Department of Primary Industries

Early sowing options: wheat phenology and yield responses – Wallendbeen 2019

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Key findings

- Despite the significant effect of seasonal conditions in 2019, grain yields of >5.5 t/ha were achieved, highlighting the opportunity for early sown winter wheats in grain-only systems.
- Differences in phenology and yield responses across sowing dates suggest cultivar performance can be manipulated by sowing time and can vary across environments.
- New winter and long season spring types with consistent yield performance provide alternative early sowing options for growers in southern NSW.

Introduction

Recently, breeders have released a number of new winter wheat genotypes suited to early sowing. In 2019, field experiments were conducted at two sites: Wallendbeen (southern NSW) and Wongarbon (central NSW) to determine the influence of phenology on grain yield responses for a set of 16 commercial and newly released genotypes in response to sowing date (SD). This paper presents results from the Wallendbeen site.

Site details

Location	Braeside, Wallendbeen NSW
Soil type	Grey kandasol
Previous crop	Canola
Sowing	• Direct drilled with DBS tynes spaced at 250 mm using a GPS auto-steer system. • Target plant density: 140 plants/m^2. • SD1: 27 March; SD2: 10 April; SD3: 30 April.
Fertiliser	• 98 kg/ha mono-ammonium phosphate (MAP) (sowing). • Activist® Max (70% zinc) 1 L/ha + Easy N 20 L/ha (21 May, 6 June). • OmniGRO 4 L/ha (24 May). • 93 kg N/ha (applied as urea, 8 July).
Weed control	Knockdown • Glyphosate (450 g/L) 2.0 L/ha. Pre-emergent • Sakura® 118 g/ha (before SD1, incorporated by rain). • Avadex Xtra 1.6 L/ha + Trifluralin (480 g/L) 0.8 L/ha (pre-sowing). In-crop • LVE MCPA 570 600 mL/ha + Paradigm® Arylex® active 25 g/ha (SD1 and SD2 on 15 May, SD3 on 26 July).

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GRDC Grains Research & Development Corporation

- Axial® 300 mL/ha (SD3 on 26 July).

Disease and pest management

- Seed treatment: Hombre® Ultra 200 mL/100 kg and Gaucho® 600 120 mL/100 kg.
- Flutriafol-treated fertiliser 250 g/L (400 mL/ha).
- Prosaro® 300 mL/ha (SD1 and SD2: 6 June, all SDs on 19 July).

Rainfall

- In-crop rainfall (April–October): 192.5 mm
- In-crop long-term average: 420 mm
- 36 mm rain recorded on 3 November, which coincided with the early grain-filling stages of winter genotypes.

Severe temperature events

- Twelve heat stress events (days >30 °C until 28 November) including 32.7 °C (6 October) (coinciding with critical flowering and early grain-filling stages).
- Eight frosts (days <0 °C), one severe frost –2.2 °C (22 June).

Harvest dates

- 28 November
- 10 December: Manning$^{\Phi}$ (all SDs) due to delayed maturity.

Treatments

Sixteen wheat genotypes varying in phenology responses (Table 1) were sown on three sowing dates: SD1: 27 March, SD2: 10 April and SD3: 30 April in 2019.

Table 1 Expected phenology responses of the 2019 experiment genotypes.

Phenology type	Genotypes*
Winter (W)	Longsword$^{\Phi}$ (F), LongReach Kittyhawk$^{\Phi}$ (M), EGA Wedgetail$^{\Phi}$ (M), Illabo$^{\Phi}$ (MF), DS Bennett$^{\Phi}$ (MS), RGT Accroc (S), Manning$^{\Phi}$ (S), ADV08.0008, ADV13.1292
Spring	Scepter$^{\Phi}$ (F), LongReach Lancer$^{\Phi}$ (M), Cutlass$^{\Phi}$ (S), Sunmax$^{\Phi}$ (S), Sunlamb$^{\Phi}$ (S), RGT Zanzibar$^{\Phi}$ (VS), **LongReach Nighthawk$^{\Phi}$ (VS)**

New release in **bold**.
* Very slow (VS), Slow (S), M (Mid), MS (Mid–slow), MF (Mid–fast) and Fast (F).

Results

Phasic development

The optimal flowering period (OFP), whereby yield is maximised and risk of frost, heat and drought is minimised, is mid to late October at Wallendbeen. In 2019, the flowering window spanned from 31 August to 25 October and, despite below average in-crop rainfall and significant heat stress events, the highest yields were achieved when flowering coincided with the OFP (Figure 1). When sown early, faster developing spring types (with minimal response to vernalisation) flowered early and recorded significant yield penalties, even with mild frost conditions (Figure 1). For example, Scepter$^{\Phi}$ sown on 30 April (SD3, closer to its recommended main season sowing window for its given phenology type), flowered on 6 October and recorded 5.01 t/ha. However, when sown early on 27 March (SD1), Scepter$^{\Phi}$ flowered on 31 August, nearly two months earlier than the OFP and had a 70% yield penalty (1.48 t/ha) (figures 1 and 3).

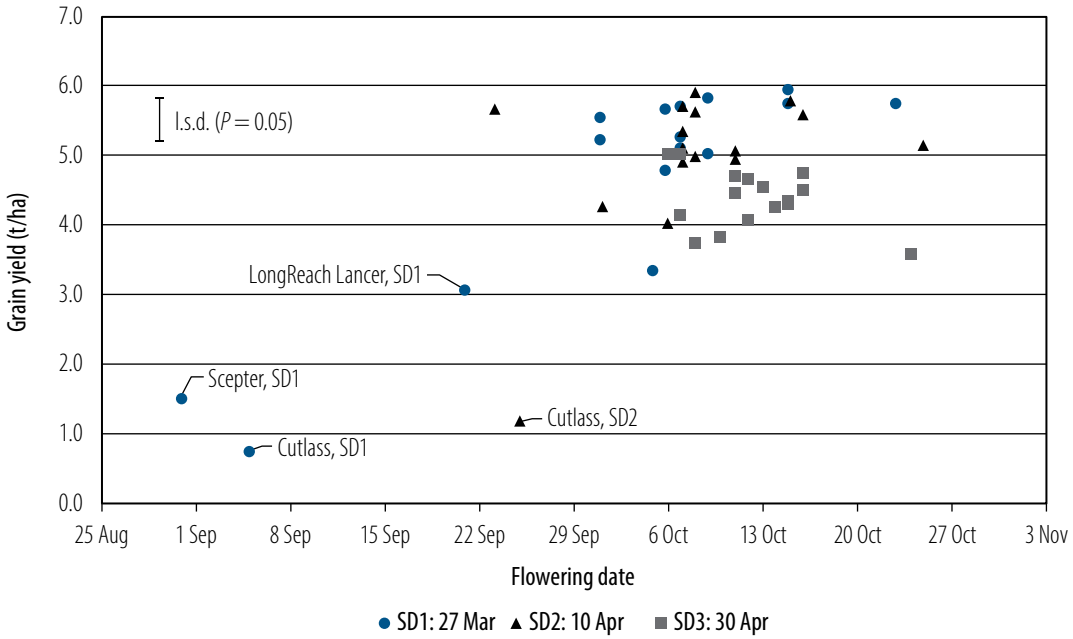


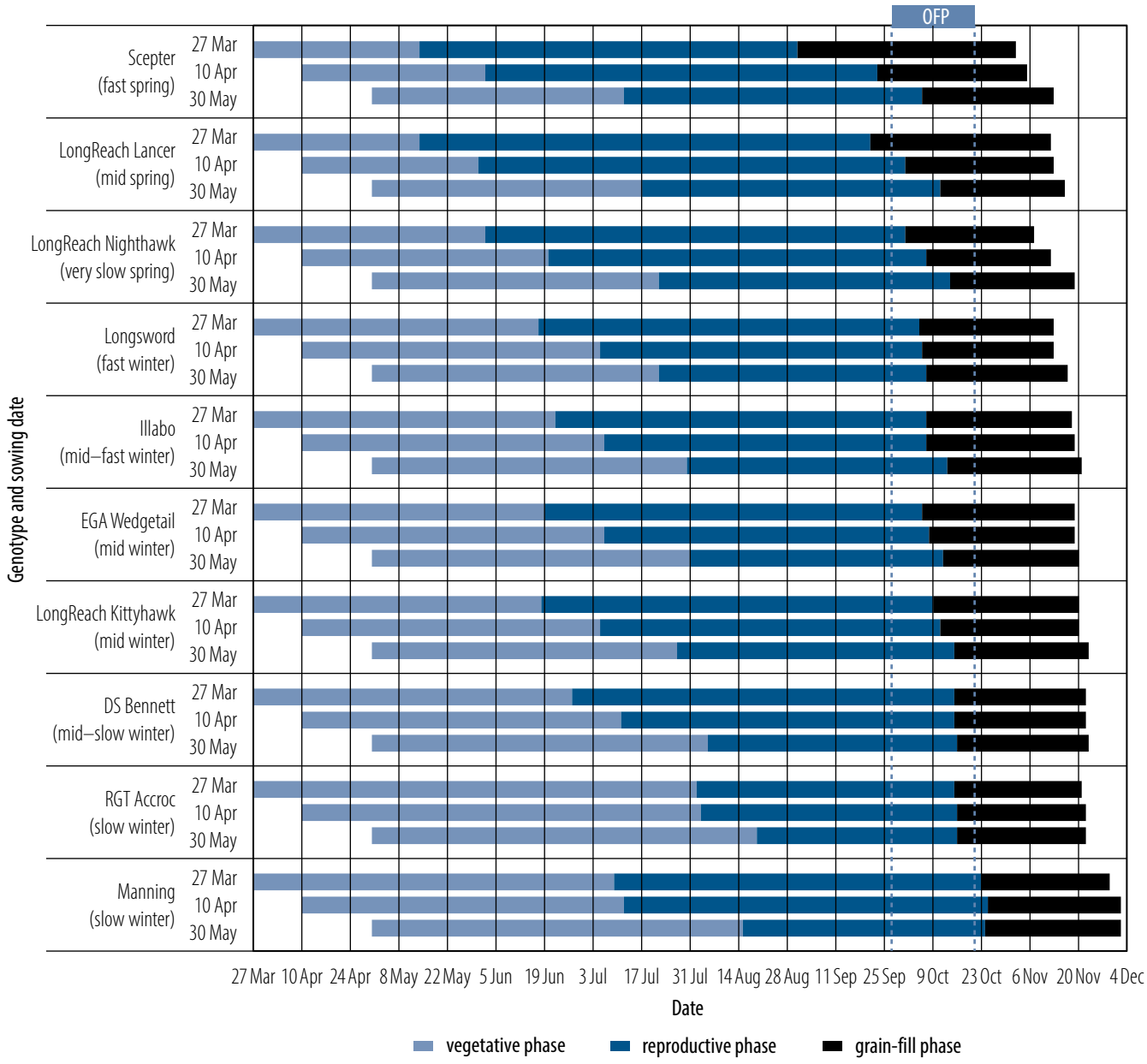
Figure 1 Relationship between flowering date and grain yield for 16 genotypes sown on 27 March (SD1), 10 April (SD2) and 30 April (SD3) at Wallendbeen, 2019.

While many of the slower developing spring and winter genotypes flowered within the OFP, we observed significant variation in phenology and grain yield responses (figures 1and 2).

The newly released LongReach Nighthawk$^{\Phi}$ showed a novel phenology response in 2017–19 field experiments. LongReach Nighthawk$^{\Phi}$, a very slow spring type, can progress quickly to stem elongation when sown early compared with more stable winter types (e.g. 17 days faster than EGA Wedgetail$^{\Phi}$ for SD1, 9 days faster for SD3). However, LongReach Nighthawk$^{\Phi}$ has shown a relatively stable flowering time across sowing dates (Figure 2), and grain yield responses to sowing date similar to mid winter types (Figure 3). This novel phenology response could provide an alternative early sowing option for growers in environments not suited to winter wheats.

In 2019, we observed similar phenology responses in mid winter types Illabo$^{\Phi}$, EGA Wedgetail$^{\Phi}$ and LongReach Kittyhawk$^{\Phi}$, with no significant difference in GS30 date (start of stem elongation) in response to sowing date. Previously, we have observed consistent differences in vegetative phase length among these types, whereby both Illabo$^{\Phi}$ and LongReach Kittyhawk$^{\Phi}$ were faster to GS30 when sown earlier than mid April, despite similar flowering responses (Harris et al., 2018, Harris et al., 2019). We did, however, observe LongReach Kittyhawk$^{\Phi}$ was 3–4 days later to flower across all sowing dates compared with Illabo$^{\Phi}$ and EGA Wedgetail$^{\Phi}$ (Figure 2). The fastest developing winter type, Longsword$^{\Phi}$, also had a similar phenology response to the mid winter types in SD1 and SD2, however, it was significantly faster to stem elongation and flowering than EGA Wedgetail$^{\Phi}$ (7–8 days) in SD3 (Figure 2).

The slow winter types DS Bennett$^{\Phi}$, Manning$^{\Phi}$ and RGT Accroc$^{\Phi}$ were significantly slower to GS30 and flowering than the other winter types. DS Bennett$^{\Phi}$ was consistently 5–8 days slower to stem elongation and flowering than EGA Wedgetail$^{\Phi}$, and had stable flowering dates across the three sowing dates, consistent with results in previous years (Harris et al., 2018; Harris et al., 2019). In 2019, we observed Manning$^{\Phi}$ to be 4–14 days faster to GS30 than RGT Accroc$^{\Phi}$, however, RGT Accroc$^{\Phi}$ flowered and reached physiological maturity 8–9 days quicker than Manning$^{\Phi}$ (Figure 2).



OFP (optimal flowering period) is marked by vertical dashed lines.

Vegetative phase (sowing to GS30); reproductive phase (GS30 to flowering); grain-fill phase (flowering to maturity).

Figure 2 Sowing date influence on phasic development of selected genotypes sown on 27 March (SD1), 10 April (SD2) and 30 April (SD3) at Wallendbeen, 2019.

Grain yield

Generally, winter genotypes achieved consistently high yields from the first two sowing dates, with a significant yield penalty for SD3 when grain-filling coincided with increased heat stress events. However, there were differences in yield responses among the winter types (Figure 3, Table 2), suggesting that there are opportunities for growers to use phenology and sowing date as a management strategy to optimise grain yield. For example, yield responses in the fast winter type Longsword[Φ] is consistent with 2017 and 2018 results (Harris et al., 2018, Harris et al., 2019), that suggest optimal sowing dates from mid April onwards when ungrazed.

The accelerated development, and earlier flowering of faster spring types (e.g. Scepter[Φ]) and spring genotypes (LongReach Lancer[Φ]), resulted in yield penalties of up to 75% in SD1 and SD2 (Figure 3, Table 2). However, when spring types were sown closer to their recommended sowing window (SD3), they were capable of flowering at an optimal time and achieving comparable yields to winter types.

Important note: while all seasons are unique, it is important to consider long-term phenology and yield data to determine varietal responses and adaptation to the growing environment.

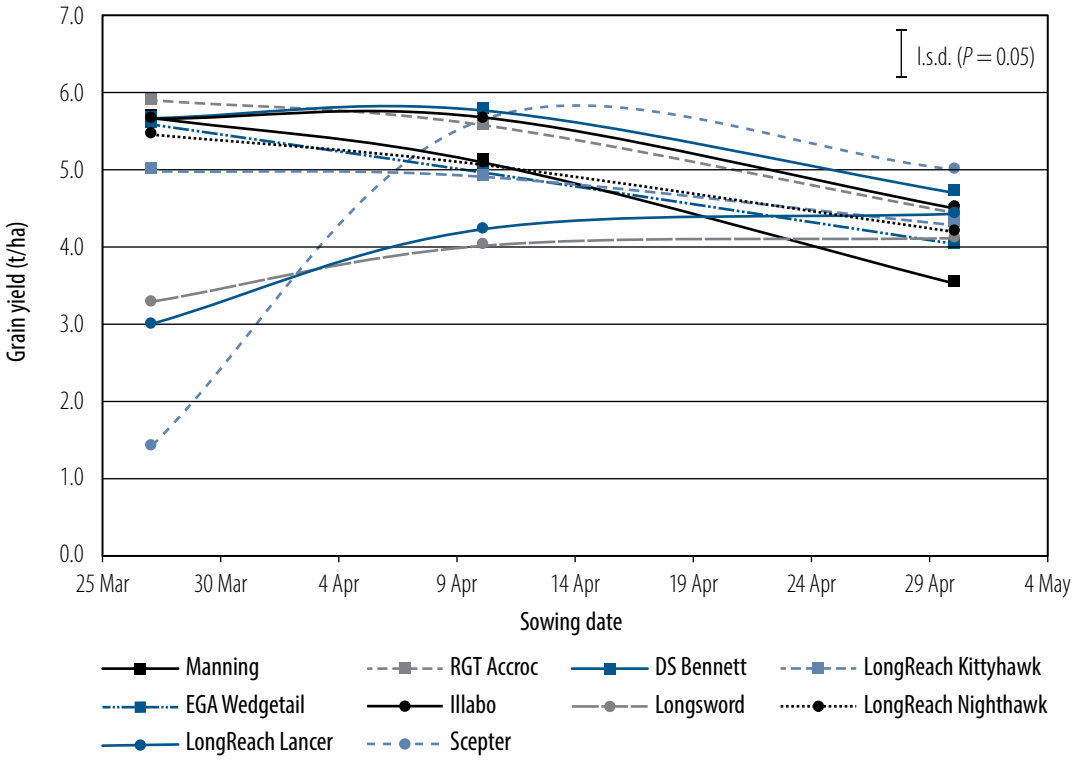


Figure 3 Grain yield responses across three sowing dates: 27 March (SD1), 10 April (SD2) and 30 April (SD3) at Wallendbeen, 2019.

Grain quality

Seasonal conditions had a significant influence on grain quality parameters in 2019 at Wallendbeen (Table 3). All genotypes achieved greater than 11.5% grain protein and, with the exception of Cutlass$^{\Phi}$ and Scepter$^{\Phi}$ (SD1), had test weights >76 kg/hL. All genotype × sowing date combinations recorded high screenings (>5%) (Table 3), which corresponds to a series of severe heat stress events during the grain-filling period (12 days >30 °C).

Table 2 Grain yield of genotypes across three sowing dates at Wallendbeen in 2019.

Genotype	Grain yield (t/ha)		
	SD1: 27 March	SD2: 10 April	SD3: 30 April
ADV08.0008	5.21	5.92	4.65
ADV13.1292	5.79	5.60	4.29
Cutlass	0.68	1.15	5.01
DS Bennett	5.69	5.79	4.72
EGA Wedgetail	5.61	4.98	4.04
Illabo	5.67	5.69	4.52
Longsword	3.30	4.03	4.13
LongReach Kittyhawk	4.99	4.92	4.30
LongReach Lancer	3.01	4.24	4.44
LongReach Nighthawk	5.48	5.09	4.22
Manning	5.70	5.12	3.54
RGT Accroc	5.91	5.59	4.46
RGT Zanzibar	5.07	5.33	4.66
Scepter	1.43	5.66	5.01
Sunlamb	4.72	5.05	3.72
Sunmax	5.18	4.88	3.79
Mean	4.59	4.94	4.34
Mean (Winter)	5.32	5.29	4.29
Mean (Spring)	3.65	4.49	4.41
l.s.d. ($P = 0.05$)			
Genotype	0.37		
SD	0.16		
Genotype × SD	0.63		

*Blue shading indicates genotype x SD are statistically similar and highest yielding.

Summary

While seasonal conditions significantly influenced phenology, grain yield and quality responses to sowing date in 2019, high grain yields were achieved from various genotype × sowing date combinations at Wallendbeen. Winter genotypes were generally stable in their flowering time, yet there were differences in phenology and grain yield responses across sowing dates from late March to late April, suggesting cultivar performance can be manipulated with management (sowing date) and can vary across growing environments.

The faster developing spring genotypes were not suited to very early sowing dates, and suffered severe yield penalties, however, some were able to achieve comparable grain yields when sown later (e.g. Scepter(ɬ) on SD3). The recent release of new winter cultivars (e.g. Illabo(ɬ)) and some novel slower developing spring cultivars (e.g. LongReach Nighthawk(ɬ)) provide increased options for growers for early sowing. These results highlight the opportunity for early sown winter wheats in grain-only systems, as well as the importance of considering phenology when determining genotype and sowing date decisions to achieve flowering at an optimal time and optimum grain yields.

Table 3 Protein (%), screenings % (SCRN) and test weight (kg/hL) (TWT) of genotypes across three sowing dates at Wallendbeen in 2019.

Genotype	SD1: 27 March			SD2: 10 April			SD3: 30 April		
	Protein (%)	TWT (kg/hL)	SCRN (%)	Protein (%)	TWT (kg/hL)	SCRN (%)	Protein (%)	TWT (kg/hL)	SCRN (%)
ADV08.0008	13.7	81.9	8.5	14.4	81.2	15.6	14.7	79.6	12.4
ADV13.1292	13.4	83.6	11.1	13.7	84.1	14.4	13.9	81.4	13.0
Cutlass	14.9	73.2	10.2	16.5	75.2	11.5	13.8	80.1	16.3
DS Bennett	13.1	81.9	10.5	13.0	81.2	15.9	13.4	79.4	17.0
EGA Wedgetail	14.8	79.9	13.3	15.5	81.5	7.2	15.9	76.3	17.6
Illabo	14.0	81.3	9.9	14.5	86.0	14.2	15.3	77.3	10.8
Longsword	16.4	79.4	11.6	16.6	81.3	11.0	15.9	82.0	15.8
LongReach Kittyhawk	13.7	83.6	10.3	13.5	83.1	5.8	14.1	80.7	14.9
LongReach Lancer	16.2	81.1	11.0	15.5	83.8	11.6	14.5	80.1	8.1
LongReach Nighthawk	12.6	83.7	12.5	13.4	83.4	18.2	14.2	81.7	17.9
Manning	12.8	77.2	12.9	12.5	78.2	10.0	13.5	77.7	15.1
RGT Accroc	13.6	80.5	13.4	14.2	80.3	9.6	14.9	78.3	13.2
RGT Zanzibar	12.7	81.0	10.5	13.3	79.9	9.6	13.7	80.2	12.6
Scepter	15.3	74.5	11.7	12.6	82.9	8.7	14.0	79.1	18.7
Sunlamb	14.4	83.3	11.4	14.5	82.6	10.9	15.8	81.9	12.9
Sunmax	13.1	83.6	7.7	14.2	79.8	9.5	16.0	79.2	13.0
l.s.d. ($P = 0.05$)									
Genotype	0.6	8.0	ns						
SD	0.2	3.5	1.5						
Genotype × SD	1.0	13.8	5.9						

References

Harris F, Kanaley H, Copeland C, Maccallum D and Petty H, 2019. Early sowing options: sowing date influence on phenology and grain yield of long-season wheat genotypes – Wallendbeen, 2018; D Slinger, T Moore and C Martin (eds), *Southern NSW research results 2019*, pp. 11–16, NSW Department of Primary Industries.

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