Capturing the best sowing opportunities for wheat in WA

Brenda Shackley, Christine Zaicou-Kunesch, Jeremy Curry and Dion Nicol, DPIRD (Katanning, Geraldton, Esperance and Merredin)

Key messages

- Match the maturity of a variety with sowing date to maximise the yield potential: – “If sowing early, sow long”.
- Sowing different varieties in order to target the optimum flowering period could minimise the impact of frost or other end of season stressors. Consider using multiple varieties (with different flowering times and maturities) to target flowering throughout the optimal flowering period for your location.
- Use of long or mid-long varieties in April can increase the diversity of a wheat program that typically consists of >70% short-mid varieties and is geared towards May sowings.
- Performance of varieties with sowing date is compared for Mullewa, Merredin, Katanning and Gibson (EDRS) in 2017.

Aims

To determine the appropriate sowing time by variety combination to maximise the grain yield and quality of wheat in the WA.

Method

A series of time-of-sowing trials were located at Mullewa, Merredin (Merredin Dryland Institute), Katanning (Great Southern Agriculture Research Institute) and Gibson (Esperance Downs Research Station, EDRS) in 2017. These trials examined 24 wheat varieties sown at five sowing dates. The varieties ranged from winter types to short maturing varieties (Appendix 1). The sowing dates were similar at all four sites. These dates will be collectively referred to as mid-April, late April, early May, late May and mid-June.

To ensure that germination occurred shortly after seeding, irrigation was applied (via an irrigator at Merredin and water trucks and a boom at Mullewa, Katanning and EDRS). At Mullewa, irrigation applied was 15mm prior to each sowing time and 6mm one week later. At Merredin, a total of 70mm of water was applied over the whole trial in 10mm allocations prior to and/or after each seeding. Katanning had 12mm applied prior to seeding in mid-April and 4.5mm after seeding for late April. An additional 4.5mm was applied prior to and after seeding for the early May sowing. EDRS had 12mm applied after seeding for the April sowings only.

Trials were sown as six banks of small plots (7.5 to 10m long x 1.54m wide) with three replicates per time of sowing. All trials were sown into canola stubble (except Merredin, which followed fallow) with fertiliser (treated with Uniform®) banded below the seed (treated with Emerge®). Plots were seeded to target an establishment of 150plants/m^2. Further nitrogen was applied at 4-5 weeks after sowing as Flexi-N®, and Prosaro® was applied as required to control powdery mildew and yellow spot/septoria compendium.

Plant establishment counts were conducted at 2-3 weeks after sowing. Heading and flowering dates were recorded two or three times a week (Zadok score). Yield component cuts were taken at maturity on a sub set of varieties. Grain yields were recorded from plots using a small plot harvester and samples were taken and cleaned for grain quality testing.

Results

Summer rainfall was higher than average across much of the wheatbelt in 2017, however by mid-April through to May, most of the sites had a drying top soil (Table 1). Mullewa had an average establishment of 116 plants/m^2. At Katanning and EDRS establishment averaged 145 plants/m^2 although this was slightly lower at EDRS for the April sowing. Establishment at Merredin ranged from 55 to 125 plants/m^2 over the five sowing times due to issues with surface crusting that was more prominent with the earlier sowings.

In 2017, the average maximum temperatures for April and May were higher than 2015 and 2016. Temperatures ranging from +1.3°C (Katanning) to +3°C (Mullewa and Merredin) in April and +1°C (Merredin) to +2.5°C (EDRS) in May. However, average maximum temperature for September and October were similar to 2016 and lower than 2015, ranging from -1°C (Merredin, Katanning and EDRS) to -4°C (Mullewa) and -3°C (Mullewa and EDRS) and to -5°C (Merredin and Katanning) respectively. These temperatures had different influences on the flowering date of Mace (as an example). Although flowering dates were generally later in 2016 (one of the coldest years on record) the difference between flowering dates in 2017 and 2015 depended on location and sowing time. The cooler grain filling period may have contributed to higher than expected yields, particularly after the dry start at most locations.

Table 1: Rainfall (mm) for the four trial sites recorded at closest DPIRD weather stations in 2017.

Site	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Summer (Ja-Mar)	GSR
Mullewa	**116**	**73**	**2**	**0**	**9**	**6**	**34**	**100**	**26**	**3**	**191**	**178 ***
Merredin	**47**	**42**	**19**	**6 (30)**	**14(30)**	**5 (10)**	**44**	**45**	**42**	**37**	**108**	**194 (70)**
Katanning	**0**	**161**	**41**	**26**	**33**	**11**	**81**	**51**	**55**	**31**	**202**	**289***
EDRS	**75**	**160**	**29**	**12**	**45**	**24**	**85**	**43**	**82**	**27**	**284**	**317***

Brackets indicate extra irrigation applied to whole site. *Irrigation applied only to seeded area at sowing: 21mm applied to each sowing time at seeding at Mullewa. 12mm, 4.5mm and 9mm applied to first three sowing times respectively at Katanning. 12mm applied to April sowings at EDRS.

Frosts at Katanning affected grain yields. Tiny tag temperature loggers at canopy level (as per NFI trial protocols) recorded significantly more low temperature events than the nearest weather station. These low temperatures resulted in a range of frost damage (measured by Floret Sterility, FS) which was reflected in the grain yield recorded at Katanning. Low temperatures were also recorded at Merredin, but negligible frost damage was observed at the trial sites. This will be confirmed when the yield component data is available. The position in landscape and soil type played a large role in the extent of frost damage in the trials with Katanning having a west facing slope with a sandy surface, factors likely to increase frost damage, while Merredin had a red loam soil type.

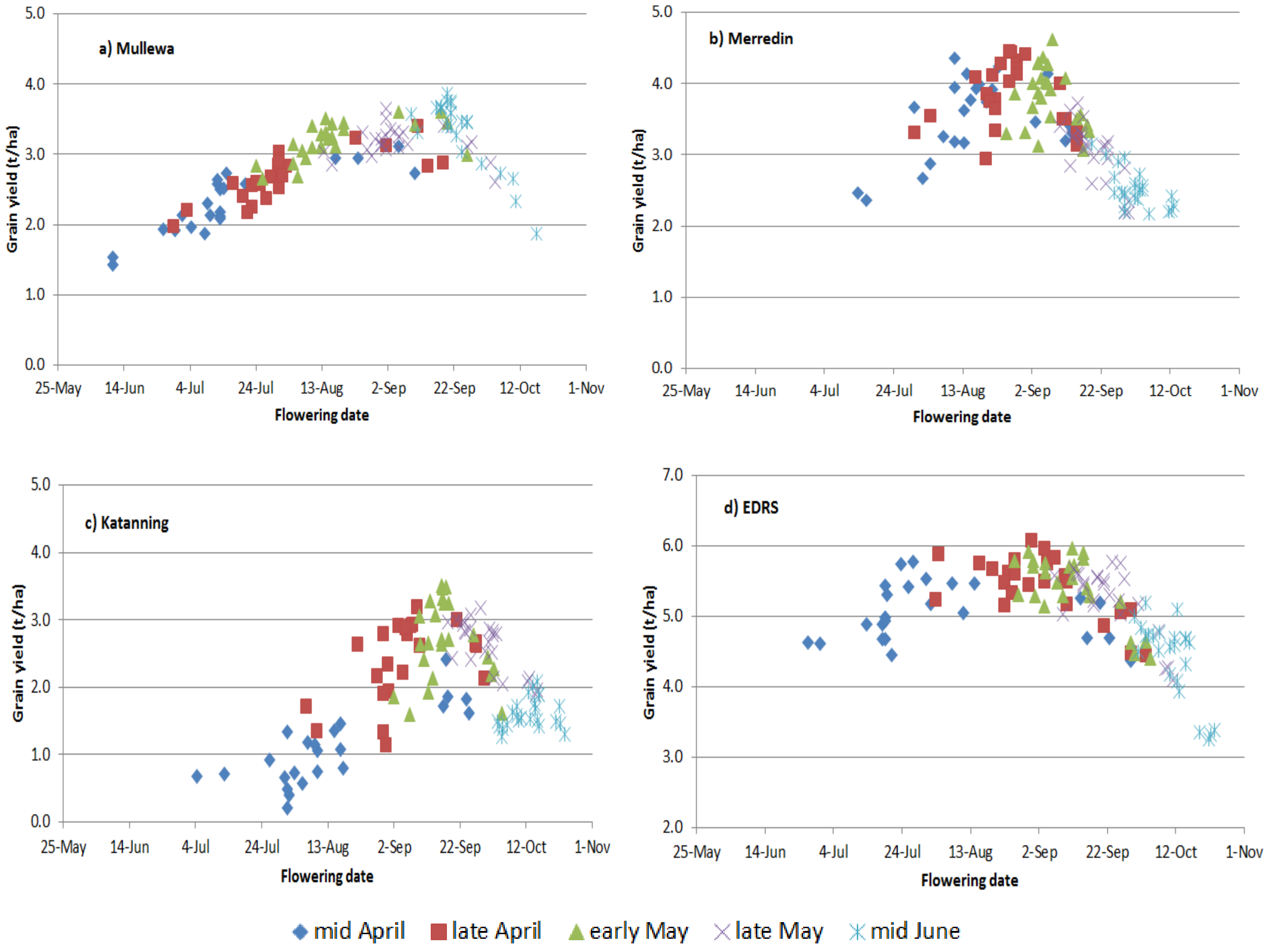


Figure 1: Yield response with flowering date of 24 wheat varieties sown mid-April, late April, early May, late May and mid-June at a) Mullewa, b) Merredin, c) Katanning and d) EDRS in 2017.

Merredin, Katanning and EDRS showed a trend that as flowering was delayed, grain yields increased to a peak before decreasing in yield at later flowering dates (particularly evident in mid-June sown treatments). Although Mullewa had a similar increase in yield with later flowering, peak yields occurred at later flowering dates with only the very late flowering treatments showing a reduction in yield and some varieties yielded the highest when sown mid-June (Figure

1). This yield response was attributed to the good moisture present through the latter half of the season after a very dry start; circumstances that have a low probability of occurring from year to year.

On the whole, April sowing was not associated with increased yields at Mullewa and Katanning. At Katanning, varieties with a similar flowering date ranged in yield from 1t/ha to nearly 3t/ha, likely due to frost (Floret Sterility (FS) scores will be available at a later date). The response at Mullewa suggests “bolting”, however limited yield component data indicates that biomass and tiller number where not limiting in the April sowings (complete data set will be available at a later date). In contrast, depending on the variety, April sowings were associated with higher yields at Merredin and EDRS, although the dates of flowering associated with the highest yields were narrower at Merredin compared to EDRS.

In 2017, the “optimum flowering period (OFP)” was later and wider at Mullewa than the 25 August to 15 September outlined by Anderson et al. (2000). Alternatively, the “OFPs” were slightly earlier than September at Merredin, similar at Katanning (mid-September to early October) and wider than September at EDRS than those suggested by Anderson et al. Growing season conditions (Table 1) at each location in 2017 will have influenced these responses.

Variety response to sowing time

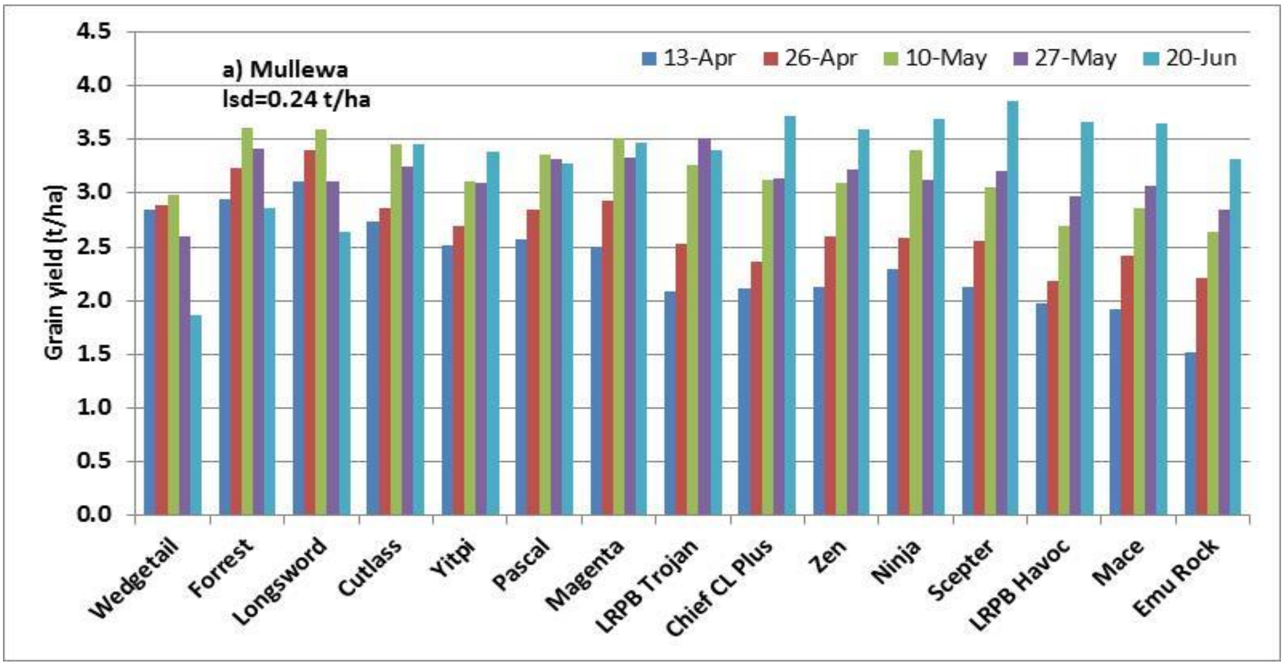
At Mullewa, as in Dandaragan in 2015 and Mullewa in 2016 (Shackley et al. 2016, Shackley et al. 2017), the highest yields for the long (including winters) and mid-long maturing varieties were achieved at the early May sowing (Figure 2a). Forrest$^{\phi}$ (long spring, ASW) and Longsword$^{\phi}$ (fast winter, default Feed) achieved the highest yields in the April and early May sowings. The mid-long maturing varieties yielded similarly to the long maturity varieties when sown in early May and unlike the longer varieties or results of previous years, showed no yield penalty when sowing was delayed until late May or mid-June (likely due to the favourable finish). All short and mid maturing varieties yielded highest when sown in June. So while Forrest$^{\phi}$ flowered 50 to 32 days after Mace$^{\phi}$ when sown April to early May and Longsword$^{\phi}$ flowered 68 to 45 days after Mace$^{\phi}$, at the sowing time that gave peak yield (early May for Forrest$^{\phi}$ and Longsword$^{\phi}$ and mid-June for Mace$^{\phi}$), these varieties all flowered within 13 to 0 days respectively, highlighting the opportunities that using multiple varieties can give in maximising yield across wide sowing times.

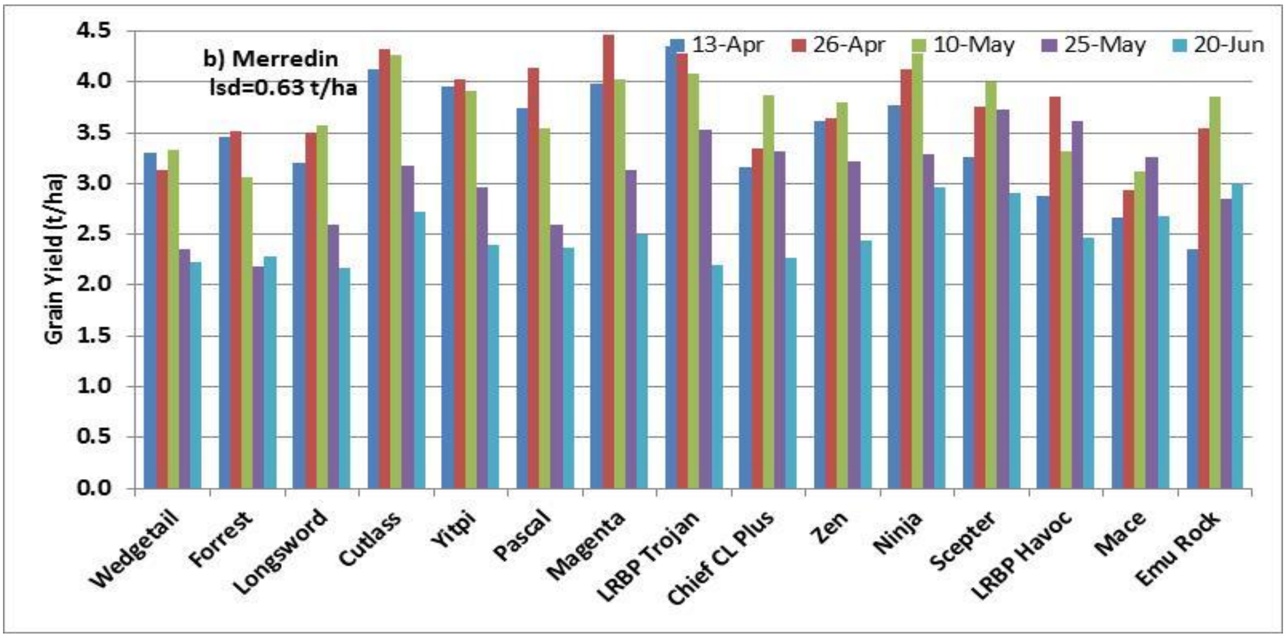
At Merredin, early sowing (whether April or early May) did not have a large impact on the yields of the long and mid-long maturing varieties (Figure 2b). However Forrest$^{\phi}$ and Longsword$^{\phi}$ yielded significantly lower than the mid-long varieties at these sowing times which is in contrast to Forrest$^{\phi}$’s performance in 2016. Although this site had a long fallow/peas rotation, crown rot was evident at the site (S Miyan pers comm) which could explain the poor performance of Forrest$^{\phi}$ (rated SVS for crown rot) in 2017 and the excellent performance of Trojan$^{\phi}$ and Emu Rock$^{\phi}$ which are rated MS. It should be noted that Magenta$^{\phi}$, Cutlass$^{\phi}$ and Ninja$^{\phi}$ also yielded well at this site despite the ratings of MSS, S and SVS$_p$ respectively. The short-mid varieties, such as Scepter$^{\phi}$, yielded significantly higher than the longer maturing varieties when sown later, however although these are the best option for late sowing, unlike Mullewa they were lower yielding than longer maturing varieties that were sown early.

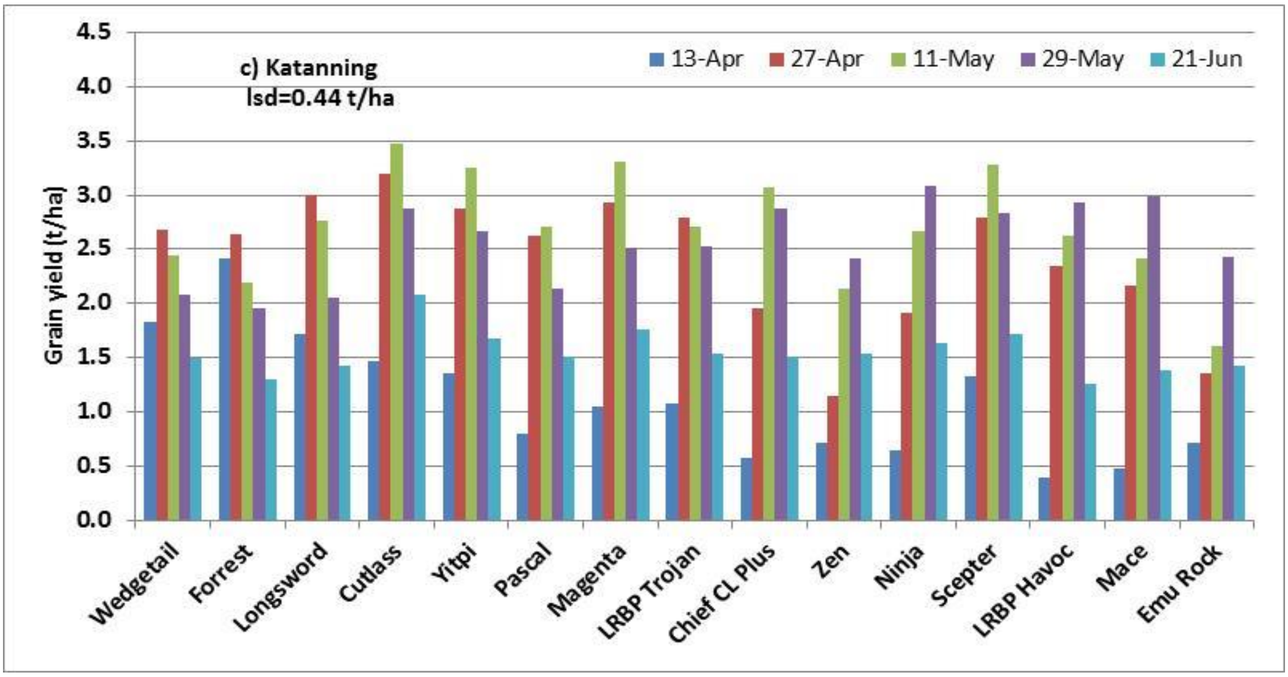
Frost was an issue at Katanning in 2017, although not as severe as 2016. Forrest$^{\phi}$ was the highest yielding variety sown mid-April (Figure 2c), where the frost damage was estimated to range from over 95% FS to approximately 10% FS for the long maturing varieties (complete data available at a later date). Longsword$^{\phi}$ and the mid-long maturing varieties were the highest yielding when sown late April, while the highest yields were achieved at the early May sowing by Cutlass$^{\phi}$, Yitpi$^{\phi}$, Magenta$^{\phi}$, Chief CL Plus$^{\phi}$ and Scepter$^{\phi}$. The outstanding performance of Scepter$^{\phi}$ and Chief CL Plus$^{\phi}$ was not expected when sown early May in this frost prone environment. Initial observations are that Scepter$^{\phi}$ and Chief CL Plus$^{\phi}$ have lower FS scores than other short to mid varieties which is not totally explained by the differences in flowering – Scepter$^{\phi}$ was only 2 days later to flower than Mace$^{\phi}$. Generally the mid and short-mid maturing varieties were the highest yielding varieties at the later sowing dates.

Forrest$^{\phi}$, Longsword$^{\phi}$, Cutlass$^{\phi}$, Yitpi$^{\phi}$, Pascal$^{\phi}$, Trojan$^{\phi}$ and Scepter$^{\phi}$ were the highest yielding varieties sown mid-April at EDRS in 2017 (Figure 2d). In this environment, short-mid varieties have performed exceptionally well at early sowing dates despite their shorter maturity (Shackley et al. 2016, Shackley et al. 2017). Apart from the long maturing varieties, maturity has had less impact on when a variety should be sown at EDRS than at other locations. This is likely due to the moderate temperatures (low bolting risk, low frost and heat event frequency etc.) of the area and the exceptional seasons of the last three years characterised by consistent rainfall (lack of dry spells) across the growing season. There was very little yield decline with delayed sowing at this site with averages of 4.9t/ha sown mid-April, 5.4t/ha sown late April and early May, and 5.3t/ha sown late May. Despite low yield decline with delayed sowing (or conversely a yield penalty for sowing short maturity varieties early), the consistent performance of some long (e.g. Forrest$^{\phi}$) and mid-long (e.g. Cutlass$^{\phi}$, Trojan$^{\phi}$, Pascal$^{\phi}$) varieties across seasons at April sowing dates gives growers an opportunity to diversify their wheat program that typically consists of >80% short to mid varieties and is geared towards May sowings.

Yield component analysis is still to be completed for all the four sites in 2017.


a) Mullewa
lsd=0.24 t/ha
13-Apr
26-Apr
10-May
27-May
20-Jun
Grain yield (t/ha)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Wedgetail
Forrest
Longsword
Cutlass
Yitpi
Pascal
Magenta
LRPB Trojan
Chief CL Plus
Zen
Ninja
Scepter
LRPB Havoc
Mace
Emu Rock


b) Merredin
lsd=0.63 t/ha
13-Apr
26-Apr
10-May
25-May
20-Jun
Grain Yield (t/ha)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Wedgetail
Forrest
Longsword
Cutlass
Yitpi
Pascal
Magenta
LRBP Trojan
Chief CL Plus
Zen
Ninja
Scepter
LRBP Havoc
Mace
Emu Rock


c) Katanning
lsd=0.44 t/ha
13-Apr
27-Apr
11-May
29-May
21-Jun
Grain yield (t/ha)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Wedgetail
Forrest
Longsword
Cutlass
Yitpi
Pascal
Magenta
LRBP Trojan
Chief CL Plus
Zen
Ninja
Scepter
LRBP Havoc
Mace
Emu Rock

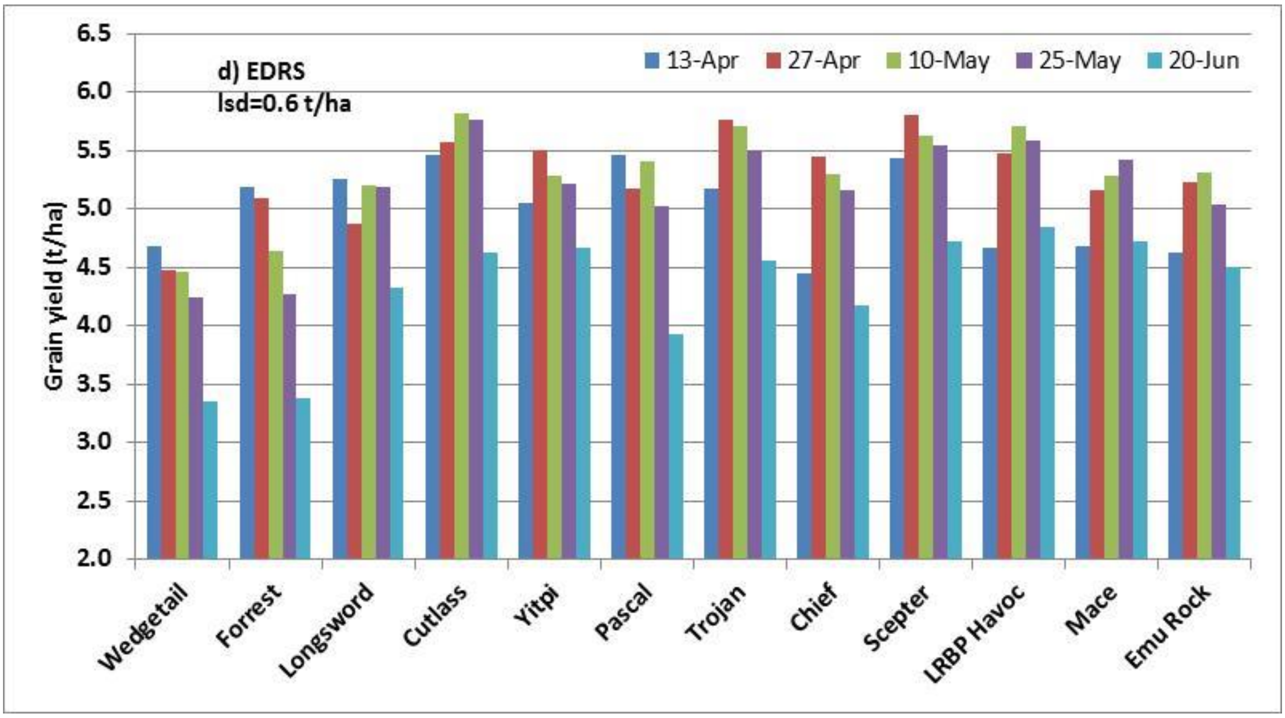


Figure 2: Grain yield (t/ha) response of wheat varieties to sowing time at a) Mullewa, b) Merredin, c) Katanning and d) EDRS in 2017. Varieties arranged from left to right in order of average maturity at that site. Severe frost damage occurred at Katanning and crown rot was evident at Merredin.

Grain quality

As in previous seasons, preliminary grain quality analysis has shown stained grain (blackpoint) to be present in the early sowings, as was frost damage at Katanning in 2017.

Conclusion

With the succession of April sowing opportunities over the past few years, growers are seeking information on varieties suitable for April sowings. Long maturing varieties such as Longsword⫚ (released by AGT in 2017) and Forrest⫚ have been shown to be competitive in terms of yield with mid-long maturing varieties such as Cutlass⫚ and Magenta⫚ when sown in April, but the lower grain classification of Feed (by default) and ASW may deter their adoption. Along with yield, grain quality (blackpoint, pre-harvest sprouting etc.) and disease risk varies with sowing time and environment and varietal susceptibility to these factors will be an important consideration when choosing what variety to sow in a particular environment at any given sowing time.

Sowing wheat at the right time is one of the most important means of maximising grain yield (Sharma et al. 2008) and it should be noted that the highest grain yields were not associated with the earliest sowing date at all sites. Yields were limited by frost at Katanning and by other factors such as heat stress, lack of biomass (bolting) and drought at Mullewa. Although varied across environments and seasons, maturity effect on yield performance was evident and the results highlight that just as long maturing varieties should not be sown in late May, mid maturing through to short maturing varieties are typically not suited to be sown in April.

These results support the previous work of Anderson et al. (2000) in defining the “optimum flowering period” and in emphasising the importance of optimising sowing time for a given variety in the wheat program to optimise yield.

Note:

‘⫚ Varieties displaying this symbol beside them are protected under the Plant Breeders Rights Act 1994.

® Registered trademark

References

Anderson, W.K., Belford, R.K., Crosbie, G.B., Loss, S.P., Mason, M.G. & Perry, M.W. 2000. Sowing Time. *In:* Anderson, W.K. & Garlinge, J. (eds.) *The Wheat Book: Principles and Practice.* 2 ed. Perth, Western Australia: Department of Agriculture, Western Australia.

Shackley, B., Zaicou-Kunesch, C. and Curry, J. (2016). Early sown wheat – opportunities and risks. 2016 GRDC WA Grains Research Update, Perth, WA, 29-30 Feb 2016.

Shackley, B., Zaicou-Kunesch, C., Curry, J., and Nicol, D. (2017). Capturing early sowing opportunities for wheat in WA. 2017 GRDC WA Grains Research Update, Perth, WA, 27-28 Feb 2017.

Sharma, D.L., D'Antuono M.F., Anderson, W.K. Shackley, B.J., Zaicou-Kunesch, C.M. and Amjad M. 2008: Variability of optimum sowing time for wheat yield in Western Australia. *Australian Journal of Agricultural Research*, 59, 958–970

Key words

Sowing, flowering, wheat varieties

Acknowledgments

The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and GRDC investment. The author would like to thank them for their continued support. This research is also co-funded by DPRID. Sincere thanks to the Critch family for the provision of land at Mullewa, to the Geraldton, Merredin, Katanning and Esperance RSUs for the management of trials and for the technical support of Melanie Kupsch, Bruce Haig and Rod Bowey.

GRDC Project Number: DAW00249 'Tactical wheat agronomy for the west'

Paper reviewed by: Kelly Ryan

Appendix

Appendix 1: Characteristics of wheat varieties included in the 2017 trials.

Variety	Classification	Maturity	Maturity traits		
			Vernalisation	Photoperiod	BVP
Emu Rock	APW	Short	Low	Low	Low
Mace	AH	Short-mid	Very low	Nil	Medium
Scepter	AH	Short-mid	Very low	Nil	Medium
LRBP Havoc	AH	Short-mid			
Hydra	APW	Short-mid	Very low	Nil	Medium
Chief CL Plus	APW	Mid			
Ninja	ANW	Mid			
LRPB Arrow	APW	Mid			
LRPB Trojan	APW	Mid-long	Very low	Low	Medium
Zen	ANW	Mid-long			
Tungsten	AH	Mid-long			
Magenta	APW	Mid-long	Low	Very low	High
DS Pascal	APW	Mid-long			
Yitpi	AH	Mid-long	Nil	High	High
Cutlass	APW	Mid-long	Nil	High	High
Forrest	ASW	Long	Nil	Very high	High
Longsword	Feed (default)	Long (fast winter)	High	Nil	High
LRBP Kittyhawk	Feed (default)	Long (winter)	High	Nil	Very high
EGA Wedgetail	APW	Long (winter)	High	Nil	Very high