Department of Primary Industries

Wheat phenology and yield responses to sowing time – Harefield 2020

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Key findings

- In the high yielding 2020 season, flowering earlier than the optimal flowering period resulted in significant yield penalties.
- Grain yield responses varied in response to sowing date, and the highest yields occurred when varietal phenology was matched with the recommended sowing windows.
- A key recommendation for growers is to remain disciplined with sowing dates.

Introduction

The 'Optimising yield potential of winter cereals in the northern grains region (NGR)' project has been a GRDC and NSW DPI joint investment under the Grains Agronomy and Pathology Partnership (GAPP) in collaboration with the Queensland Department of Agriculture and Fisheries (QDAF). From 2017–20, field experiments were sown across 10 locations in New South Wales and Queensland where annual rainfall ranged from 184 mm to 853 mm and grain yields ranged from 0.2 t/ha to 10 t/ha. The project aimed to provide a better understanding of wheat phenology and yield responses across different environments to refine sowing recommendations and improve yield stability and profitability of growers in the NGR.

This paper presents results from the Harefield site (southern NSW) in 2020 and discusses the influence of sowing date (SD) on the phenology and grain yield responses of a core set of 36 wheat genotypes.

Site details

Location	Harefield NSW
Soil type	Red chromosol
Previous crop	Canola
Sowing	Direct drilled with DBS tynes spaced at 240 mm using a GPS auto-steer system.
Target plant density	140 plants/m^2.
Soil pH_{Ca}	4.9 (0–10 cm); 5.7 (10–30 cm)
Mineral nitrogen (N)	155 kg N/ha at sowing (1.5 m depth)
Fertiliser	• 92 kg/ha mono-ammonium phosphate (MAP) (sowing). • 42 kg N/ha applied as urea (10 July and 4 August).
Weed control	• **Knockdown**: Weedmaster® DST® (470 g/L glyphosate) 2.5 L/ha, Revolver® (135 g/L paraquat and 115 g/L diquat) 2 L/ha. • **Pre-emergent**: Sakura® (850 g/ka pyroxasulfone) 118 g/ha + Avadex® Xtra (500 g/L tri-allate) 1.6 L/ha + trifluralin (480 g/L) 0.8 L/ha.

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GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

- **In-crop**: LVE MCPA (570 g/L) 600 mL/ha + Paradigm® (200 g/kg halauxifen and 200 g/kg florasulam) 25 g/ha (applied 22 May to SD1 and SD2 only).

Disease and pest management

- **Seed treatment**: Hombre® Ultra (360 g/L imidacloprid and 12.5 g/L tebuconazole) 200 mL/100 kg and Gaucho® 600 (600 g/L imidacloprid)120 mL/100 kg.
- **Fertiliser treatment**: Flutriafol (250 g/L) 400 mL/ha.
- **Foliar fungicide:** Prosaro® 420 SC (210 g/L prothioconazole and 210 g/L tebuconazole) 300 mL/ha 19 June (SD1 and SD2), 3 August, 18 September.

Rainfall In-crop (April–October): 408 mm

Severe temperature events

- No heat stress events (days >30 °C), during the growing season.
- 11 frosts (days <0 °C), including −2.3 (5 August), −2.8 (6 August), −1 (26 August) and −1.1 (28 September).

Harvest date 26 November 2020

Treatments

Genotype

Thirty-six wheat genotypes (Table 1), varying in phenology responses.

Sowing date (SD)

SD1: 6 April

SD2: 21 April

SD3: 6 May

SD4: 19 May

Table 1 Expected phenology responses of the 2020 experiment genotypes.

Phenology type	Genotypes
Winter (W)	Longsword$^{\Phi}$ (Quick), LongReach Kittyhawk$^{\Phi}$ (Mid), EGA Wedgetail$^{\Phi}$ (Mid), DS Bennett$^{\Phi}$ (Mid–slow), RGT Accroc (Slow), Manning$^{\Phi}$ (Slow)
Very slow (VS)	EGA Eaglehawk$^{\Phi}$, RGT Zanzibar, **LongReach Nighthawk**$^{\Phi}$
Slow (S)	Sunmax$^{\Phi}$, Cutlass$^{\Phi}$, Sunlamb$^{\Phi}$
Mid (M)	Mitch$^{\Phi}$, LongReach Lancer$^{\Phi}$, Coolah$^{\Phi}$, DS Pascal$^{\Phi}$, EGA Gregory$^{\Phi}$, LongReach Trojan$^{\Phi}$, **Catapult**$^{\Phi}$, **Rockstar**$^{\Phi}$
Mid–quick (MQ)	Janz, Beckom$^{\Phi}$, Sunvale$^{\Phi}$, Suntop$^{\Phi}$ LongReach Reliant$^{\Phi}$
Quick (Q)	Scepter$^{\Phi}$, Corack$^{\Phi}$, Mace$^{\Phi}$, LongReach Mustang$^{\Phi}$, LongReach Spitfire$^{\Phi}$, Sunprime$^{\Phi}$, **LongReach Hellfire**$^{\Phi}$
Very quick (VQ)	Condo$^{\Phi}$, LongReach Dart$^{\Phi}$, H45$^{\Phi}$, Vixen$^{\Phi}$

New releases in **bold**.

Results

Phasic development

The consistent messages presented from the project to date have centred around synchronising crop development (phenology) with seasonal conditions to ensure that the optimal flowering period (OFP) is matched to the growing environment. In 2020, the flowering window spanned from 8 August to 24 October (Figure 1). Mild temperatures, combined with unlimited soil moisture in autumn–early winter, resulted in optimal conditions for both growth and crop development, and as such many winter and slow spring types were able to meet their vernalisation (cold temperature) requirements very

quickly, progressing to stem elongation and flowering ~7–14 days earlier than recorded in previous years (Harris et al. 2018; 2019; 2020).

Favorable seasonal conditions resulted in high yields across a wide flowering window, and mild spring temperatures meant that there was no significant yield penalty associated with later flowering (in contrast to long-term data). However, there was a significant yield decline when flowering occurred earlier than mid September (Figure 1) associated with some minor frost, that coincided with critical development stages.

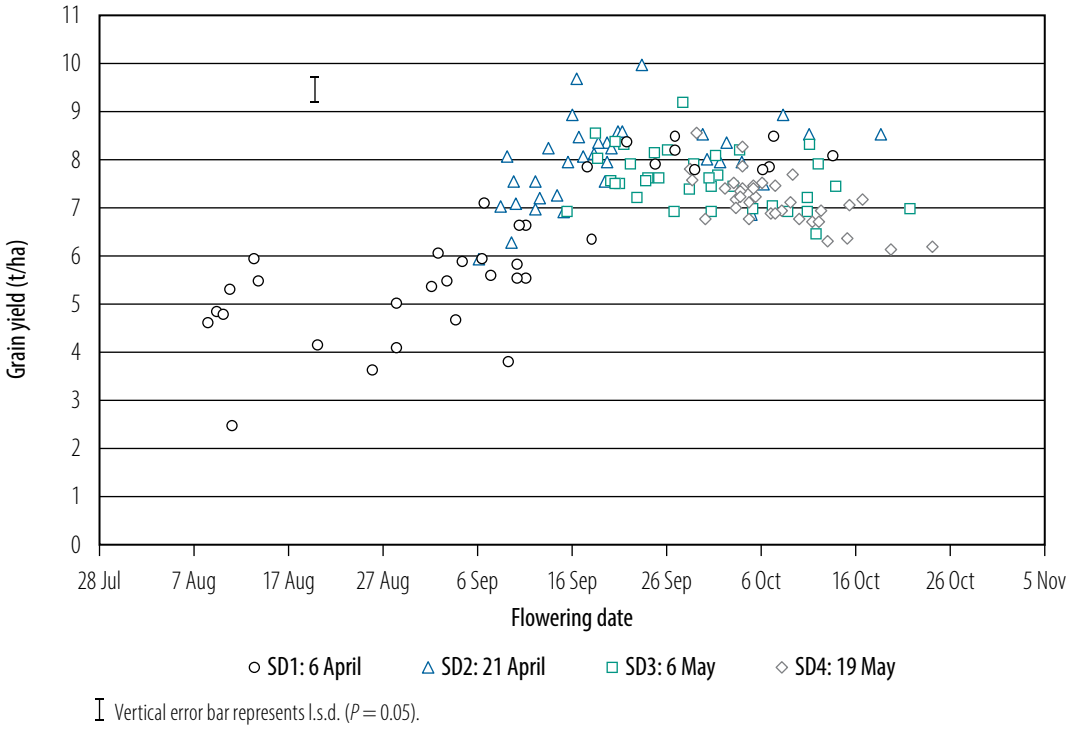

Figure 1 Relationship between flowering date and grain yield for 36 genotypes sown on four dates at Harefield, 2020.

There were significant variations in phenology responses to sowing date amongst spring types from 2017–20. When sown early (when temperatures are warmer and days longer) flowering can be unpredictable and varies substantially across seasons. The earlier flowering dates were recorded in quick developing spring types that progressed quickly when sown on SD1 and SD2, and flowered significantly earlier than the OFP. For example, Vixen$^{\Phi}$ (SD1: 6 April) flowered on 8 August, however, when sown on SD4 (19 May), which aligns with its recommended sowing window, Vixen$^{\Phi}$ flowered on 29 September and within the OFP (Figure 2). The earlier flowering in SD1 also resulted in a 53% yield reduction compared with SD4 (SD1: 4.54 t/ha and SD4: 8.56 t/ha, Table 2). In contrast, the winter types had more stable flowering behaviour across sowing dates despite the earlier flowering dates recorded in 2020 compared with previous years (Harris et al. 2018; 2019; 2020).

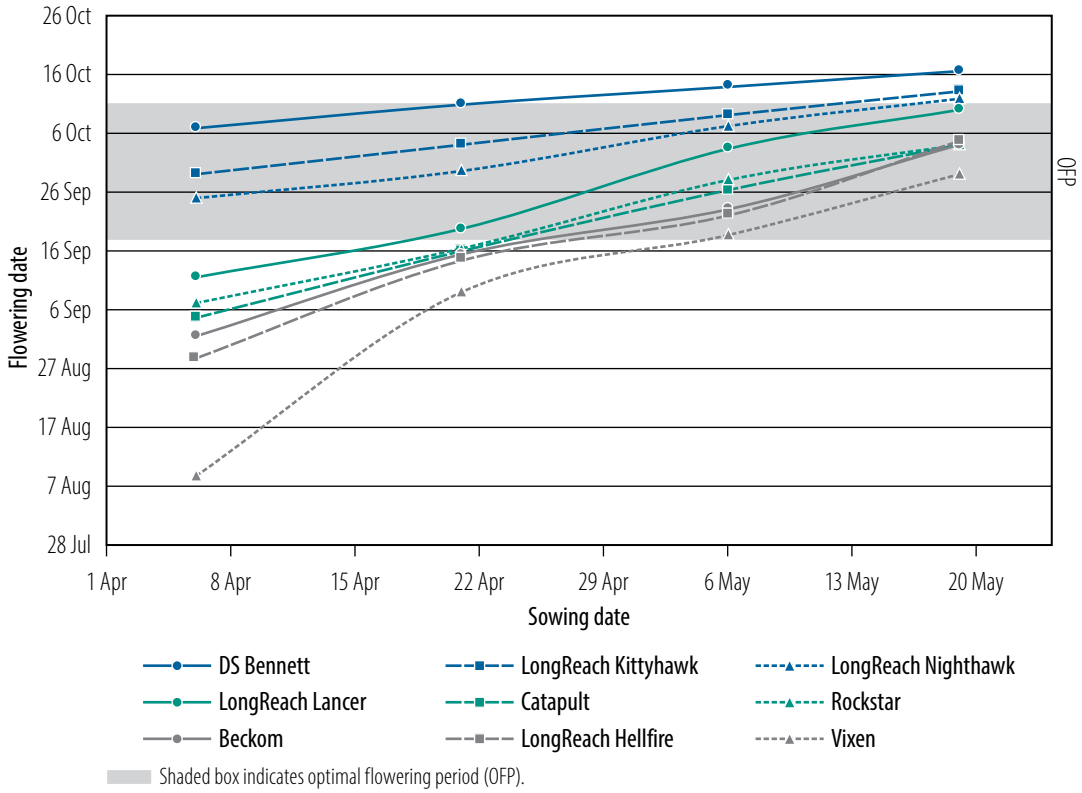

Figure 2 Influence of sowing date on flowering of selected genotypes sown on four dates at Harefield, 2020.

Grain yield

Grain yields and genotype rankings varied significantly across the sowing dates (early April to late May) (Table 2), reinforcing the key project finding that varietal phenology needs to be matched to sowing date. In 2020, slower developing spring types (e.g. RGT Zanzibar, Rockstar(ϕ), Catapult(ϕ)) and some winter types (e.g. RGT Accroc) in SD2 (21 April) achieved the highest grain yields; quick spring types ranked highest in SD2 and SD3 (e.g. Scepter(ϕ), Vixen(ϕ)) (Table 2). While mean yield was reduced when sowing was delayed after early May, there were significant yield penalties when quick developing spring wheats were sown in early April (SD1), associated with rapid development and exposure to frost damage and reduced biomass accumulation in a high yield potential season (Figure 3).

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 growing environment.

Table 2 Grain yield of genotypes across four sowing dates at Harefield, 2020.

Genotype	Grain yield (t/ha) (rank)							
	SD1: 6 April		SD2: 21 April		SD3: 6 May		SD4: 19 May	
Beckom	5.31	(25)	7.96	(23)	8.23	(5)	7.84	(3)
Catapult	5.84	(18)	8.92	(3)	8.16	(7)	7.37	(13)
Condo	4.80	(28)	7.04	(31)	7.99	(10)	7.80	(4)
Coolah	6.60	(12)	8.59	(5)	7.36	(24)	6.94	(25)
Corack	2.43	(36)	6.28	(35)	7.47	(19)	7.57	(6)
Cutlass	3.74	(34)	7.96	(22)	8.25	(4)	7.49	(8)
DS Bennett	7.80	(7)	8.51	(9)	7.38	(23)	7.16	(19)
DS Pascal	6.56	(13)	7.97	(21)	7.59	(14)	7.11	(20)
EGA Eaglehawk	**8.42**	**(1)**	6.89	(34)	6.88	(33)	6.36	(33)
EGA Gregory	5.76	(19)	8.09	(17)	7.35	(25)	7.21	(17)
EGA Wedgetail	8.11	(4)	8.04	(19)	6.95	(29)	6.71	(31)
H45	5.44	(23)	7.09	(30)	7.47	(20)	7.40	(12)
Janz	4.62	(30)	8.12	(16)	7.56	(17)	7.09	(21)
Longsword	6.32	(14)	8.58	(6)	8.01	(9)	7.37	(14)
LongReach Dart	4.74	(29)	5.96	(36)	6.87	(34)	6.77	(28)
LongReach Hellfire	4.02	(33)	7.25	(28)	7.48	(18)	6.76	(29)
LongReach Kittyhawk	7.73	(9)	7.97	(20)	6.85	(35)	6.28	(34)
LongReach Lancer	5.50	(22)	8.34	(13)	7.40	(22)	6.72	(30)
LongReach Mustang	5.25	(26)	7.23	(29)	7.18	(26)	6.99	(23)
LongReach Nighthawk	7.82	(6)	8.55	(7)	6.97	(28)	6.67	(32)
LongReach Reliant	5.41	(24)	6.94	(33)	6.90	(31)	7.31	(15)
LongReach Spitfire	4.08	(32)	7.58	(24)	7.57	(16)	7.16	(18)
LongReach Trojan	5.55	(20)	8.47	(10)	8.11	(8)	7.44	(9)
Mace	3.60	(35)	7.01	(32)	7.85	(11)	7.52	(7)
Manning	8.04	(5)	8.53	(8)	6.94	(30)	6.18	(35)
Mitch	6.01	(15)	8.28	(14)	7.85	(12)	7.42	(10)
RGT Accroc	**8.41**	**(2)**	8.92	(4)	7.84	(13)	7.06	(22)
RGT Zanzibar	7.80	(8)	**10.00**	**(1)**	8.16	(6)	7.69	(5)
Rockstar	7.02	(11)	**9.67**	**(2)**	**9.13**	**(1)**	**8.27**	**(2)**
Scepter	4.96	(27)	8.25	(15)	8.29	(3)	7.41	(11)
Sunlamb	7.72	(10)	7.53	(27)	6.41	(36)	6.15	(36)
Sunmax	**8.31**	**(3)**	8.37	(11)	7.18	(27)	6.94	(24)
Sunprime	5.91	(16)	7.58	(25)	7.43	(21)	7.22	(16)
Suntop	5.91	(17)	8.34	(12)	7.58	(15)	6.88	(27)
Sunvale	5.51	(21)	7.57	(26)	6.90	(32)	6.89	(26)
Vixen	4.54	(31)	8.07	(18)	8.51	(2)	**8.56**	**(1)**
Mean	5.99		7.96		7.56		7.16	
l.s.d. Genotype	0.26							
l.s.d. SD	0.09							
l.s.d. Genotype × SD	0.53							

Yield ranking according to sowing date treatment in parentheses, **bold** text indicates highest yielding treatments.

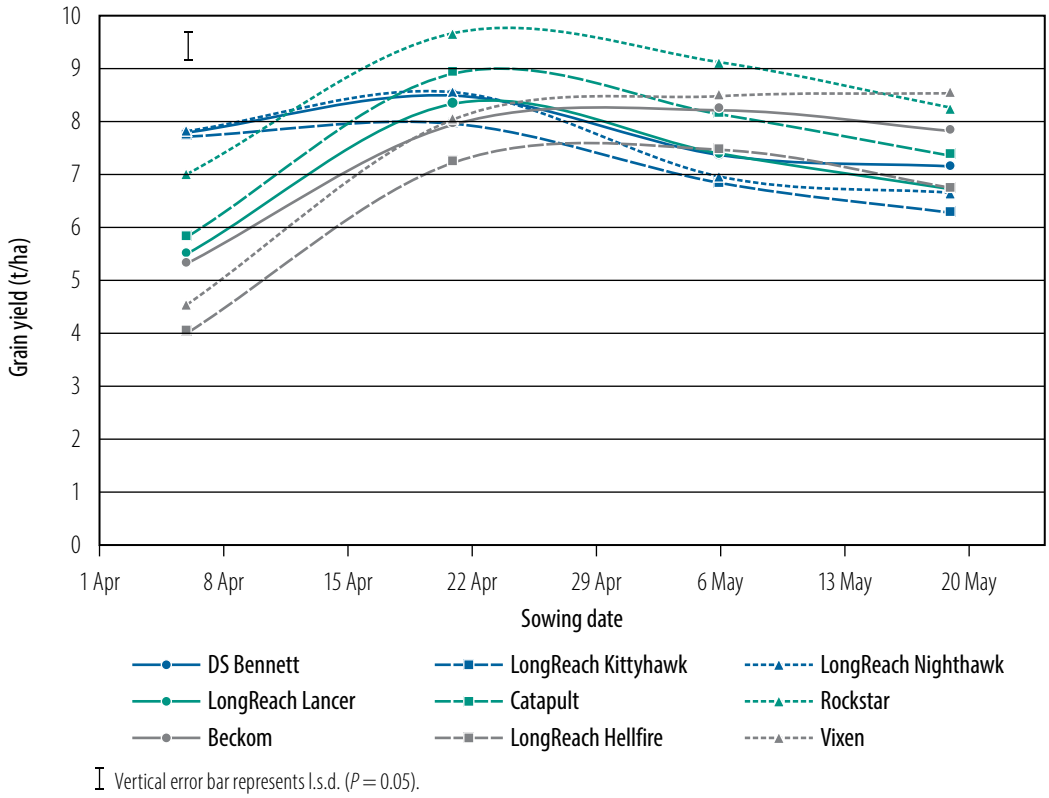

Figure 3 Grain yield of selected genotypes for four sowing dates at Harefield, 2020.

Grain quality

There were significant differences within genotype, sowing date and the interaction between genotype and sowing date on grain quality in 2020 (Table 3). All commercial genotypes achieved greater than 11.5% grain protein in their recommended sowing windows, except for DS Bennett$^{\Phi}$ (Australian Standard White – ASW), Manning$^{\Phi}$ (Australian Feed – FEED), RGT Accroc (FEED) and RGT Zanzibar (FEED), which recorded low grain protein across all sowing dates. Most genotypes achieved a test weight of >76 kg/hL, with the exception of those significantly affected by frost (SD1 Corack$^{\Phi}$, Cutlass$^{\Phi}$, Mace$^{\Phi}$ and Spitfire$^{\Phi}$) and Manning$^{\Phi}$ at the later sowing dates (SD3 and SD4). Generally, most genotype × sowing date combinations recorded low screenings, however RGT Zanzibar recorded high screenings (>5%) across all sowing dates.

Table 3 Grain protein (GP), screenings (SCRN) and test weight (TWT) of genotypes across four sowing dates at Harefield, 2020.

Genotype	SD1: 6 April			SD2: 21 April			SD3: 6 May			SD4: 19 May		
	GP (%)	SCRN (%)	TWT (kg/hL)	GP (%)	SCRN (%)	TWT (kg/hL)	GP (%)	SCRN (%)	TWT (kg/hL)	GP (%)	SCRN (%)	TWT (kg/hL)
Beckom	14.6	1.7	79.1	12.2	1.1	80.5	11.3	2.0	80.1	11.6	2.4	80.7
Catapult	13.8	3.1	79.2	11.6	1.7	81.5	10.8	3.4	81.6	11.9	3.0	80.8
Condo	17.1	2.2	80.1	14.4	2.9	82.9	13.0	2.6	83.5	12.4	4.1	83.7
Coolah	13.2	2.5	79.5	11.4	2.2	79.6	11.2	2.0	80.8	11.8	2.4	80.6
Corack	17.0	3.4	64.5	14.1	1.5	79.6	12.8	1.3	82.1	12.6	1.8	81.8
Cutlass	16.0	2.5	70.9	12.5	1.6	81.4	11.5	2.1	82.3	11.7	1.9	81.9
DS Bennett	8.9	2.8	81.3	9.7	2.8	81.1	9.5	4.7	81.9	10.6	6.3	80.2
DS Pascal	13.7	1.1	77.8	11.8	1.2	80.2	11.4	1.9	80.7	12.2	2.3	81.8
EGA Eaglehawk	11.1	3.3	81.0	11.8	4.2	81.0	11.2	3.4	82.6	12.5	4.0	81.7
EGA Gregory	14.6	2.2	79.5	12.6	1.9	81.5	12.1	2.4	82.5	12.2	2.5	82.4
EGA Wedgetail	12.4	2.2	78.0	12.3	1.8	77.0	12.7	1.7	78.5	12.4	1.9	78.2
H45	14.8	1.3	79.6	12.1	1.2	80.1	11.4	1.5	82.4	11.2	2.1	81.6
Janz	15.4	1.7	77.5	12.5	1.2	79.9	12.2	1.9	81.1	12.4	2.8	80.3
Longsword	14.4	0.7	77.5	12.4	0.7	81.0	11.7	1.4	82.1	12.2	1.4	82.4
LongReach Dart	16.7	2.1	77.3	16.0	1.8	77.2	13.9	1.9	80.7	12.8	4.3	78.7
LongReach Hellfire	17.4	2.4	77.2	15.0	1.5	82.3	13.7	2.6	84.0	14.3	2.4	81.8
LongReach Kittyhawk	10.6	2.8	83.3	11.4	2.4	83.5	12.1	2.6	83.6	12.4	2.3	83.7
LongReach Lancer	15.5	2.2	75.8	13.2	2.0	80.8	13.0	2.0	82.8	12.9	2.1	82.5
LongReach Mustang	14.3	2.8	78.8	13.7	2.4	78.7	12.6	4.1	80.4	12.0	4.1	81.7
LongReach Nighthawk	11.6	1.6	81.2	11.4	1.4	82.2	11.3	2.3	82.7	11.2	1.8	83.1
LongReach Reliant	15.2	2.8	77.2	13.0	3.5	80.7	12.0	3.9	81.4	11.8	3.3	83.4
LongReach Spitfire	17.3	2.5	74.8	15.0	2.4	81.4	13.3	3.2	84.0	13.4	3.0	82.5
LongReach Trojan	14.6	1.3	79.2	12.0	1.2	81.4	11.8	2.4	82.1	11.8	2.6	82.3
Mace	17.3	2.3	70.4	13.5	1.1	80.1	12.4	1.8	81.3	12.4	2.6	80.1
Manning	9.4	3.9	78.3	10.1	4.1	77.9	10.7	6.1	75.2	12.0	8.3	72.3
Mitch	13.9	2.1	81.4	11.3	2.0	79.5	10.5	2.1	80.7	10.8	2.1	80.9
RGT Accroc	10.5	2.0	78.5	10.5	2.0	79.1	11.3	2.2	78.4	11.2	2.9	76.8
RGT Zanzibar	11.5	10.7	78.8	11.2	7.1	79.6	11.4	5.2	81.5	11.4	5.4	81.6
Rockstar	13.7	3.0	77.3	11.6	2.1	81.7	11.0	3.0	81.3	11.2	2.8	79.8
Scepter	15.3	3.0	77.2	12.4	2.0	81.5	11.7	2.2	82.8	11.6	3.1	81.2
Sunlamb	12.1	5.1	78.4	12.4	4.0	79.7	13.0	4.9	80.9	13.0	4.7	81.1
Sunmax	11.0	4.4	79.3	11.8	5.3	79.1	11.4	5.6	80.1	12.2	5.5	80.0
Sunprime	14.7	1.7	79.5	13.0	2.3	80.1	12.4	3.1	80.4	12.2	3.4	80.8
Suntop	14.2	2.7	80.2	12.2	1.9	81.2	11.9	2.1	82.3	12.2	2.9	81.9
Sunvale	15.3	1.3	78.0	13.2	1.0	80.8	12.9	1.5	82.5	13.1	1.4	83.6
Vixen	17.4	2.0	75.7	13.7	1.9	79.6	12.3	1.8	81.4	11.7	3.1	80.8
Mean	14.1	2.7	77.9	12.5	2.3	80.4	11.9	2.7	81.5	12.1	3.1	81.1
l.s.d. Genotype	0.3	0.4	1.1									
l.s.d. SD	0.1	0.1	0.4									
l.s.d. Genotype × SD	0.6	0.8	2.2									

Summary

Seasonal conditions significantly influenced phenology, yield and grain quality responses to sowing date in 2020. Mild temperatures, combined with unlimited soil moisture throughout the growing season provided optimal conditions for crop development and growth, resulting in a very high yield potential and some varied phenology responses. While vernalisation responsive winter types flowered ~7–14 days earlier than recorded in previous years, they were still able to flower within the OFP. Quick developing spring types sown in early April suffered significant yield penalties as critical development stages coincided with frosts in August. These results reinforce the key phenology findings and highlight the importance for growers to consider long-term responses when determining cultivar selection and sowing time decisions.

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