Can we extend the sowing window of canola in WA: #3 Beverley

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Key messages

- Yields were relatively stable across sowing times ranging from 2.2 to 3.1 t/ha.
- Early and mid-season hybrid varieties out-yielded the open pollinated varieties of the same season length.
- These hybrids combine early flowering, high biomass and in some cases a long flowering period.
- In general varieties had substantial plasticity and growers may be able to use a few varieties across a wide range of emergence dates; this is important if pre-ordering hybrid seed and/or dry sowing.

Background

There is considerable interest in sowing canola early to maximise yield and minimise the risk of missing a sowing opportunity (Harries 2016). Traditionally ANZAC day marked the date on which growers would start dry seeding. However, now growers are routinely sowing in mid-April and are prepared to sow around the first week of April if there is rain at that time (Fletcher et al 2016). For the past 120 years, since the release of Federation wheat, plant breeding programs of all crop species have focused on increasingly short season varieties with high harvest index (Pugsley 1983). More recently longer wheat genotypes are being explored (Hunt 2017), because these may be better adapted to earlier sowing. The same needs to occur with broadleaf species by testing current varieties at a wide range of sowing dates and comparing these to diverse phenotypes.

Aims

To investigate yield and phenology of canola varieties when sown in March to provide better advice to agronomists and growers about the best varieties to use and safe sowing and flowering windows.

Method

The trial was conducted in 2018 at the Department of Primary Industries and Regional Development frost research site at Westdale, 50km west of Brookton on a grey sandy loam. Plots were 12m long by 1.54m wide. Treatments included 11 varieties and four times of sowing (TOS) (March 15, April 5, April 26 and May 17). The varieties were all Triazine Tolerant (TT) and included both open pollinated and hybrid plant types of a wide range of season lengths: CBTelfer (V.Early), ATR Stingray (Early), ATR Bonito (Early/mid), ATR Wahoo (Late), Hyola 350TT(V.early) Bayer InVigor T4510 (Early), Pioneer 44TO2 (Early), Hyola 559TT (Mid), SF Ignite (Mid/late), DG 670TT (Late), Hyola 725RT (Late). Varieties were blocked within times of sowing and there were 4 replicates.

Measurements included: plant density, Normalised Difference Vegetation Index (NDVI), ground cover, flowering dates, plant biomass near maturity, seed yield, seed oil content and seed weight. The seed rate used for each variety was calculated for a target density of 40 plants/m^2 at an expected field establishment rate of 65%. Irrigation was applied for establishment and to ensure survival of seedlings in the dry conditions from Mid-March to May 23. Consequently more irrigation was required for earlier sowing dates: TOS 1, 2, 3, and 4 received 108, 128, 75 and 73 mm respectively.

Results

Seasonal conditions

Rainfall at the site from March 15 to October 31 was 220mm and 121mm had been received prior to March 15. There was only 9.6mm of rain between the first and last sowing dates, March 15 and May 17. Total growing season rainfall plus irrigation was 309, 332, 281 and 292mm for TOS 1, 2, 3 and 4 respectively. It was not possible to apply more water to later sowing dates as the site was at risk of waterlogging.

Table 1. Rainfall (mm) Westdale Research station, 2018

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Site	89	31	1	8	45	42	51	54	5	15	0	0	341

Soil moisture

Soil moisture increased with depth and was similar for each sowing time, consistent with lack of rainfall to May 23. Prior to sowing on March 15 gravimetric water content was: 5.9, 7.5, 9.8, 14.2 and 15.5% at 0-10, 10-20, 20-30, 30-50 and 50-90cm respectively.

Soil and air temperature

Maximum air temperature spiked to 30°C from mid-March to early-May (Figure 1) and surface soil temperature exceeded 30 degrees from mid-March to early April (Figure 2a). After the first week of April sub-soil temperature declined to around 20°C (Figure 2b). Air temperature declined below 0°C on several days in mid-September. Data loggers at canopy height recorded a maximum of 3.3 hours below 0°C across the site.

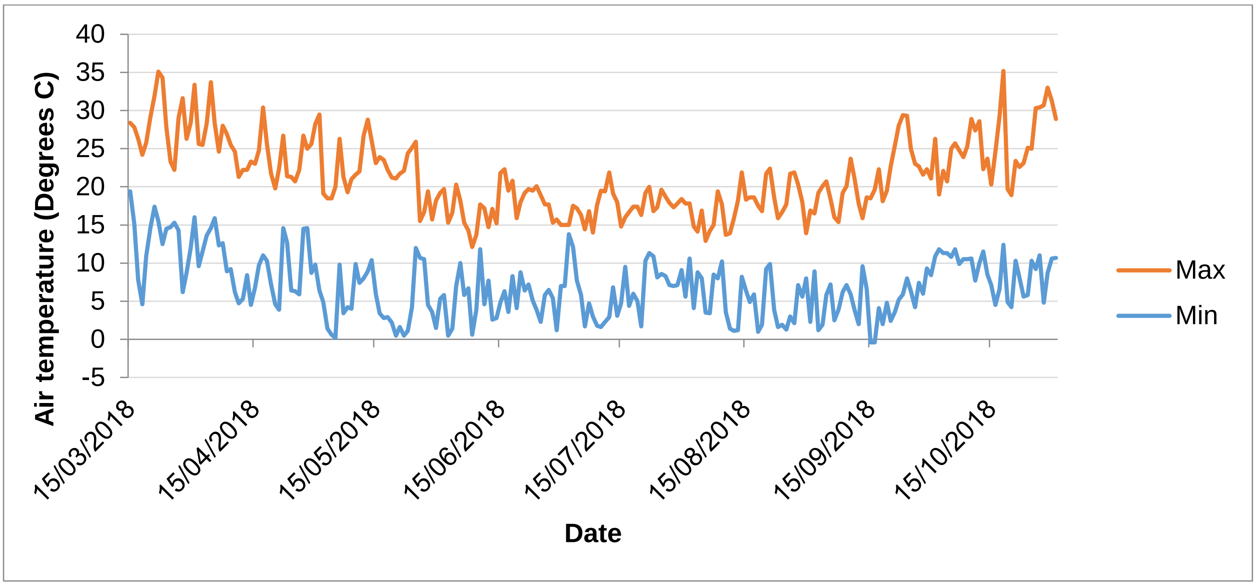


Figure 1. Air temperature measured daily at the Westdale Research station 2018 (°C)

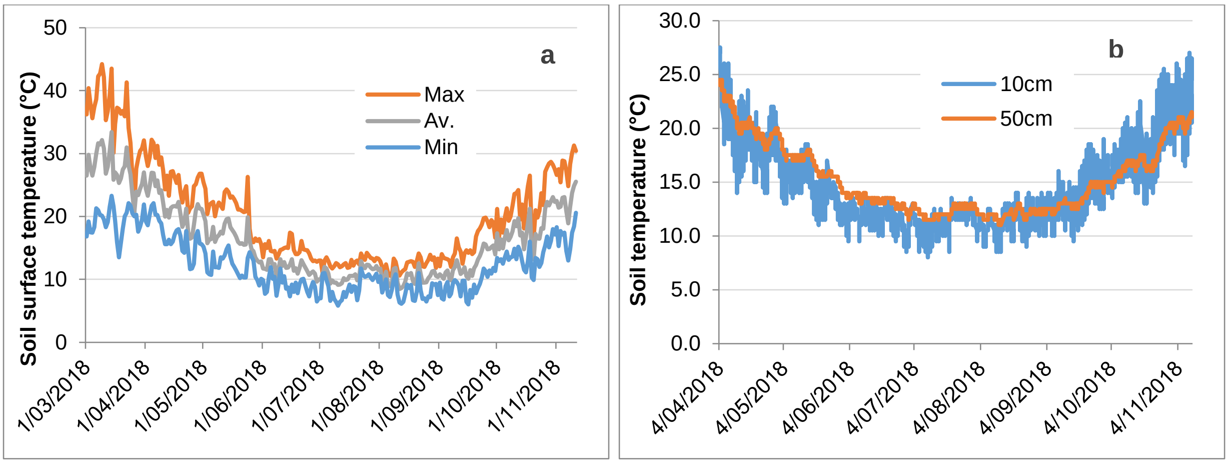


Figure 2. Soil temperatures at the Westdale Research station 2018. Surface daily, 10 and 50cm, 3 hourly (°C).

Establishment and growth

Overall plant establishment was close to the target and was 35 plants/m^2 and 56% field establishment (FE). There was a significant TOS response, (P <0.001). From TOS 1 there were more plants per square metre than the other three sowing times; 55 plants/m^2 (88% FE) compared to 27 plants/m^2 (44% FE), 28 plants/m^2 (45% FE) and 28 plants/m^2 (45% FE) for TOS 2, 3 and 4 respectively. There was also a difference (P <0.001) in establishment of the varieties, despite all plots receiving 1173 viable seeds. The range between varieties was 28 plants/m^2 to 39 plants/m^2. CBTelfer and Hyola 725RT produced the lowest densities. Seed of these varieties was a few years old because it was not available for purchase. There was no statistical interaction of TOS and variety. Field establishment was not related to seed size at any sowing date.

Plant growth was measured as biomass (Figure 3a) and % ground area cover (Figure 3b) at several dates. Sowing date had a large effect on both when measured at 47 and 41 days after sowing (P <0.001). This indicates higher growth rates with earlier sowing times, as expected given the warmer conditions at earlier sowing times. Averaged across sowing times there was a variety effect on biomass 47 days after sowing ($P < 0.01$) but not on ground cover 41 days after sowing. At 47 Days after sowing ATR Stingray had produced the least biomass 92 g/m^2, less than all other varieties except ATR Bonito, and InVigor T4510 had produced the most at 116 g/m^2.

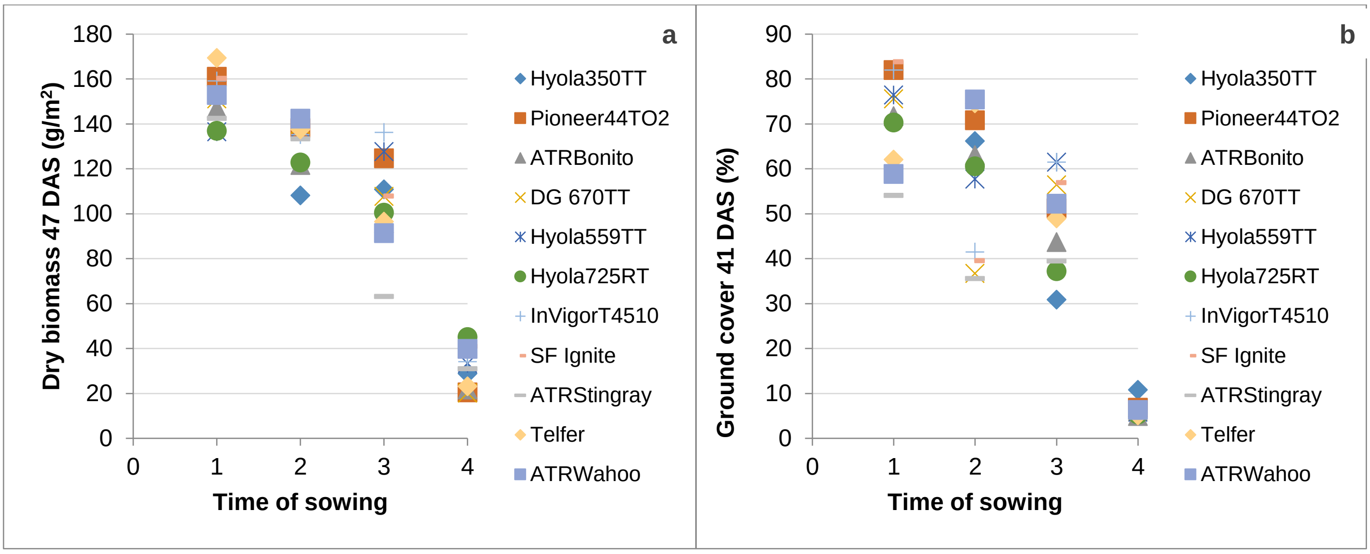


Figure 3. Plant growth (g/m^2) at 47 days after sowing (DAS) and % ground cover at 41 DAS of 11 canola varieties.

Development

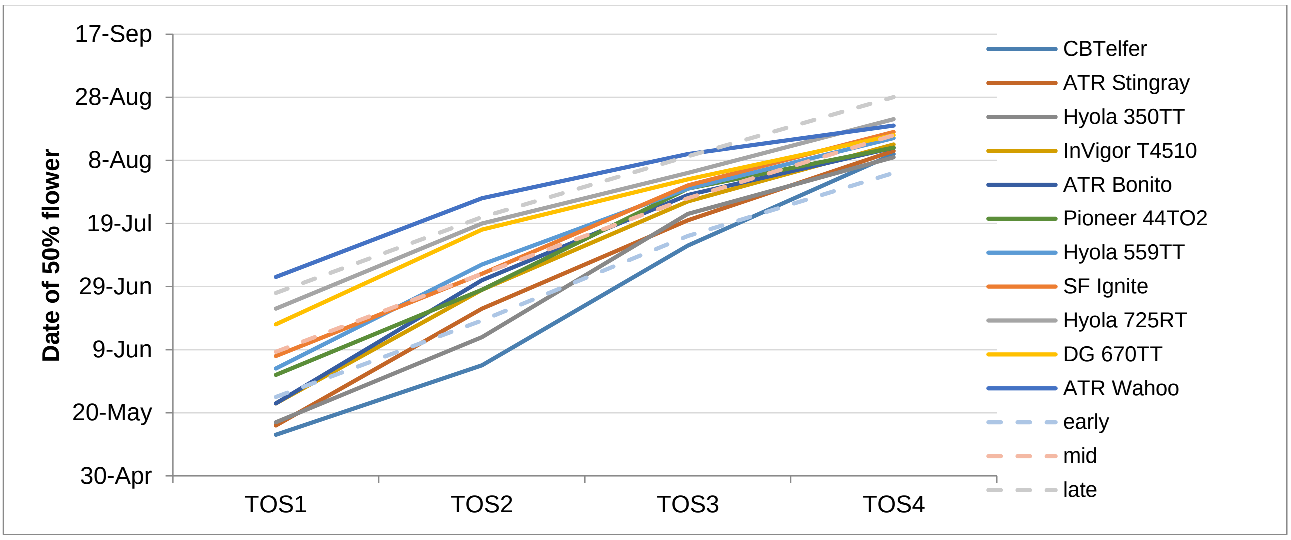
Flowering on the main stem was measured from the same 20 plants per plot throughout the experiment. Later sowing had the effect of reducing the differences in flowering time of the varieties, as would be expected to occur in response to reduced growing period (Figure 4). From TOS 1 the earliest varieties reached 50% of plants with flowers on the main stem by May 13 (59 DAS) and latest varieties reached this stage on July 2 (109 DAS), such that there was 50 days difference between them. For TOS 4 the earliest varieties reached 50% of plants with flowers on the main stem by August 1 (84 DAS) and latest varieties reached this stage on August 14 (96 DAS), such that there was 12 days difference between them (Figure 4). The duration of flowering of the whole plant was estimated by rating the percentage bloom from whole plots. Flowering duration from TOS 1 ranged across varieties from 50 to 78 days. This compared to 49 to 59 days for TOS 4. Hence later sowing had the effect of reducing the whole plant flowering duration and the difference in flowering duration between varieties (Table 2).

APSIM modelling of flowering dates differed from observations. It was observed that delaying sowing caused flowering dates of the varieties to converge more than was predicted by APSIM (Figure 4). This may be associated with the way in which APSIM calculates vernal time. The model uses 24 hour maximum/minimum average temperature however averaging smaller time steps may be more accurate and identify a greater number of vernalisation hours (Whish 2018). APSIM results are discussed further in (Farre et al 2019).

Table 2. Whole plot ratings of bloom, dates at first and last 10% of bloom and duration between these dates.

	March 15 (TOS 1)			April 5 (TOS 2)			April 26 (TOS 3)			May 17 (TOS 4)			
Variety	First 10%	Last 10%	Days	First 10%	Last 10%	Days	First 10%	Last 10%	Days	First 10%	Last 10%	Days	Days difference TOS 1 to TOS 4
ATR Stingray	14/5	24/7	71	8/6	10/8	63	11/7	26/8	46	3/8	23/9	51	20
Hyola 350TT				24/5	10/8	78	12/7	2/9	52	1/8	19/9	49	
InVigor T4510	18/5	31/7	74	15/6	17/9	94	17/7	2/9	47	6/8	24/9	49	25
ATR Bonito	18/5	26/7	69	13/6	15/8	63	18/7	2/9	46	6/8	24/9	49	20
Pioneer 44TO2	19/5	5/8	78	16/6	17/8	62	15/7	2/9	49	3/8	22/9	50	28
Hyola 559TT	23/5	6/8	75	23/6	18/8	56	18/7	7/9	51	6/8	24/9	49	26
DG 670TT	4/6	14/8	71	27/6	20/8	54	19/7	14/9	57	6/8	24/9	49	22
SF Ignite	23/6	12/8	50	18/6	20/8	63	20/7	16/9	58	7/8	27/9	51	-1
Hyola 725RT	8/6	20/8	73	29/6	3/9	66	24/7	18/9	56	9/8	3/10	55	18
ATR Wahoo	20/6	29/8	70	10/7	6/9	58	31/7	20/9	51	8/8	6/10	59	11

Note: Telfer not reported as bird damage affected flowering duration.



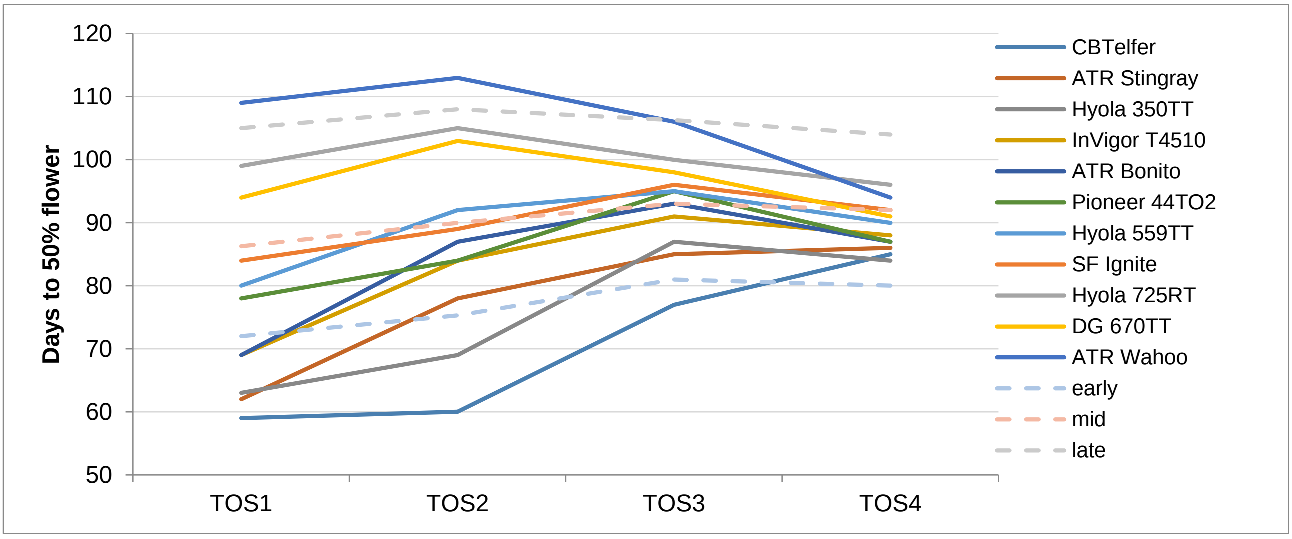


Figure 4. Flowering on main stem; dates and days from seeding for 11 canola varieties, and simulated APSIM dates for 4 canola maturity groups, from time of sowing 1 (March 15), 2 (April 5), 3 (April 26) and 4 (May 17) at Westdale in 2018.

Yield and quality

Yield was 2.17, 2.93, 3.09, and 3.01 t/ha for TOS 1, 2, 3 & 4 respectively. It should be noted that there was bird damage to TOS 1 and apart from this time of sowing the yield response was not significantly different across the April 5 to May 17 sowing dates. Averaged across sowing times, variety yields were significantly different (P <0.001) ranging from 2.1 t/ha (CBTelfer) to 3.1 t/ha (InVigor T4510). Across all sowing times the short season Hybrids (Pioneer 44TO2, InVigor T4510 and Hyola 350 TT) out-yielded the short season OP's (CBTelfer and ATR Stingray) by 31%. The mid-season hybrids out-yielded Bonito by 12% and Hyola 725RT yielded 16% less than ATR Wahoo, the OP long season variety. There was no significant interaction between variety and sowing date (Table 3). Time of sowing and variety affected seed oil and seed size (Table 3). Seed oil concentration was lowest from TOS 4 and highest from TOS 2. Varieties ranged from 44.1 to 46.7%, this represents a $20/tonne difference between varieties. Seed weight was highest from TOS 3 and lowest from TOS 1 and varieties ranged from 3.2 to 4.6 grams per 1000 seed.

Table 3. Yield (kg/ha), seed oil concentration (%) and 1000 seed weight (g).

	Yield (kg/ha)					**Oil (%)**					**1000 seed weight (g)**				
Variety	TOS 1	TOS 2	TOS 3	TOS 4	Var av	TOS 1	TOS 2	TOS 3	TOS 4	Var Av	TOS 1	TOS 2	TOS 3	TOS 4	Var Av
Pioneer 44TO2	2.50	2.61	3.19	3.29	2.90	44.9	45.0	45.5	44.6	45.0	4.4	4.3	4.1	3.6	4.1
ATR Bonito	1.95	3.00	2.88	2.81	2.66	45.7	47.5	47.7	46.2	46.7	4.6	4.3	4.4	3.9	4.3
DG670TT	2.37	3.50	3.42	2.97	3.06	45.3	46.3	44.9	42.3	44.7	4.0	4.0	3.8	3.7	3.9
Hyola 350TT		3.57	3.12	3.40	3.36		44.7	45.4	44.9	45.0		4.4	4.3	4.0	4.2
Hyola 559TT	2.41	2.70	3.28	3.16	2.89	47.0	46.4	46.9	45.4	46.4	4.8	4.8	4.7	4.2	4.6
Hyola 725RT	1.90	2.59	2.78	2.67	2.49	46.6	47.8	47.0	45.0	46.6	4.1	4.0	4.3	3.8	4.0
InVigor T4510	2.28	3.28	3.53	3.33	3.10	44.8	45.6	45.8	44.1	45.1	4.2	3.9	4.0	3.9	4.0
SFIgnite	2.57	3.00	3.46	3.01	3.01	44.5	44.2	45.4	43.6	44.4	3.9	3.9	3.8	3.4	3.7
ATR Stingray	1.50	2.67	2.73	3.03	2.48	44.6	46.4	46.6	45.8	45.8	3.4	3.1	3.1	3.1	3.2
CBTelfer	1.74	2.08	2.46	2.44	2.18	45.3	45.8	46.3	44.6	45.5	4.2	4.0	4.1	3.8	4.0

ATR Wahoo	2.47	3.29	3.13	2.99	2.97	45.4	45.9	46.1	44.7	45.5	4.2	4.1	4.1	3.7	4.0
TOS Av.	2.17	2.93	3.09	3.01	2.83	46.6	49.1	47.2	45.1	47.0	3.8	4.1	4.3	4.0	4.0
P value TOS	NS					<0.05					<0.05				
Lsd TOS						0.85					0.166				
P value Var	<0.001					<0.001					<0.001				
Lsd Var	0.231					0.41					0.075				
P value interaction	NS					<0.001					<0.001				
Lsd interaction	0.05					1.02					0.193				

Conclusion

There are a wide range of maturity types within existing canola cultivars. Mid season varieties had the greatest plasticity in flowering duration over a wide range of sowing dates. Yields were flat across sowing times and there was no sowing time by varieties response. This indicates that varieties have substantial plasticity and growers may be able to use a few varieties across a wide range of sowing dates. This is particularly important for growers using hybrids as seed needs to be ordered well in advance of the break of the season. The yield and plasticity of the new early/mid hybrid types was impressive and these varieties represent a move towards early flowering types which are able to continue growth and seed production while seasonal conditions are favourable. This is an ideotype breeders should pursue, particularly as the area of dry sown canola increases and emergence time is unknown at the time of sowing. We will repeat this trial in 2019 and net plots to avoid bird damage.

Key words

Canola, sowing time, variety

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