittyhawk (82%), respectively.

Table 3 Mean main effects on grain yield (t/ha) from management factors at Loxton and Yarrawonga (2017 & 2018 = 4 sites)

Management factor (Grain yield t/ha)						Mean management effect (t/ha)
Cultivar choice	DS Bennett (2.21) & Kittyhawk	(2.10)	Vs.	Longsword	(2.40)	+0.30***
Seeding rate (target density)	150 plants/m^2	(2.14)	Vs.	50 plants/m^2	(2.35)	+0.21***
Nitrogen timing	Seedbed applied N	(2.32)	Vs.	N Delayed to Stem Elongation	(2.21)	-0.11 ns
Grazing ^	Ungrazed	(2.38)	Vs.	Grazed	(2.11)	-0.27***
Sowing date#	Early May Germination	(1.70)	Vs.	Mid-April Germination	(2.19)	+0.49***

*^ grazing was simulated by using mechanical defoliation at Z15 and Z30, #Sowing date effect derived from experiment 1 at Loxton and Yarrawonga. Level of significance of main effect indicated by ns=not significant, *** = P<0.001.*

What does this mean?

Growers in the low-medium rainfall zones of the southern region now have winter wheat cultivars that can be sown over the entire month of April and are capable of achieving similar yields to Scepter sown at its optimum time. However, grain quality of the best performing cultivars leaves something to be desired (Longsword=feed, DS Bennett=ASW). Sowing some wheat area early allows a greater proportion of farm area to be sown on time. Growers will need to select winter wheats suited to their flowering environment (fast winter in low rainfall, mid and mid-slow winter in medium rainfall) and maximum yields are likely to come from early–mid April planting dates. If planting in April, enough rainfall to allow germination and emergence will also be enough to keep plants alive until winter. If planting in March, at least 25 mm is required on heavy soils. Reducing plant density from 150 to 50 plants/m² gives a small yield increase, grazing tends to reduce yield slightly.

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