

# Sowing date influence on phenology and grain yield of wheat – Cudal 2017

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## Key findings

- Frost had a significant effect on phenology and grain yield responses in 2017.
- High grain yields were achieved through a range of sowing date × variety combinations, indicating that growers can optimise yield through various sowing options.
- Differences in pre-flowering development phases were observed among genotypes of similar maturity, resulting in a significant influence on grain yield responses in 2017.

**Introduction** In 2017, field experiments were conducted across eight sites in the northern grains region (NGR) in central and southern QLD, northern, central and southern NSW to determine the optimal grain yield potential of wheat genotypes in the NGR. This paper presents results from the Cudal site (southern NSW) and discusses the influence of sowing date on the phenology and grain yield responses of a core set of 30 wheat genotypes.

|              |                      |                                                                                                                                                                                                                                             |
|--------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site details | Location             | 'Rutherford', Cudal, NSW                                                                                                                                                                                                                    |
|              | Soil type            | Red–brown chromosol                                                                                                                                                                                                                         |
|              | Previous crop        | Canola                                                                                                                                                                                                                                      |
|              | Sowing               | Direct drilled with Horwood Bagshaw seeding units, spaced at 220 mm using a GPS auto-steer system.                                                                                                                                          |
|              | Target plant density | 140 plants/m <sup>2</sup>                                                                                                                                                                                                                   |
|              | Mineral nitrogen (N) | 115 kg N/ha at sowing (0.9 m depth)                                                                                                                                                                                                         |
|              | Fertiliser           | 100 kg/ha mono-ammonium phosphate (MAP) (sowing)<br>100 kg/ha urea (sowing)<br>100 kg/ha urea (top dressed, 8 August 2017)                                                                                                                  |
|              | Weed control         | Knockdown: glyphosate (450 g/L) 2 L/ha, Spray.Seed® 2 L/ha<br>Pre-emergent: Triflur X 1.6 L/ha, Avadex Xtra® 1.6 L/ha, Sakura® 850 118 g/ha<br>In-crop: Precept® 2 L/ha (14 June)<br>Axial® 300 mL/ha, Adigor® 500 mL/100 L water (15 June) |
|              | Disease management   | Seed treatment: Hombre® Ultra 200 mL/100 kg<br>Flutriafol-treated fertiliser (400 mL/ha)<br>Cogito® 300 mL/ha (14 June)<br>Prosaro® 420 mL/ha (22 August)                                                                                   |
| Treatments   | Pest management      | Aphidex® 200 g/ha (14 June)                                                                                                                                                                                                                 |
|              | In-crop rainfall     | 146 mm (April–October) (long-term average: 353 mm)                                                                                                                                                                                          |

Table 1. Putative phenology types of the experiment genotypes.

| Phenology type   | Genotypes                                                                                                                                                          |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Winter (W)       | Longsword <sup>Ⓛ</sup> (fast), LongReach Kittyhawk <sup>Ⓛ</sup> , EGA Wedgetail <sup>Ⓛ</sup> , RGT Accroc <sup>Ⓛ</sup> (slow), Manning <sup>Ⓛ</sup> (slow)         |
| Very Slow (VS)   | Sunlamb <sup>Ⓛ</sup> , EGA Eaglehawk <sup>Ⓛ</sup> , Sunmax <sup>Ⓛ</sup>                                                                                            |
| Slow (S)         | Cutlass <sup>Ⓛ</sup> , Kiora <sup>Ⓛ</sup> , Sundtime <sup>Ⓛ</sup>                                                                                                  |
| Mid - Slow (S-M) | Mitch <sup>Ⓛ</sup> , LongReach Lancer <sup>Ⓛ</sup> , Coolah <sup>Ⓛ</sup> , DS Pascal <sup>Ⓛ</sup> , EGA Gregory <sup>Ⓛ</sup> , LongReach Trojan <sup>Ⓛ</sup>       |
| Mid (M)          | Janz, Beekom <sup>Ⓛ</sup> , Sunvale <sup>Ⓛ</sup> , Suntop <sup>Ⓛ</sup> ,                                                                                           |
| Fast (F)         | Scepter <sup>Ⓛ</sup> , Corack <sup>Ⓛ</sup> , LongReach Reliant <sup>Ⓛ</sup> , Mace <sup>Ⓛ</sup> , LongReach Mustang <sup>Ⓛ</sup> , LongReach Spitfire <sup>Ⓛ</sup> |
| Very fast (VF)   | Condo <sup>Ⓛ</sup> , LongReach Dart <sup>Ⓛ</sup> , Tenfour                                                                                                         |

## Results

### Phasic development

Optimum grain yield is achieved when genotypes are matched with sowing date to ensure flowering occurs at an appropriate time. In southern NSW, this response is commonly driven by the high risk of frost damage early, and heat and moisture stress later. Generally, the genotype and sowing date combinations that flower early to mid October at Cudal have the highest grain yields. As with the Wagga Wagga site, early stem frost damage resulted in significant tiller losses and late regrowth, which resulted in variable maturity within plots, and delayed the recorded flowering date in 2017. The Cudal site recorded 37 days below 0 °C (13 days below −2 °C) from June to September. The frost events affected flowering time, with the flowering window spanning from 18 September to 24 October for the Cudal site. As a result, significant variation in grain yields for genotype × sowing date combinations were observed, even when flowering occurred on the same day (Figure 1). For example, LongReach Trojan<sup>Ⓛ</sup> (mid spring type) sown on 20 April, flowered on 6 October and recorded 2.49 t/ha; while Scepter<sup>Ⓛ</sup> (fast spring type) that was sown on 18 May flowered the same day as LongReach Trojan<sup>Ⓛ</sup> yet recorded 5.59 t/ha.

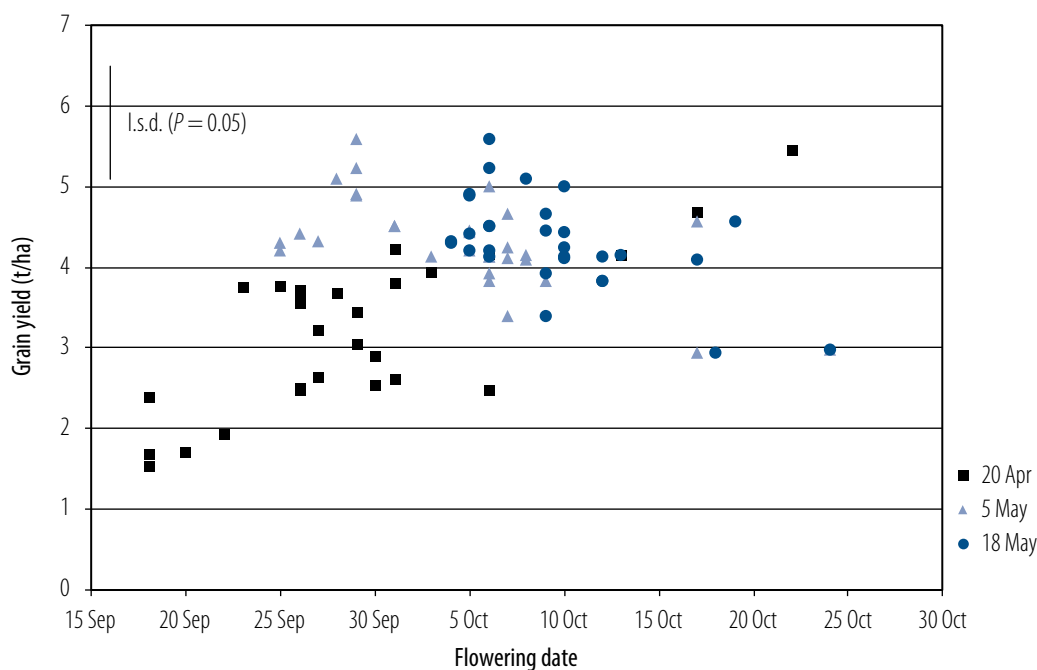


Figure 1. Relationship between flowering date and grain yield for 30 genotypes sown on 20 April, 5 May and 18 May at Cudal, 2017.

There is variation in the vernalisation and photoperiod responses among the 30 genotypes, hence differences in the phase duration of genotypes in response to sowing date were observed (Figure 2). Faster-developing, spring types (with minimal response to vernalisation), progressed quickly when sown in late April. For example, LongReach Mustang<sup>Ⓛ</sup>, Condo<sup>Ⓛ</sup> and Scepter<sup>Ⓛ</sup> sown

on 20 April 2017 at Cudal started stem elongation (GS30) between 15–20 June. However, when the winter type EGA Wedgetail<sup>®</sup> was sown on the same day (20 April), it reached GS30 a month later on 20 July (Figure 2) due to a prolonged vegetative phase associated with its vernalisation requirement. Winter types with a strong vernalisation and photoperiod response, such as RGT Accroc<sup>®</sup>, had an extended vegetative and reproductive period (Figure 2).

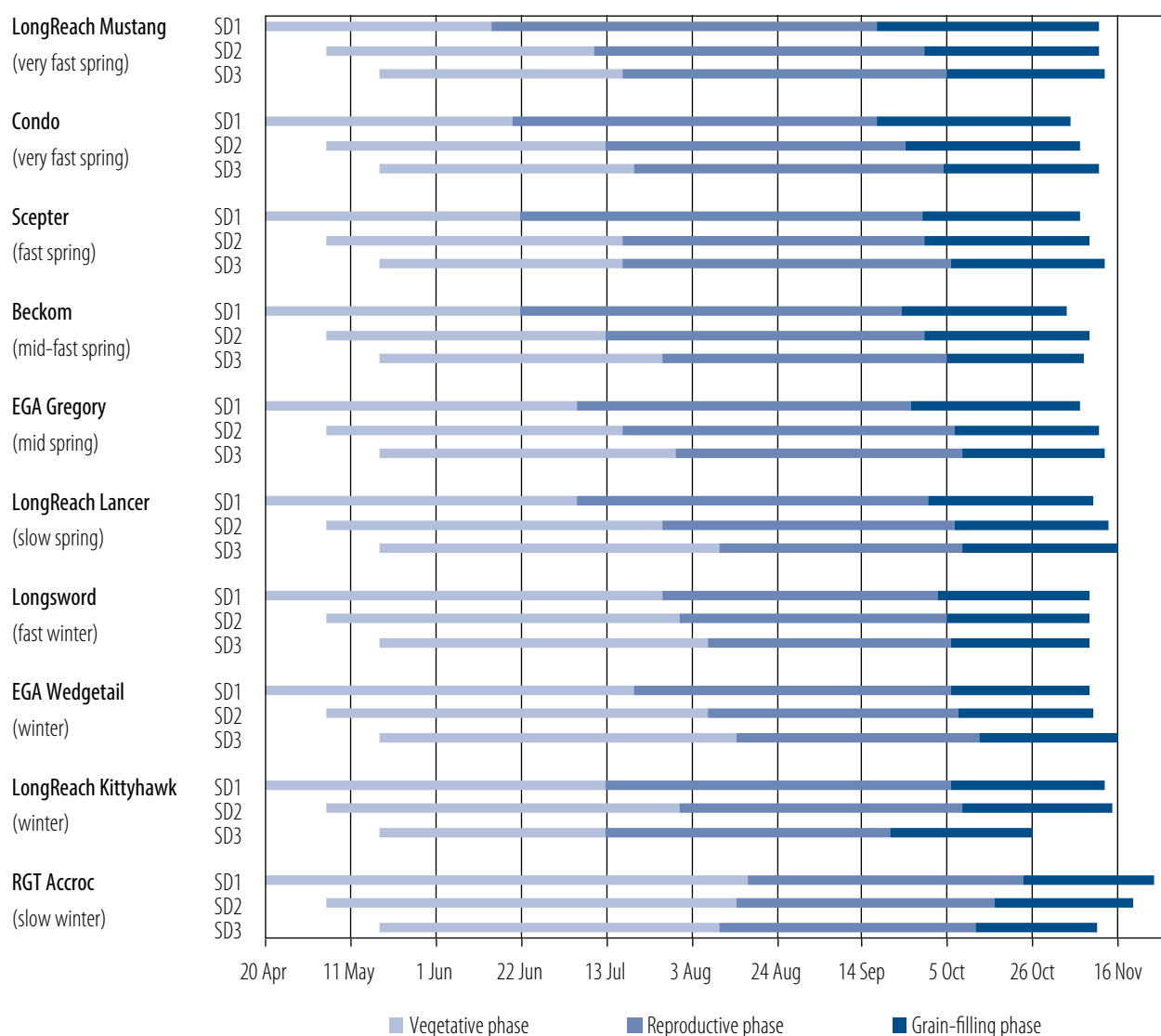


Figure 2. Sowing date influence on phasic development of selected genotypes sown on 20 April (SD1), 5 May (SD2) and 18 May (SD3) at Wagga Wagga, 2017. Vegetative phase (sowing to GS30); reproductive phase (GS30 to flowering); grain-fill phase (flowering to maturity).

### Grain yield

In 2017, as with the Wagga Wagga site, winter and long-season genotypes achieved high yields from early sowing and were relatively stable across sowing dates at the Cudal site (Table 2). This is likely due to the extended vegetative phase, which reduced exposure to frosts during early reproductive development and resulted in flowering at an optimal time for the season. In contrast, faster developing genotypes, when sown early, were exposed to several frosts during stem elongation through to flowering, which significantly reduced yield potential.

Table 2. Grain yield of genotypes across three sowing dates at Cudal in 2017. Percentage of sowing date mean in parentheses. Highest yielding genotype shaded grey in each sowing date.

| Genotype                      | Grain yield (t/ha) |       |            |       |             |       |
|-------------------------------|--------------------|-------|------------|-------|-------------|-------|
|                               | SD1: 20 Apr        |       | SD2: 5 May |       | SD3: 18 May |       |
| Beckom                        | 3.77               | (118) | 4.85       | (99)  | 4.92        | (114) |
| Condo                         | 2.40               | (76)  | 4.42       | (90)  | 4.32        | (100) |
| Coolah                        | 3.05               | (96)  | 5.64       | (115) | 4.15        | (96)  |
| Corack                        | 1.72               | (54)  | 4.30       | (88)  | 5.09        | (118) |
| Cutlass                       | 2.65               | (83)  | 5.24       | (107) | 5.01        | (116) |
| LongReach Dart                | 1.69               | (53)  | 4.05       | (83)  | 4.21        | (98)  |
| DS Pascal                     | 4.23               | (133) | 4.66       | (95)  | 4.25        | (99)  |
| EGA Eaglehawk                 | 3.94               | (124) | 5.69       | (116) | 4.13        | (96)  |
| EGA Gregory                   | 3.56               | (112) | 5.19       | (106) | 4.66        | (108) |
| EGA Wedgetail                 | 2.49               | (78)  | 5.06       | (103) | 4.16        | (97)  |
| Janz                          | 3.78               | (119) | 5.40       | (110) | 4.13        | (96)  |
| Kiora                         | 2.90               | (91)  | 4.48       | (91)  | 4.1         | (95)  |
| LongReach Kittyhawk           | 4.17               | (131) | 4.58       | (93)  | 3.84        | (89)  |
| LongReach Lancer              | 2.54               | (80)  | 4.83       | (98)  | 3.40        | (79)  |
| LongReach Mustang             | 1.68               | (53)  | 4.79       | (98)  | 4.89        | (113) |
| LongReach Reliant             | 3.23               | (102) | 4.63       | (94)  | 5.24        | (122) |
| LongReach Trojan              | 2.49               | (78)  | 4.69       | (96)  | 4.51        | (105) |
| Longsword                     | 3.94               | (124) | 5.31       | (108) | 4.22        | (98)  |
| Mace                          | 2.62               | (82)  | 4.74       | (97)  | 4.33        | (101) |
| Manning                       | 5.46               | (172) | 4.60       | (94)  | 2.98        | (69)  |
| Mitch                         | 3.68               | (116) | 5.29       | (108) | 3.83        | (89)  |
| RGT Accroc                    | 4.68               | (147) | 5.19       | (106) | 4.56        | (106) |
| Scepter                       | 3.45               | (109) | 5.62       | (115) | 5.59        | (130) |
| LongReach Spitfire            | 1.94               | (61)  | 4.96       | (101) | 4.47        | (104) |
| Sunlamb                       | 4.15               | (130) | 4.64       | (94)  | 2.93        | (68)  |
| Sunmax                        | 2.51               | (79)  | 5.79       | (118) | 4.44        | (103) |
| Suntime                       | 3.69               | (116) | 4.38       | (89)  | 4.52        | (105) |
| Suntop                        | 3.71               | (117) | 4.85       | (99)  | 3.93        | (91)  |
| Sunvale                       | 3.81               | (120) | 4.90       | (100) | 4.13        | (96)  |
| Mean                          | 3.18               | (100) | 4.91       | (100) | 4.31        | (100) |
| l.s.d.                        |                    |       |            |       |             |       |
| sowing date                   | 0.38               |       |            |       |             |       |
| genotype                      | 0.82               |       |            |       |             |       |
| sowing date $\times$ genotype | 1.42               |       |            |       |             |       |

Genotype yield responses varied across the three sowing dates (Figure 3). Generally, slow developing genotypes had a positive yield response when sown early, (indicated by negative slope), while faster developing, spring genotypes had a positive yield response when sown later (indicated by positive slope). In 2017, winter types, such as Manning<sup>®</sup> (strong vernalisation response) and LongReach Kittyhawk<sup>®</sup> (mid vernalisation response) achieved a yield advantage of between 0.7–1.2 t/ha when sown on 20 April, with a declining yield response thereafter. In contrast, the yield responses of faster developing spring types, for example Scepter<sup>®</sup>, peaked at later sowing dates. Despite the extreme frost conditions, some spring genotypes were able to maintain relatively

stable grain yields (indicated by flatter slope), for example, Beekom<sup>®</sup>, which showed a similar response at the Wagga Wagga site.

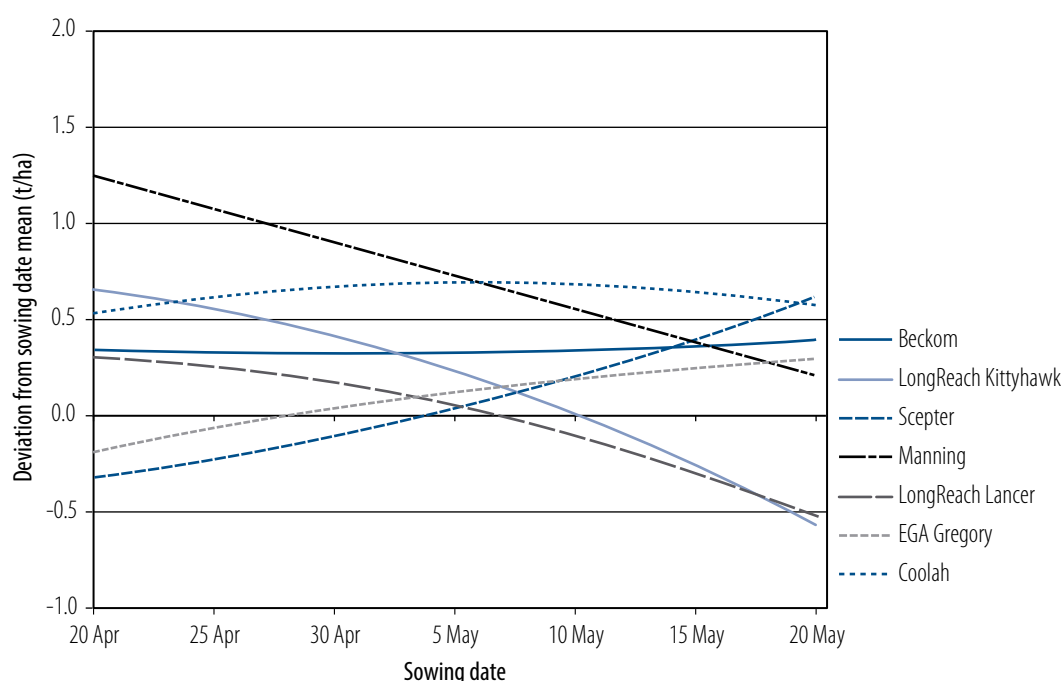


Figure 3. Genotype by sowing date response in 2017 for selected genotypes. Response is presented as deviation from sowing date mean across four sowing dates at Cudal. Sowing date mean: 20 April 3.03 t/ha; 5 May 3.20 t/ha; 18 May 3.26 t/ha.

### Grain quality

Grain protein, test weight and screenings were significantly affected by genotype and sowing date. There was also a significant interaction between genotype and sowing date for grain quality (Table 3). All treatment combinations achieved greater than 11.5% grain protein, with frosted treatments (fast-developing genotypes sown early) accumulating higher protein concentrations (e.g. LongReach Dart<sup>®</sup>, Condo<sup>®</sup>, LongReach Mustang<sup>®</sup> in SD1). All genotype and sowing date combinations also achieved a test weight of >76 kg/hL and <5% screenings, indicative of frost damage before grain filling (Table 3).

Table 3. Protein (%), screenings % (SCRN) and test weight (kg/hL) (TWT) of genotypes across three sowing dates at Cudal in 2017.

| Genotype               | SD1: 20 April |             |          | SD2: 5 May  |             |          | SD3: 18 May |             |          |
|------------------------|---------------|-------------|----------|-------------|-------------|----------|-------------|-------------|----------|
|                        | Protein (%)   | TWT (kg/hL) | SCRN (%) | Protein (%) | TWT (kg/hL) | SCRN (%) | Protein (%) | TWT (kg/hL) | SCRN (%) |
| Beckom                 | 14.3          | 83.5        | 0.3      | 13.0        | 83.4        | 0.3      | 12.8        | 84.2        | 0.3      |
| Condo                  | 16.6          | 83.9        | 0.3      | 14.3        | 84.7        | 0.4      | 13.9        | 85.1        | 0.4      |
| Coolah                 | 12.7          | 83.8        | 0.4      | 12.3        | 84.8        | 0.3      | 12.8        | 85.4        | 0.2      |
| Corack                 | 15.7          | 83.3        | 0.2      | 13.9        | 84.9        | 0.3      | 13.1        | 84.8        | 0.3      |
| Cutlass                | 15.3          | 83.9        | 0.3      | 12.6        | 85.4        | 0.2      | 12.4        | 84.7        | 0.2      |
| LongReach Dart         | 17.4          | 81.8        | 0.3      | 14.0        | 84.6        | 0.2      | 14.4        | 84.3        | 0.7      |
| DS Pascal              | 12.2          | 83.2        | 0.3      | 12.4        | 83.4        | 0.5      | 13.0        | 84.0        | 1.1      |
| EGA Eaglehawk          | 12.8          | 84.5        | 0.3      | 12.5        | 84.7        | 0.5      | 13.9        | 85.0        | 0.6      |
| EGA Gregory            | 14.1          | 83.7        | 0.5      | 12.4        | 84.6        | 0.4      | 13.2        | 84.9        | 0.4      |
| EGA Wedgetail          | 13.9          | 80.6        | 0.2      | 13.0        | 82.3        | 0.2      | 14.3        | 82.0        | 0.2      |
| Janz                   | 14.4          | 83.9        | 0.2      | 13.1        | 84.5        | 0.2      | 13.4        | 84.8        | 0.2      |
| Kiora                  | 13.6          | 84.1        | 0.2      | 13.3        | 85.1        | 0.2      | 13.7        | 85.8        | 0.2      |
| LongReach Kittyhawk    | 12.9          | 85.5        | 0.3      | 13.1        | 85.7        | 0.2      | 13.5        | 85.7        | 0.2      |
| LongReach Lancer       | 14.5          | 83.1        | 0.3      | 13.5        | 84.5        | 0.2      | 14.8        | 84.9        | 0.3      |
| LongReach Mustang      | 15.2          | 84.7        | 0.3      | 12.8        | 86.2        | 0.4      | 12.7        | 86.4        | 0.3      |
| LongReach Reliant      | 13.8          | 84.0        | 0.6      | 12.5        | 84.3        | 0.5      | 11.7        | 85.2        | 0.4      |
| LongReach Trojan       | 14.4          | 84.8        | 0.2      | 13.0        | 85.1        | 0.1      | 13.1        | 86.5        | 0.1      |
| Longsword              | 14.5          | 82.5        | 0.1      | 13.1        | 83.9        | 0.2      | 13.6        | 83.3        | 0.1      |
| Mace                   | 16.1          | 82.5        | 0.2      | 13.2        | 83.9        | 0.2      | 13.2        | 83.3        | 0.3      |
| Manning                | 12.2          | 77.7        | 0.5      | 12.8        | 78.2        | 1.1      | 13.7        | 77.9        | 1.8      |
| Mitch                  | 13.1          | 82.3        | 0.7      | 11.9        | 82.6        | 0.8      | 12.9        | 83.7        | 1.3      |
| RGT Accroc             | 12.4          | 82.8        | 0.7      | 12.5        | 82.8        | 0.6      | 12.6        | 76.5        | 0.5      |
| Scepter                | 14.6          | 83.8        | 0.5      | 12.1        | 84.8        | 0.4      | 11.6        | 84.8        | 0.4      |
| LongReach Spitfire     | 18.5          | 83.6        | 0.3      | 14.6        | 85.9        | 0.3      | 14.9        | 86.2        | 0.2      |
| Sunlamb                | 13.9          | 83.5        | 0.7      | 13.8        | 83.8        | 1.5      | 14.5        | 79.2        | 1.8      |
| Sunmax                 | 14.3          | 82.7        | 0.4      | 13.0        | 83.7        | 0.3      | 13.9        | 84.3        | 0.4      |
| Suntime                | 14.1          | 84.4        | 0.3      | 13.7        | 84.2        | 0.2      | 13.6        | 85.7        | 0.3      |
| Suntop                 | 13.6          | 84.1        | 1.7      | 12.5        | 84.8        | 1.8      | 12.9        | 84.9        | 2.8      |
| Sunvale                | 14.3          | 84.4        | 0.2      | 13.6        | 85.0        | 0.1      | 13.2        | 85.7        | 0.2      |
| l.s.d.                 |               |             |          |             |             |          |             |             |          |
| genotype               | 0.6           | 0.5         | 0.2      |             |             |          |             |             |          |
| sowing date            | 0.2           | 0.2         | 0.1      |             |             |          |             |             |          |
| genotype × sowing date | 1.1           | 0.9         | 0.3      |             |             |          |             |             |          |

## Summary

High grain yields were still achieved from various genotype x sowing date combinations for the 2017 season. The highest yields in SD1 were achieved by winter genotypes with strong vernalisation responses (Manning<sup>®</sup> and RGT Accroc<sup>®</sup>), though yield of these genotypes declined with delayed sowing. Frost had a significant effect on phasic development and grain yield in 2017, and while fast-developing spring genotypes were not suited to early sowing, they were able to achieve comparable grain yields when sown at an optimal time. For example, Corack<sup>®</sup> had a significant yield penalty for SD1 (1.72 t/ha), but achieved 5.09 t/ha for SD3. These results highlight the interaction between phasic development and yield formation, and the importance of matching genotype and sowing date to achieve flowering at an appropriate time as an effective management strategy for optimising grain yields.

## Acknowledgements

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