# Management of flowering time and early sown slow developing wheats

Kenton Porker, Dylan Bruce, Melissa McCallum, Brenton Spriggs and Sue Buderick[1]; James Hunt[2]; Felicity Harris and Greg Brooke[3]; Sarah Noack[4]; Michael Moodie, Mick Brady, and Todd McDonald[5]; Michael Straight[6]; Neil Fettell, Helen MacMillan, and Barry Haskins[7]; Genevieve Clarke, and Kelly Angel[8]

[1]SARDI, [2]La Trobe University; [3] NSW DPI, [4] Hart Field-Site Group, [5]Moodie Agronomy, [6]Foundation for Arable Research, [7]Central West Farming Systems, [8]Birchip Cropping Group

**Key Findings**

- Different winter wheat varieties are required to target different optimum flowering windows.
- The best yields from winter wheats sown early are similar to Scepter sown in its optimal window.
- If sowing early use the right winter variety for the right yield and flowering environment.
- Highest yields for winter wheats come from early – late April establishment.
- Mid - slow developing spring varieties are less suited to pre – April 20 sowing.

**Background**

Timely operations are key to maximising farm profit, and sowing is one of the most time-critical operations. This is because there is only a short period (approximately 10 days) in spring during which crops can flower and yields can be maximised. This period is referred to as the *optimal flowering period* and its timing and length varies with location and climate. During the optimal flowering period, combined yield loss from drought, heat, frost and insufficient radiation are minimised, and yield maximised. Increasing farm sizes (and cropped area) and declining autumn rainfall have made it more challenging for growers to get crops flowering during the optimal period.

Sowing early with appropriate varieties is one management strategy to increase the amount of cropped area that flowers during the optimal period and thus farm yield can be maximised. Sowing earlier requires varieties that are slower developing to take advantage of early establishment opportunities. They are ideally sown into a moist seed bed following breaking rain or preceding a convincing forecast of enough rain to allow germination. This should not be confused with dry sowing which typically uses fast developing varieties sown into a dry seed bed that will establish when breaking rains fall.

**Winter wheats for early sowing**

For sowing prior to April 20, winter varieties 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 varieties will flower too early when sown early. The longer vegetative period of winter varieties also opens opportunities for grazing. Winter wheat varieties allow wheat growers in the southern region to sow much earlier than currently practiced, meaning a greater proportion of farm can be sown on time.

**Management of Early Sown Wheat Experiments**

The aim of this series of the GRDC Management of Early Sown Wheat experiments was to determine which of the new generation winter varieties 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 had little exposure to new winter varieties, particularly at early sowing dates (mid – March). Three different experiments were conducted in the southern region in low – medium rainfall environments during 2017, 2018 and 2019, including collaboration in NSW for additional datasets presented in this paper.

*Experiment 1 - Which wheat variety performs best in which environment and when should they be sown?*

- Target sowing dates: March 15, April 1, April 15 and May 1 (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 varieties – New winter wheats differ in quality classification, development speed and disease rankings (Table 1).

*Table 1. Summary of winter varieties, including Wheat Australia quality classification and disease rankings based on the 2020 SA Crop Sowing Guide.*

| Variety | Release Year | Company | Development | Quality | Disease Rankings# | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Stripe Rust | Leaf Rust | Stem Rust | YLS |
| Kittyhawk | 2016 | LRPB | Mid winter | AH | RMR | MS | MRMS-S | MRMS |
| Longsword | 2017 | AGT | Fast winter | Feed | RMR | MSS | MR | MRMS |
| Illabo | 2018 | AGT | Mid-fast winter | AH/APH* | RMR | S | MS | MS |
| DS Bennett | 2018 | Dow | Mid – slow winter | ASW | RMR | S | MRMS | MRMS |
| ADV15.9001 | ? | Dow | Fast winter | ? | - | - | - | - |
| Nighthawk | 2019 | LRPB | Very slow spring | ? | RMR | MSS | RMR | MS |
| 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

**Different winter varieties are required to target different optimum flowering windows**

Flowering time is a key determinant of wheat yield. Winter varieties are very stable in flowering date 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 different optimum flowering windows. The flowering time difference between winter varieties are characterised based on their relative development speed into three broad groups fast, mid – fast, mid and slow – mid for low-medium rainfall environments (Table 1 and Figure 1).

For example, at Birchip in 2018 and 2019, each winter variety flowered within a period of 7 – 10 days across all sowing dates, whereas spring varieties were unstable and ranged in flower dates over one month apart (Figure 1). In the Birchip example, the fast – mid developing winter wheats with development speeds similar to Longsword and Illabo were best suited to flowering within the optimum period of September 10 – 20 for Birchip. In other lower yielding environments such as Loxton, Minnipa and Mildura the faster developing winter varieties ADV15.9001 and Longsword were better suited to achieve flowering times require in the first 10 days in September.

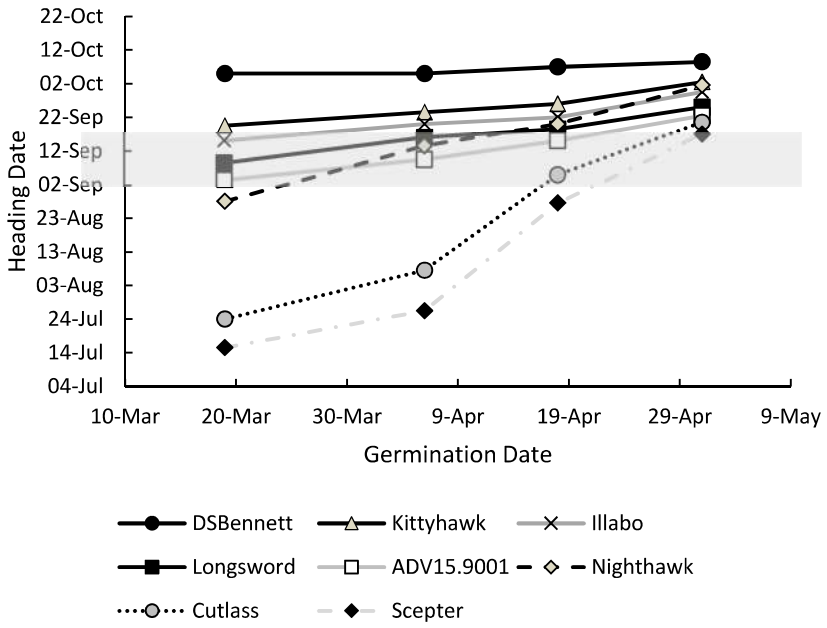


*Figure 1. Average heading date responses from winter and spring varieties at Birchip in 2018 and 2019 across all sowing times, grey box indicates the optimal period for heading at Birchip.*

**Best yields of winter wheats sown early are similar to Scepter sown in optimal window**

- 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 21 out of 28 sites, greater in five and less than in two environments (Figure 2).
- The best performing winter wheat yielded similar to the best performing slow developing spring variety (alternative development pattern) at 24 sites, greater at two and less than at two sites.

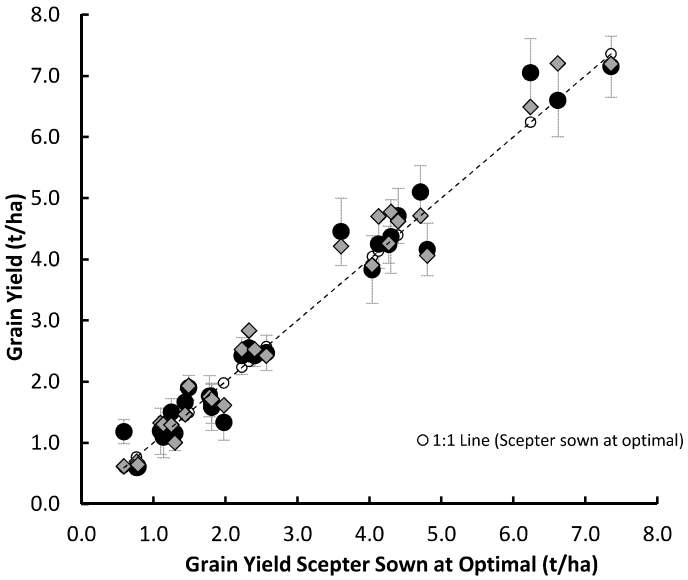


*Figure 2. Grain yield performance of Scepter wheat sown at its optimal time (late April-early May) in 28 environments (2017 – 2019) compared to the performance of the best performing winter wheat. Error bars indicate LSD (P≤0.05).*

*Table 2. Summary of grain yield performance of the best performing winter and alternate spring variety 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 | Grain yield of Scepter sown ~1 May (t/ha) | | Highest yielding winter variety | | | | Highest yielding slower spring variety | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Grain Yield (t/ha) | | Variety# | Germ Date | Grain Yield (t/ha) | | Variety# | Germ Date |
| Yarrawonga* | 2018 | 0.6 | b | 1.2 | a | DS Bennett | 16-Apr | 0.6 | b | Cutlass | 16-Apr |
| Booleroo | 2018 | 0.8 | a | 0.6 | a | Longsword | 4-Apr | 0.7 | a | Trojan | 2-May |
| Booleroo | 2019 | 0.8 | a | 0.6 | a | ADV15.9001 | 05-Apr | 0.6 | a | Cutlass | 01-May |
| Loxton | 2018 | 1.1 | a | 1.2 | a | Longsword | 19-Mar | 1.3 | a | Cutlass | 3-May |
| Loxton* | 2019 | 1.1 | a | 1.1 | a | ADV15.9001 | 15-Mar | 1.3 | a | Cutlass | 01-May |
| Minnipa | 2018 | 1.3 | a | 1.5 | a | Longsword | 3-May | 1.3 | a | Trojan | 3-May |
| Mildura | 2019 | 1.3 | a | 1.2 | a | ADV15.9001 | 29-Apr | 1.0 | a | IGW6566 | 15-Apr |
| Mildura* | 2018 | 1.4 | b | 1.7 | a | DS Bennett | 1-May | 1.5 | ab | Nighthawk | 1-May |
| Mildura | 2017 | 1.5 | b | 1.9 | a | Longsword | 13-Apr | 1.9 | a | Cutlass | 28-Apr |
| Minnipa | 2019 | 1.8 | a | 1.8 | a | ADV15.9001 | 05-Apr | 1.7 | a | Cutlass | 05-Apr |
| Horsham* | 2018 | 1.8 | a | 1.6 | a | DS Bennett | 6-Apr | 1.7 | a | Trojan | 2-May |
| Hart | 2019 | 1.8 | a | 1.6 | a | Illabo | 05-Apr | 1.7 | a | Nighthawk | 18-Apr |
| Booleroo | 2017 | 2.0 | a | 1.3 | b | DS Bennett | 4-May | 1.6 | b | Cutlass | 4-May |
| Minnipa | 2017 | 2.2 | a | 2.4 | a | Longsword | 18-Apr | 2.5 | a | Cutlass | 5-May |
| Loxton | 2017 | 2.3 | a | 2.6 | ab | Longsword | 3-Apr | 2.8 | b | Nighthawk | 3-Apr |
| Hart | 2018 | 2.4 | a | 2.4 | a | Illabo | 17-Apr | 2.5 | a | Nighthawk | 17-Apr |
| Condobolin | 2018 | 2.6 | a | 2.5 | a | DS Bennett | 19-Apr | 2.4 | a | Trojan | 7-May |
| Yarrawonga | 2019 | 3.6 | b | 4.5 | a | ADV15.9001 | 15-Mar | 4.2 | a | Nighthawk | 05-Apr |
| Birchip | 2018 | 4.0 | a | 3.8 | a | Longsword | 30-Apr | 3.9 | a | Trojan | 30-Apr |
| Hart | 2017 | 4.1 | a | 4.3 | a | Illabo | 18-Apr | 4.7 | b | Nighthawk | 18-Apr |
| Yarrawonga | 2017 | 4.3 | a | 4.2 | a | DS Bennett | 3-Apr | 4.3 | a | Cutlass | 26-Apr |
| Wongarbon | 2017 | 4.3 | a | 4.4 | a | DS Bennett | 28-Apr | 4.8 | a | Trojan | 13-Apr |
| Tarlee | 2018 | 4.4 | a | 4.7 | a | Illabo | 17-Apr | 4.6 | a | Nighthawk | 17-Apr |
| Birchip | 2019 | 4.7 | a | 5.1 | a | DS Bennett | 01-May | 4.7 | a | Nighthawk | 01-May |
| Horsham | 2019 | 4.8 | a | 4.2 | b | Longsword | 05-Apr | 4.1 | b | Nighthawk | 05-Apr |
| Wallendbeen | 2017 | 6.2 | b | 7.1 | a | DS Bennett | 28-Mar | 6.5 | b | Cutlass | 1-May |
| Birchip | 2017 | 6.6 | b | 6.6 | b | DS Bennett | 15-Apr | 7.2 | a | Trojan | 15-Apr |
| Horsham | 2017 | 7.4 | a | 7.2 | a | DS Bennett | 16-Mar | 7.2 | a | Trojan | 28-Apr |

*stem and/or reproductive frost substantially affected yield
#varieties Trojan and ADV15.9001 were not included at all sites

**The best performing winter variety depends on yield environment and development speed**

The best performing winter wheat varieties depended on yield environment, development speed and the severity and timing of frost (Table 2). The rules generally held that winter varieties well-adjusted to a region yielded similar to Scepter sown in its optimal window. These results demonstrate 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 and ADV15.9001 were generally favoured (Figure 3).
- In environments greater than 2.5 t/ha the mid – slow developing varieties were favoured; Illabo in the Mid-North of SA, and DS Bennett at the Vic and NSW sites (Figure 4).

The poor relative performance of Longsword in higher yielding environments was explained by a combination of flowering too early and having inherently greater floret sterility than other varieties irrespective of flowering date.

Sites defined by severe September frost and October rain included Yarrawonga, Mildura, and Horsham in 2018. In this scenario the slow developing variety DS Bennett was the highest yielding winter wheat and had the least amount of frost induced sterility. The late rains also favoured this variety in 2018 and mitigated some of the typical yield loss from terminal drought (i.e. Birchip 2019). Nonetheless the ability to yield well outside the optimal flowering period maybe a useful strategy for highly frost prone environments where growers want to sow early.

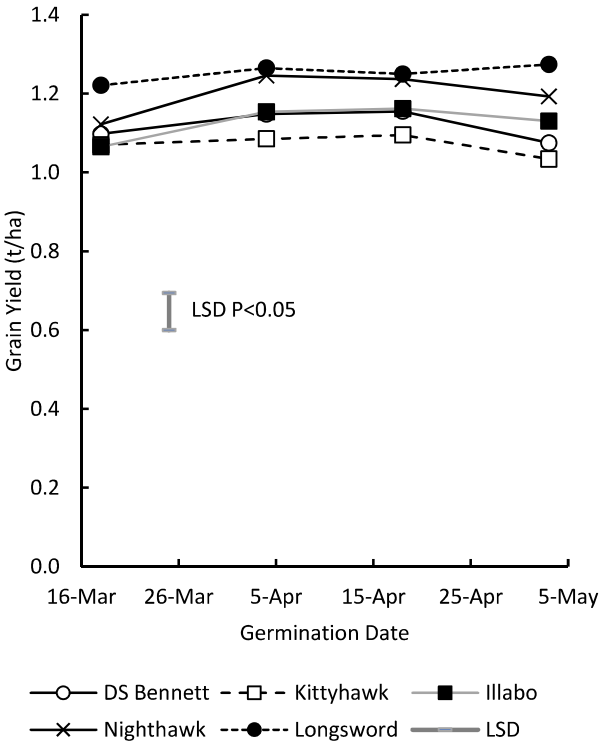


*Figure 3. Average yield performance of winter wheat in yield environments less than 2.5 t/ha (n=16 sites in SA/Vic).*

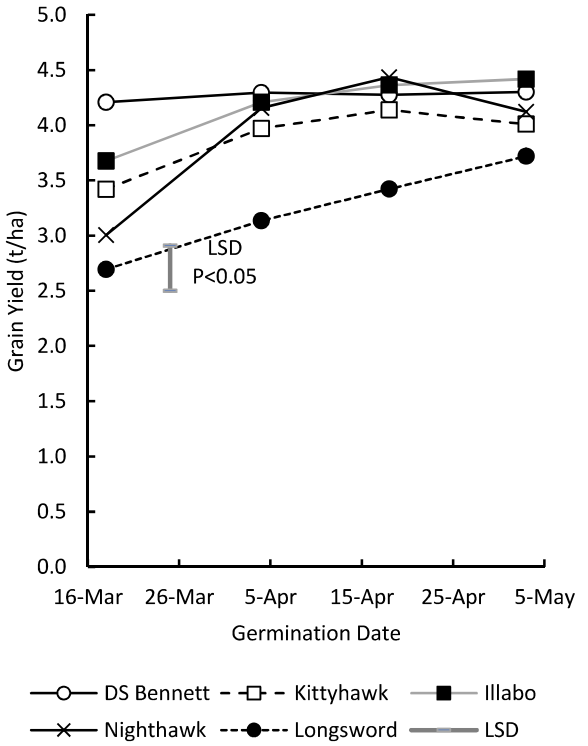


*Figure 4. Average yield performance of winter wheat in yield environments greater than 2.5 t/ha (5 sites in SA/Vic).*

**Highest yields for winter wheats come from early – late April establishment**

- Across all environments the highest yields for winter wheats generally came from early – late April establishment. The results also suggested yields may decline from sowing dates earlier than April and these dates may be too early to maximise winter wheat performance (Table 2, Figure 3 and Figure 4). The variety DS Bennett maintained yield better than all other varieties from March establishment.
- Mid – slower developing springs (i.e. Cutlass) performed best from sowing dates after April 20 and yielded less than the best performing winter varieties when sown prior to April 20. This reiterates slow developing spring varieties are not suited to pre – April 20 sowing in low – medium frost prone environments.
- The very slow developing spring Nighthawk yielded similar to the best performing winter variety in both yield environments from mid-April establishment dates.

More details on the experiment one can be found here:
http://agronomyaustraliaproceedings.org/images/sampledata/2019/2019ASA_Hunt_James_173.pdf

**Conclusion**

Growers in the low-medium rainfall zones of the southern region now have winter wheat varieties that can be established over the entire month of April and are capable of achieving similar yields to Scepter sown at the optimum time. However, grain quality of the best performing varieties 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.

**Acknowledgements**

The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC, the author would like to thank them for their continued support. The project is led by La Trobe University in partnership with the South Australian Research and Development Institute (SARDI), Hart Field-Site Group, Moodie Agronomy, Birchip Cropping Group, Agriculture Victoria, FAR Australia, Mallee Sustainable Farming. Collaboration with New South Wales DPI and Central West Farming systems.

GRDC project Management of Early Sown Wheat 9175069.


*To access this resource, click on the image above or visit: https://grdc.com.au/ten-tips-for-early-sown-wheat*