# Effect of sowing date on phenology and grain yield of 19 bread wheat and five durum cultivars – Tamworth 2016

Rick Graham, Stephen Morphett, Michael Dal Santo and Neroli Graham
NSW DPI, Tamworth

## Key findings

- Cooler spring temperatures and excellent plant available soil moisture, favoured the yield potential of longer season and mid maturing wheat varieties in 2016.
- The mid–late and mid-season bread wheat varieties Suntime$^{\Phi}$, LRPB Flanker$^{\Phi}$, Suntop$^{\Phi}$, Beckom$^{\Phi}$, Mitch$^{\Phi}$ and EGA Gregory$^{\Phi}$ all performed well from an April 27 sowing date (SD1) with yields >6.5 t/ha. The new long-season spring type Sunmax$^{\Phi}$, likewise achieved ~6.5 t/ha.
- The longer season bread wheat varieties LRPB Kittyhawk$^{\Phi}$ and Sunlamb$^{\Phi}$ also demonstrated their yield potential, achieving yields >6 t/ha for SD1.
- Varieties that performed well across the three sowing dates included EGA Gregory$^{\Phi}$, Mitch$^{\Phi}$, LRPB Flanker$^{\Phi}$, Suntop$^{\Phi}$ and Beckom$^{\Phi}$.
- The new mid-fast season variety LRPB Reliant$^{\Phi}$ yielded well from a main season and delayed sowing date.
- Warm autumn temperatures resulted in many spring wheat entries, particularly the more temperature responsive cultivars, reaching anthesis faster (days from effective SD to anthesis) for SD1 compared with SD2. LRPB Lancer$^{\Phi}$ for example was ~9 days faster to reach anthesis for SD1 vs SD2.
- The advanced durum line AGT D043 performed well, achieving yields comparable to the best performing durum DBA Aurora$^{\Phi}$ and bread wheats from a main season sowing date.

## Introduction

The autumn break and subsequent sowing window in Northern NSW can occur anytime between March and June, with the reliability of the break often more inconsistent compared with Southern NSW. Increasingly, varieties with large differences in maturity have been released by breeding programs. These vary in phenology from slow developing winter types, to fast developing spring varieties. These varietal phenology differences enable late-maturing varieties (winter and slow spring types) to be sown when the break is early, and earlier maturing varieties such as fast spring types, to be sown when there is a late break which, when coupled with no-till farming systems, has increased the length of sowing opportunities.

The combination of phenology and sowing date (SD) determines the probable timing of environmental stresses (frost and heat stress) at key developmental stages, such as anthesis and during the critical post-flowering grain-fill period. The optimum flowering window is considered an agronomic compromise between avoiding excessive yield loss due to frost and ensuring that flowering occurs early enough to enable a long grain-fill period, before heat and moisture stress restrict yield potential.

Variety response to SD experiments help to determine how new varieties compare in maturity and yield with existing varieties across the sowing window at a regional level. This provides data to better inform growers about varietal response to SD options and therefore to better match variety with SD. Overtime, these experiments provide greater confidence in varietal performance estimates and flowering behaviour.

This experiment reports the effect of three sowing dates on the timing of anthesis, grain yield and grain quality parameters for a range of commercially available and advanced bread wheat and durum varieties.

## Site details

| | |
|---|---|
| Location | Tamworth Agricultural Institute |
| Soil type | Brown vertosol |
| Previous crop | Sorghum, long fallowed |
| Sowing | Direct drilled using twin disc openers on 33 cm row spacing. |
| Starting nitrogen | Soil nitrate N was approximately 91 kg N/ha (0–120 cm) |

| | |
|---|---|
| In-crop rainfall | 550 mm (May to October) |
| Irrigation | 15 mm applied 28 April to establish first SD only |
| Trial design | A fully factorial, three replicated, split plot design, with four sowing dates. |
| Fertiliser | 60 kg/ha Granulock Z extra and 195 kg urea (90 kg N/ha) side banded at planting. |
| Harvest date (HD) | HD1 and HD 2: 30 November 2016<br>HD3: 14 December<br>HD4: 18 December |

## Treatments

### Varieties (24)

Nineteen bread wheat and five durum cultivars commercially available or advanced breeders' lines (Table 1).

### Sowing date (SD)

SD1: 27 April 2016
SD2: 17 May (Effective 27 May)
SD3: 17 June
SD4: 29 July

### Plant populations (PP)

Targeting 100 plants/$m^2$

## Results

### Seasonal overview

Although growing season rainfall (May to October) was 550 mm (90 percentile range), with record monthly rainfall totals for June and September recorded, early sowing conditions were less than ideal. Total rainfall received, March to April inclusive, was 28 mm, with only 4.8 mm received in April. As a consequence SD1 on the 27 April was dry sown and received a post sowing irrigation of ~15 mm, using a low pressure dripper system to encourage establishment.

In contrast, SD2 was dry sown on the 17 May but did not receive a post sowing irrigation, which meant that its effective sowing date was the 27 May, the date when in-crop rain was received.

SD3 on 17 June was compromised by waterlogged conditions, receiving over 80 mm in the 72-hour period immediately post sowing. This resulted in an average plant establishment of only 53 plants/$m^2$, a 55% reduction in establishment, compared with SD1, SD2 and SD4 with ~95 plants/$m^2$. As a consequence, results from SD3 are not presented.

### Phenological response to sowing date

The warm autumn temperatures resulted in many spring wheat entries, particularly temperature-responsive cultivars, reaching anthesis faster (days from effective SD to anthesis) in SD1 compared with SD2 (Table 1). Conversely, the cooler spring temperatures appeared to extend the days to flowering for many of these varieties with delayed sowing (SD2).

The phenological differences between the durum varieties evaluated were comparatively small compared with the bread wheat entries. Of the durum lines evaluated (SD1), the advanced breeder's line 190873 was approximately 9–11 days faster to reach anthesis compared with the other cultivars evaluated (113 days vs. 122–124 days; Table 1). This difference in developmental maturity was largely maintained for SD2 (117 days vs. 125–127 days), with all durum varieties flowering within two days of each other at the delayed SD4 on 29 July (89 vs. 99 days).

Table 1. Grain yield and days to anthesis for 23* wheat lines sown over three sowing dates – Tamworth 2016.

| Variety | Sowing date | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 27 April | | | 27 May | | | 29 July | | |
| | Grain yield (t/ha) | Yield rank | Days to anthesis | Grain yield (t/ha) | Yield rank | Days to anthesis | Grain yield (t/ha) | Yield rank | Days to anthesis |
| Beckom | 6.60 | 4 | 114 | 6.11 | 7 | 117 | 4.55 | 9 | 96 |
| EGA Gregory | 6.59 | 6 | 123 | 6.17 | 4 | 125 | 5.24 | 1 | 96 |
| LRPB Dart | 5.09 | 19 | 104 | 5.31 | 18 | 110 | 4.39 | 11 | 85 |
| LRPB Flanker | 6.73 | 2 | 123 | 6.03 | 8 | 125 | 4.80 | 4 | 96 |
| LRPB Gauntlet | 5.65 | 16 | 119 | 4.99 | 20 | 122 | 3.65 | 22 | 96 |
| LRPB Kittyhawk | 6.40 | 8 | 142 | 5.45 | 16 | 139 | 3.60 | 23 | 106 |
| LRPB Lancer | 5.77 | 14 | 123 | 5.40 | 17 | 132 | 4.37 | 12 | 99 |
| LRPB Reliant | 5.94 | 11 | 118 | 5.97 | 9 | 117 | 4.88 | 3 | 91 |
| LRPB Spitfire | 5.75 | 15 | 115 | 5.95 | 10 | 118 | 3.65 | 21 | 91 |
| LRPB12-0494 | 5.97 | 10 | 114 | 5.87 | 14 | 117 | 4.62 | 6 | 91 |
| Mitch | 6.60 | 5 | 123 | 6.28 | 3 | 127 | 4.92 | 2 | 96 |
| Sunguard | 5.48 | 18 | 122 | 5.31 | 19 | 123 | 3.67 | 19 | 96 |
| Sunlamb | 6.17 | 9 | 147 | 5.88 | 13 | 145 | 4.59 | 7 | 99 |
| Sunmate | 5.85 | 13 | 107 | 5.89 | 12 | 117 | 4.09 | 17 | 91 |
| Sunmax | 6.49 | 7 | 145 | 6.38 | 1 | 141 | 4.36 | 13 | 99 |
| Suntime | 6.77 | 1 | 129 | 5.92 | 11 | 134 | 4.28 | 15 | 99 |
| Suntop | 6.69 | 3 | 115 | 6.29 | 2 | 123 | 4.65 | 5 | 91 |
| SUN 760B | 5.00 | 20 | 106 | 5.83 | 15 | 115 | 4.29 | 14 | 89 |
| 190873** | 4.12 | 21 | 113 | 4.87 | 21 | 117 | 3.67 | 20 | 89 |
| AGT D043** | 5.92 | 12 | 124 | 6.11 | 6 | 125 | 4.56 | 8 | 91 |
| Caparoi** | 3.55 | 22 | 123 | 4.35 | 23 | 125 | 4.20 | 16 | 91 |
| DBA Aurora** | 5.62 | 17 | 122 | 6.13 | 5 | 125 | 4.41 | 10 | 91 |
| DBA Lillaroi** | 3.36 | 23 | 123 | 4.45 | 22 | 127 | 4.09 | 18 | 91 |
| l.s.d Grain yield ($P = 0.05$) = 0.66 t/ha | | | | | | | | | |

* One advanced bread wheat line was excluded from the data set.

** Denotes durum wheat entries

In contrast to the durum wheats, there were much greater differences in the phenological responses to SD in the bread wheats. This was particularly pronounced when comparing the fast maturing spring variety LRPB Dart$^{\phi}$ with the newly-released APH classified winter wheat LRPB Kittyhawk$^{\phi}$. When sown on the April 27 (SD1), LRPB Dart$^{\phi}$ reached anthesis on 18 August, compared with 26 September for LRPB Kittyhawk$^{\phi}$, a difference of 39 days. This highlights the differences in phenology of the bread wheat varieties now available to growers, that is, a fast spring wheat, with minimal response to vernalisation (e.g. LRPB Dart$^{\phi}$) compared with a winter wheat that has a defined vernalisation requirement (e.g. LRPB Kittyhawk$^{\phi}$).

Apart from winter types, northern NSW growers also have available to them APH-classified slow spring types such as Sunmax$^{\phi}$. When looking at response to sowing date from a 27 April planting (SD1), Sunmax$^{\phi}$ reached anthesis in ~145 days (29 September) compared with ~123 days (September 7) for both EGA Gregory$^{\phi}$ and LRPB Lancer$^{\phi}$.

Interestingly, when looking at differences in days to reach anthesis with a delayed sowing (SD1 vs. SD2), LRPB Lancer$^{\phi}$ took seven days longer to reach anthesis from SD2 (132 days) compared with EGA Gregory$^{\phi}$ (125 days). This highlights the accelerated maturity of LRPB Lancer$^{\phi}$ due to its responsiveness to temperature compared with EGA Gregory$^{\phi}$. Other bread wheat entries that showed accelerated development (days to reach anthesis) in response to temperature: >6 days: (SD1 vs. SD2), included Suntop$^{\phi}$, Sunmate$^{\phi}$ and LRPB Dart$^{\phi}$ (Table 1). Suntime$^{\phi}$, a longer season spring type, also appeared to respond to the warmer

autumn/winter temperatures, and although six days later to reach anthesis compared with EGA Gregory$^{\phi}$ at SD1, was nine days later to flower at SD2.

Varieties that were not as responsive to temperature, that is, did not differ greatly in days to reach anthesis (SD1 vs. SD2), included LRPB Reliant$^{\phi}$, EGA Gregory$^{\phi}$, LRPB Flanker$^{\phi}$ and LRPB Gauntlet$^{\phi}$.

These results highlight the influence of seasonal conditions on wheat phenology, and underscore the importance of sowing date experiments.

## Grain yield

The cooler spring temperatures and excellent plant-available soil moisture, generally favoured higher yield potential in the longer season, and mid maturing bread wheat cultivars.

The delayed SD2 (27 May) did not incur a yield penalty, which is often associated with delayed flowering (Figure 1). There was no significant difference ($P$<0.001) in the mean grain yield of SD1 and SD2 (5.69 t/ha vs. 5.67 t/ha).

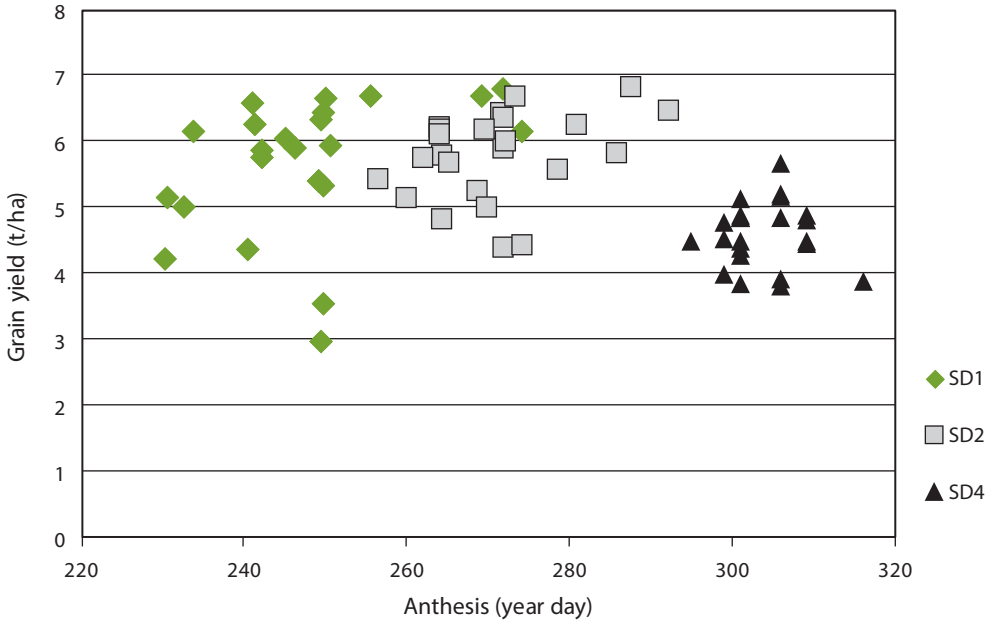


Figure 1. Year day of anthesis and grain yield for 24 wheat entries sown at three sowing dates – Tamworth 2016.

Despite SD4 (29 July) being extremely late, the mean yield was still 4.33 t/ha, a further reflection of the atypical growing season experienced at this site in 2016. It was also observed that despite the late SD, none of the faster maturing spring types were able to achieve significant yield advantages over the mid maturing varieties.

Mid-season and mid-late varieties namely Suntime$^{\phi}$, LRPB Flanker$^{\phi}$, Suntop$^{\phi}$, Beckom$^{\phi}$, Mitch$^{\phi}$, and EGA Gregory$^{\phi}$ all performed well from SD1, with yields >6.5 t/ha (Table 1).

Despite the 27 April (SD1) being towards the end of the preferred sowing window for the longer season varieties Sunmax$^{\phi}$, LRPB Kittyhawk$^{\phi}$ and Sunlamb$^{\phi}$, these varieties still demonstrated their yield potential, all achieving yields greater than 6.0 t/ha (Table 1).

The risk associated with sowing a fast-maturing line early was highlighted when comparing the yield of the breeder's line SUN760B, a fast spring type sown well outside its preferred sowing window (SD1), compared with the more favourable window of SD2. There was a yield loss of ~14% from SD1 vs. SD2 or 5.00 t/ha vs. 5.83 t/ha respectively. Similarly, the mid-fast maturing advanced durum line 190873 experienced a significant (P<0.001) yield decline of 0.75 t/ha (~15%) for SD1 compared with SD2 (4.12 t/ha vs. 4.87 t/ha), most likely due to frost-induced sterility.

Varieties that performed well across SDs included EGA Gregory$^{\Phi}$, Mitch$^{\Phi}$, LRPB Flanker$^{\Phi}$, Suntop$^{\Phi}$ and Beckom$^{\Phi}$. The new mid season variety LRPB Reliant$^{\Phi}$ also did well, particularly from a main season sowing (SD2) and demonstrated good yield potential from a delayed sowing (SD4), increasing its ranking relative to other varieties (Table 1).

The mid maturing durum variety DBA Aurora$^{\Phi}$ performed well from early (SD1, 27 April) and main season (SD2, effective 27 May) sowings, with yields of 5.62 t/ha and 6.13 t/ha respectively. This experiment also highlighted the yield potential of the advanced durum line AGT D043, which achieved yields of 5.92 t/ha and 6.11 t/ha from SD1 and SD2 respectively, and was comparable to the best performing bread wheat entries from a main season sowing (SD2; Table 1).

## Grain quality

Although not discussed in detail, grain protein concentration (%), screenings (% grain above 2 mm slotted screen), test weight (kg/hL) and thousand grain weight (TGW) are presented in Table 2.

Table 2. Grain quality parameters for 23* wheat lines sown over three sowing dates – Tamworth 2016.

| Variety | Sowing date | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 27 April | | | | 27 May | | | | 29 July | | | |
| | Grain protein (%) | Screening (%) | TGW# (g) | Test weight (hl/kg) | Grain protein (%) | Screening (%) | TGW# (g) | Test weight (hl/kg) | Grain protein (%) | Screening (%) | TGW# (g) | Test Weight (hl/kg) |
| Beckom | 10.9 | 0.8 | 37.0 | 81.3 | 11.0 | 1.5 | 35.7 | 83.3 | 12.5 | 2.0 | 33.0 | 76.7 |
| EGA Gregory | 11.4 | 0.8 | 45.2 | 83.6 | 11.4 | 1.8 | 44.0 | 84.5 | 11.8 | 1.0 | 38.3 | 78.6 |
| LRPB Dart | 12.8 | 1.6 | 39.8 | 79.8 | 12.5 | 2.6 | 38.8 | 81.0 | 12.8 | 3.8 | 33.8 | 70.4 |
| LRPB Flanker | 10.6 | 0.7 | 44.9 | 83.4 | 11.2 | 1.7 | 44.6 | 84.7 | 11.9 | 1.2 | 38.1 | 79.3 |
| LRPB Gauntlet | 11.1 | 1.2 | 43.0 | 81.7 | 12.2 | 2.4 | 42.4 | 82.1 | 13.3 | 1.1 | 37.4 | 79.0 |
| LRPB Kittyhawk | 10.7 | 2.3 | 39.3 | 84.9 | 11.7 | 1.4 | 42.8 | 80.8 | 13.3 | 8.4 | 26.8 | 72.0 |
| LRPB Lancer | 11.7 | 1.1 | 42.0 | 82.7 | 12.2 | 1.5 | 39.8 | 83.4 | 13.8 | 0.9 | 35.8 | 78.6 |
| LRPB Reliant | 11.5 | 1.5 | 44.9 | 82.6 | 11.5 | 2.6 | 44.9 | 83.7 | 11.7 | 1.3 | 40.7 | 79.4 |
| LRPB Spitfire | 13.1 | 0.7 | 47.9 | 82.3 | 12.8 | 1.6 | 44.1 | 83.3 | 14.1 | 2.4 | 40.5 | 77.4 |
| LRPB12-0494 | 11.3 | 1.4 | 40.2 | 80.9 | 11.7 | 2.6 | 42.4 | 82.0 | 12.4 | 1.6 | 38.6 | 77.9 |
| Mitch | 10.3 | 0.9 | 46.2 | 81.3 | 10.4 | 1.3 | 46.2 | 82.4 | 11.3 | 1.1 | 38.4 | 77.5 |
| Sunguard | 11.5 | 1.2 | 40.2 | 81.7 | 12.2 | 2.7 | 38.2 | 81.4 | 13.1 | 2.9 | 32.1 | 78.1 |
| Sunlamb | 10.4 | 5.7 | 33.1 | 81.2 | 11.8 | 5.3 | 32.8 | 74.0 | 13.3 | 4.0 | 29.7 | 74.4 |
| Sunmate | 11.7 | 2.0 | 43.3 | 79.8 | 11.6 | 2.3 | 43.2 | 81.9 | 12.5 | 1.1 | 41.6 | 76.5 |
| Sunmax | 9.9 | 3.2 | 37.9 | 83.2 | 11.2 | 2.0 | 41.2 | 80.7 | 13.5 | 1.6 | 39.3 | 77.0 |
| Suntime | 10.9 | 1.8 | 39.2 | 83.1 | 11.4 | 1.8 | 38.9 | 82.9 | 13.3 | 2.5 | 34.5 | 78.1 |
| Suntop | 11.0 | 1.7 | 40.4 | 82.3 | 11.4 | 1.8 | 40.4 | 83.2 | 12.5 | 1.5 | 38.7 | 78.8 |
| SUN 760B | 12.5 | 0.9 | 42.7 | 78.6 | 12.4 | 1.1 | 45.1 | 81.6 | 13.5 | 0.7 | 40.1 | 74.5 |
| 190873** | 13.2 | 0.7 | 53.7 | 80.5 | 13.0 | 0.8 | 53.0 | 81.7 | 13.2 | 0.4 | 47.3 | 73.5 |
| AGT D043** | 11.4 | 0.8 | 50.7 | 83.5 | 11.3 | 1.2 | 53.4 | 84.9 | 12.1 | 0.8 | 45.2 | 77.0 |
| Caparoi** | 14.6 | 0.5 | 55.9 | 80.9 | 13.7 | 0.7 | 57.8 | 82.1 | 13.2 | 0.3 | 48.4 | 74.1 |
| DBA Aurora** | 12.0 | 0.9 | 54.9 | 81.5 | 11.6 | 1.3 | 56.3 | 83.2 | 12.3 | 0.9 | 42.9 | 72.8 |
| DBA Lillaroi** | 14.9 | 0.4 | 55.4 | 80.0 | 14.2 | 0.5 | 57.0 | 80.4 | 13.0 | 0.3 | 49.7 | 75.7 |
| l.s.d Grain protein ($P = 0.05$) = 0.5 | | | | | | | | | | | | |
| l.s.d Screenings ($P = 0.05$) = 0.1 | | | | | | | | | | | | |
| l.s.d TGW*** ($P = 0.05$) = 2.3 | | | | | | | | | | | | |
| l.s.d Test weight ($P = 0.05$) = 1.8 | | | | | | | | | | | | |

* One advanced bread wheat line was excluded from the data set.

** Denotes durum wheat entries

# TGW – thousand grain weight

As a consequence of the high yields achieved, grain protein concentration (GPC) results were comparatively low, due in part to the yield dilution response, (i.e. GPC declining with increasing yields). A number of varieties (e.g. Mitch$^{\Phi}$) did have difficulties achieving 12% GPC for SD1 and SD2, while there also appears to be some evidence of varietal differences in terms of GPC achievement, as indicated by the differences between varieties at comparable yields (Table 2).

Screenings for all varieties with the exception of LRPB Kittyhawk$^{\Phi}$ for SD4 and Sunlamb$^{\Phi}$ for SD1 and SD2 were below the 5% receival standards, again reflecting the favourable and extended grain filling conditions at this site in 2016.

Most varieties were able achieve the minimum test weight receival standard of 76 kg/hl, with test weight as expected tending to be an issue only for some varieties in the delayed SD4.

Grain size expressed as TGW (g/1000 seeds) was generally excellent, with most bread wheats around 40 g/1000 seeds for SD1 and SD2, and the durum wheats around 50 g/1000 seeds.

Differences in screenings (%) and/or TGW between varieties could indicate an increased potential for downgrading due to screenings under less favourable conditions.

## Conclusions

There was no significant yield penalty for delayed sowing between SD1 vs. SD2, with the mean grain yields of 5.69 t/ha and 5.67 t/ha achieved.,Yields of >4 t/ha averaged across varieties were achieved from a late sowing on 29 July (SD4), a further indication of the atypical growing conditions experienced at this site in 2016.

Long season varieties that performed well at this site in 2016 included the new slow-maturity spring wheat Sunmax$^{\Phi}$, the winter type LRPB Kittyhawk$^{\Phi}$ and the dual purpose variety Sunlamb$^{\Phi}$, all achieving yields of >6 t/ha from the end of their optimum sowing window (27 April, SD1). Mid-late and mid season varieties, namely Suntime$^{\Phi}$, LRPB Flanker$^{\Phi}$, Suntop$^{\Phi}$, Beckom$^{\Phi}$, Mitch$^{\Phi}$ and EGA Gregory$^{\Phi}$, all yielded well from SD1, with yields >6.5 t/ha.

Varieties that performed well across sowing dates included EGA Gregory$^{\Phi}$, Mitch$^{\Phi}$, LRPB Flanker$^{\Phi}$, Suntop$^{\Phi}$ and Beckom$^{\Phi}$, with the new mid fast season variety LRPB Reliant$^{\Phi}$ performing well, particularly from a main season sowing (SD2), and demonstrating good yield potential from a delayed sowing (SD4).

Of the durum lines evaluated, the mid maturing durum variety DBA Aurora$^{\Phi}$ yielded well from early (SD1, 27 April) and main season (SD2, effective 27 May) sowings, with yields of 5.62 t/ha and 6.13 t/ha respectively. The advanced durum line AGT D043 also showed promising yield potential, achieving yields of 5.92 t/ha and 6.11 t/ha respectively for SD1 and SD2, comparable with the best performing bread wheat entries from a main season (SD2) sowing.

When looking at bread wheat phenology responses to SD, the warm autumn temperatures in 2016 resulted in many spring wheat entries, particularly temperature-responsive cultivars, reaching anthesis faster (days from effective SD to anthesis) for SD1 compared with SD2. LRPB Lancer$^{\Phi}$ for example, took 123 days to reach anthesis for SD1, the same as EGA Gregory$^{\Phi}$, while it took 132 days to reach anthesis from SD2 (27 May), which was seven days later than EGA Gregory$^{\Phi}$ at 125 days.

Varieties that were not as responsive to temperature, that is, did not differ greatly in days to reach anthesis between SD1 and SD2, included LRPB Reliant$^{\Phi}$, EGA Gregory$^{\Phi}$, LRPB Flanker$^{\Phi}$ and LRPB Gauntlet$^{\Phi}$. These results highlight the influence of seasonal conditions on wheat phenology, and underscore the importance of sowing date experiments.

## Acknowledgements

This experiment is part of the project *Variety specific agronomy packages* (VSAP; DAN 00167), with joint investment by NSW DPI and GRDC. Technical assistance provided by Jan Hosking, Peter Formann, Rod Bambach, Jim Perfrement, Tyson Peterswald and Natalie Aquilina (all NSW DPI) is also gratefully acknowledged.