Expanding sowing window of canola at Mullewa, 2020

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Key Messages

- Growers could consider taking early sowing opportunities, since early April sowing, with good follow-up irrigation was 25% higher yielding that sowing three weeks later on 29 April, in this trial.
- The yield of long maturity varieties declined with later seeding dates. However, InVigor T4510 (early-mid maturity) achieved similar yields to the longer maturity varieties with very early sowing on March 18, as well as higher yields with April sowing, proving to be very adaptable.

Aim

- To determine if a profitable canola crop can be grown from a March seeding.
- To compare the relative yield and profitability of different seeding times.
- To determine if it is best to use a long season variety for very early seeding opportunities.

Background

Climate change is causing a negative effect on Western Australian dryland cropping. The changes are manifesting as less regular autumn rainfall, reduced rainfall during the growing season and increased temperatures in spring. In the context of canola farming, this means fewer opening rain events. Yields are likely to be reduced in parallel with reduced growing season rainfall, also from higher temperatures during the critical period (at the start of flowering), and further yield reductions from earlier and greater terminal drought, caused by the combination of lower growing season rainfall and higher temperatures.

There is considerable interest in sowing canola early minimise the risk of missing a sowing opportunity, as well as achieving high yields. Traditionally ANZAC day marked the date on which growers would start seeding. However, some growers are now sowing in Mid-April and may consider sowing earlier, if an opportunity presents. Extending the sowing window to Mid-March would provide a further 31 days to capture a good sowing opportunity.

Method

Canola was sown over four sowing dates at Mullewa, at three week intervals, from 18 March 2020 (Table 2). Five triazine tolerant canola varieties were grown, from early to late maturity. The trial included both open pollinated and hybrid varieties (Table 3). Pre-seeding irrigation was done with an overhead irrigator, and surface irrigation for post seeding applications. Pre seeding irrigation was targeted to mimic the soil moisture of the 25% of wettest years (calculated from past rainfall records and trial soil type using APSIM) and adjusted for any pre-seeding rainfall. Post seeding irrigation was limited to only ensuring crop survival. Samples were taken at each TOS to calculate soil moisture at seeding. Plots were sown with 100 kg/ha Agras Xtra, and 50kg/ha urea top-dressed. A further 35 kg/ha urea was applied at 4WAS and 70 kg/ha at 7WAS. The total nitrogen application was approximately 85 kg/ha.

Table 1: Varieties sown in 2020 Mullewa trial.

Variety	Type	Harvest maturity
Hyola 350TT	Hybrid	early
ATR Bonito	OP	early-mid
InVigorT4510	Hybrid	early-mid
SF Ignite	Hybrid	mid
ATR Wahoo	OP	mid-late

In 2020, the plots of the first three TOS were netted soon after seeding, to protect from predation by birds and animals.

Crop establishment counts were done 3 weeks after sowing. Crop development was monitored weekly, using the BBCH scale. In addition , weekly flowering assessments were carried out using two methods – a visual estimate of whole plot % bloom (referred to as Plot Bloom %) and counting the number of plants with at least one open flower on the main stem from a subsample of 20 marked plants (referred to as F20 %). Plot bloom was monitored until the end of flowering, and F20 until 50% flowering. F20 was used to compare field and APSIM data. NDVI measurements were taken weekly on each plot from 3 weeks after sowing until full flowering.

As plots reached maturity (30% of seeds dark and hard), biomass cuts were taken, seed and stems separated, and harvest index calculated. Plots were harvested when all TOS plots mature, and the entire plot harvest retained. The harvested seed was weighed, cleaned and analysed for oil, moisture and protein.

Results

The very first COVID-19 lockdown for WA started on 30 March 2020. The trial was already underway with the first seeding completed by this time. Project staff and DPIRD Field Services Unit worked well to get subsequent sowings done in a safe manner and within COVID-19 regulations.

Rainfall and irrigation

Table 2 Site rainfall 2020

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	GS Total
Rainfall	16.4	48.4	29	15.4	16	17.7	62.9	68.3	9	13	184.8
Min temp	9.1	14.3	11.8	7.2	6.7	5.6	2.9	2.3	2.8	2.8	
Max temp	45.8	44.5	40.1	39.4	39.4	29.8	28.5	29.6	33.2	39.5	

Table 3: Sowing and harvest dates, irrigation and rainfall for each time of sowing.

	Effective Sowing date	Harvest date	Pre-seeding Irrigation (mm)	Post-seeding Irrigation (mm)	Rainfall (mm): sowing to harvest	Total (mm)
TOS1	18 Mar 20	13 Oct	52	70	185	307
TOS2	8 Apr 20	13 Oct	52	43	185	280
TOS3	29 Apr 20	14 Oct	52	16	185	253
TOS4	24 May 20	26 Oct	0	0	175	175

Seeding progressed as planned for this trial. The last seeding date was May 20, followed by rainfall four days later, so the effective seeding date of TOS 4 was 24 May (Table 3).

Growing season rainfall for the site was 184ml (Table 2)

Pre seeding irrigation was 52 ml for the first three seeding times, as there was negligible rainfall between the seeding times. There was good soil moisture at these sowing times, as demonstrated by the volumetric soil moisture, range of 8-12 for 0-30 cm soil, measured at each seeding day (Table 4). The measured soil moisture for TOS 4 was very low, consistent with dry seeding, and an effective sowing date of May 24, after rain.

There was very little early season rainfall and maximum temperatures of nearly 40°C in April and May (Table 2), demonstrating the risk of crop death from lack of follow-up rain in this environment. To protect our trial, we applied post-seeding irrigation. March 18 sowing had a total of 70 mm post-seeding irrigation, delivered over 12 applications, reduced to 43 mm over 9 applications for TOS 2 and 5 applications for a total of 16 mm for TOS 3.

There was very little rainfall after Aug 18. The first three sowing times were desiccated on 5 October and harvest followed on Oct 13 and 14. The final TOS was desiccated on 19 Oct with harvest following on 26 Oct.

Table 4: Volumetric soil moisture sampled at each time of sowing.

Depth	TOS1 % moisture	TOS2 % moisture	TOS3 % moisture	TOS4 % moisture
0-10	8.8	8.2	11.8	1.7
10-20	8.8	8.4	11.4	2.3
20-30	8.3	8.7	11.8	3.5
30-50	5.0	5.1	12.0	3.8

Plant establishment

There was no significant difference in field establishment due to variety.

There was a significant difference in the field establishment according to time of sowing, with only 16% establishment at March 18 sowing, and steadily increasing to 76% at May 20 sowing (Figure 1). The plots were well irrigated before seeding, so this reduction in field establishment is likely to be due to the temperature at seeding and in following days.

The soil surface was 38° for March 18 sowing, although a lower 26° in the irrigated soil at 1cm, near the seed bed, after the cooling effect of the irrigation (Table 2). Although the ambient temperature at Mullewa was 26 degrees at seeding, this was followed by 9 days with maximum temperatures between 35-40°C. Similarly, April 8 seeding was hot (36°) and similarly followed by four days of temperatures 35-40°.

This difference in field establishment caused major differences in plant density. The average plant density for TOS 1,2 and 3 was 10, 15 and 30, respectively. The plant establishment target of 40 plants/m^2 was only reached for TOS 4, with an average of 47 plants/m^2.

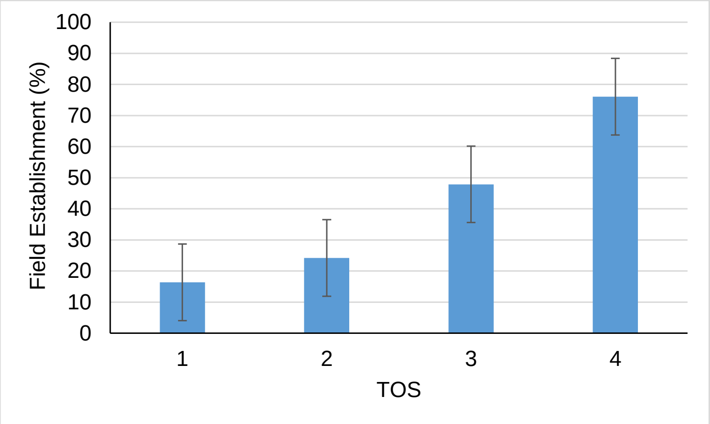

Figure 1. Field establishment (%) was reduced with early sowing (TOS *P* = 0.013, LSD 24.63, Variety *P* = ns)

Table 2. Soil temperatures high for TOS1 and TOS2

	TOS1	TOS2	TOS3	TOS4
Dry soil surface temp	37.9	40.5	27.5	23.5
Wet soil 1 cm	26.25	28	19.75	(dry sown)
Ambient temp	26.1	36.2	25.1	23.1

Development and phenology

Early seeding caused flowering to start at an earlier date. The very first flowers were recorded on 14 May, in Hyola 350TT at 4-5% flowering as well as 1% flowering in some in InVigor T4510 plots.

The duration of flowering was significantly decreased with each subsequent sowing, with an average of 63 days for March 18 sowing (TOS 1) and declined steadily to 34 days at May 24 sowing (TOS4) (Figure 2).

Variety development differences were magnified with early sowing, and crop development converged with later sowing, and (Figures 3 and 4). At March 18 sowing, there was 47 days difference in the days to reach early flowering (50% Plot Bloom), with Hyola 350TT flowering first after only 73 days, and ATR Wahoo flowering last at 120 days. While with the last sowing on 20 May, there was only 16 days difference in the days taken to reach early flowering (85 days for Hyola 350TT and 102 days for ATR Wahoo)

This convergence in phenology is due to vernalisation requirements in longer maturity varieties and the response to thermal time in the short season varieties. The earlier the longer season varieties were sown, the longer the period of time to reach the cool conditions necessary for vernalisation, and flowering initiation. Conversely, when short season varieties are sown early, this generally corresponds to warmer conditions so thermal time requirements are met in a shorter period of time.

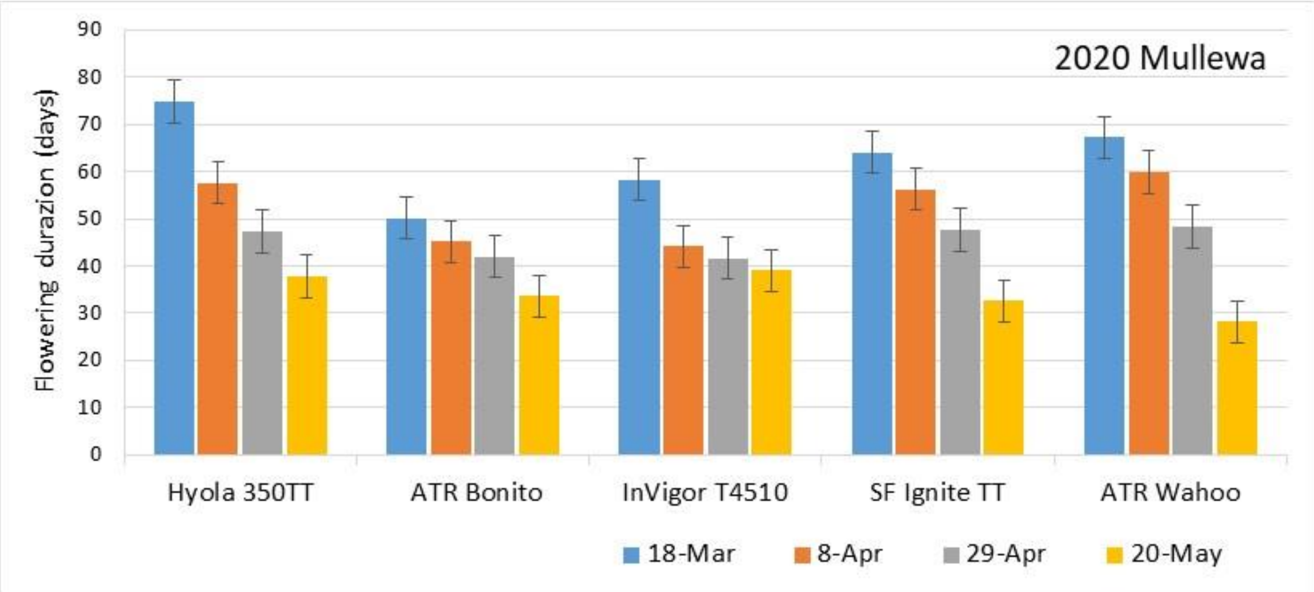

Figure 2 Duration of plot flowering (10% bloom to 90% bloom) (TOS *P* = 0.003, Variety *P* =<0.001, TOS.Variety *P* = 0.003, LSD 8.967)

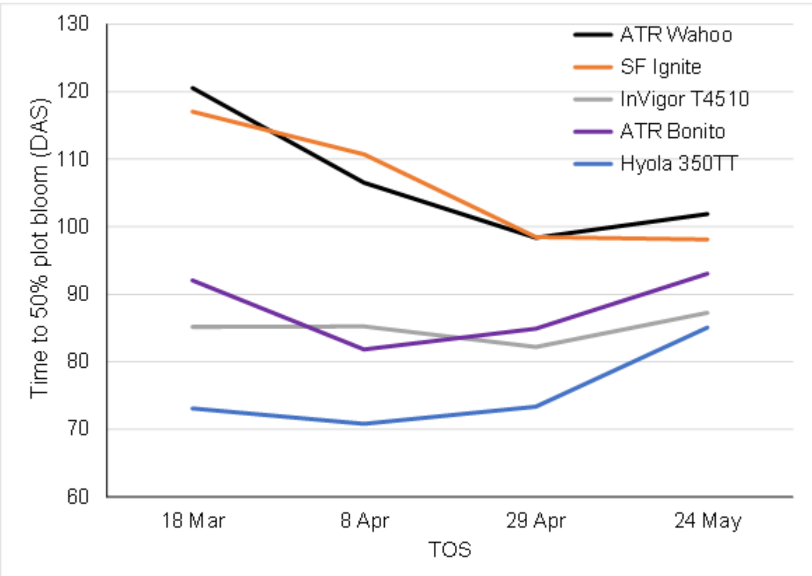

Figure 3 Days from seeding to early flowering (50% Plot flowering) (TOS *P* = 0.055, Variety *P* =<0.001, TOS.Variety *P* = <0.001, LSD 6.229)

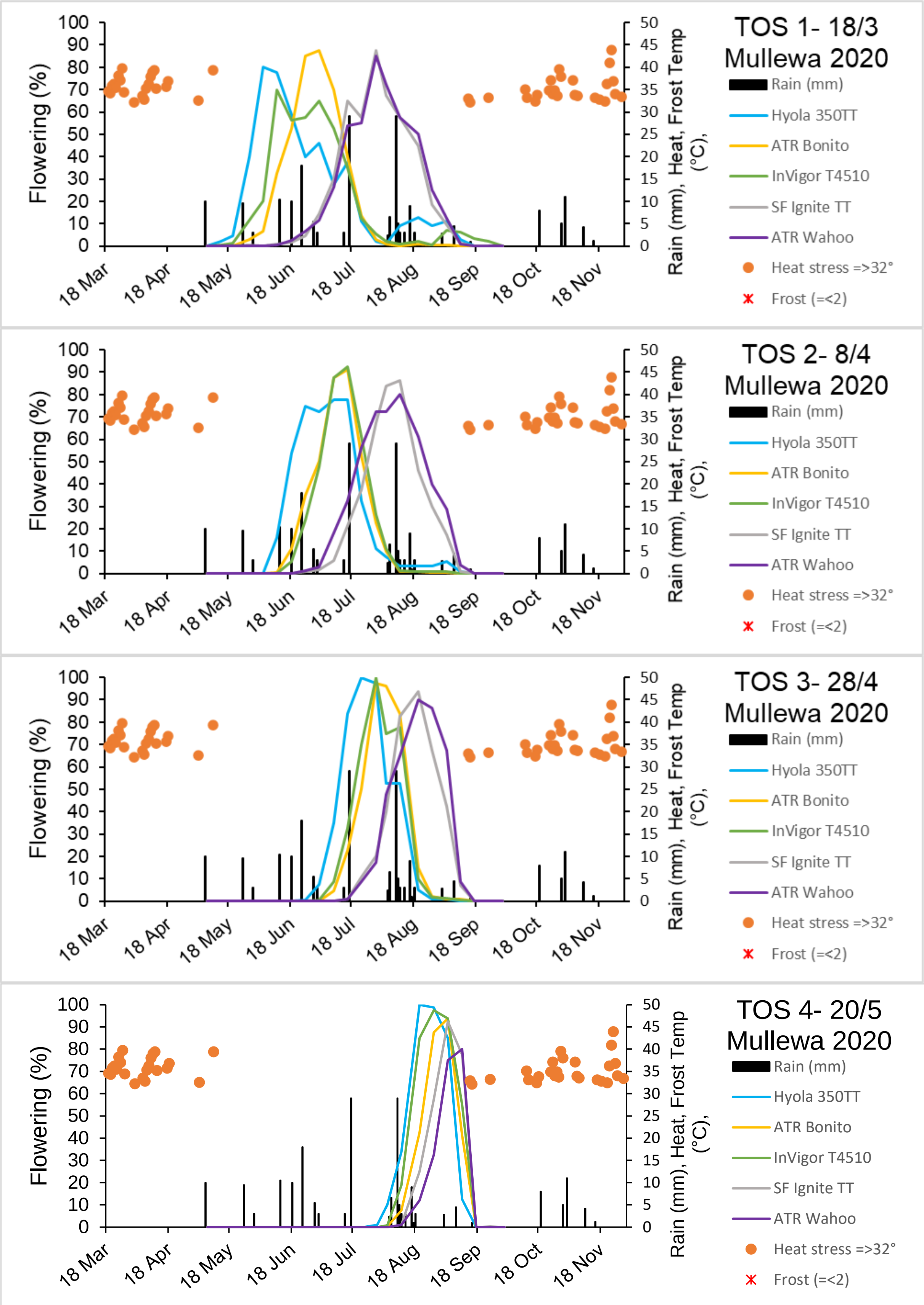

Figure 4 Progression of flowering for short (Hyola 350TT), early-mid (ATR Bonito, InVigor T 4510) and longer maturity varieties (SF Ignite TT, ATR Wahoo), with site rain, critical heat (>32°C) and frost characteristics.

Early sowing brings the flowering period forward, which reduced the risk of critical temperatures at the end of flowering, especially for shorter maturity varieties (Fig 4) Early sowing can also improve the fit of crop growth and seasonal rainfall, increasing the probability or proportion of crop maturation before the terminal drought.

Long term APSIM modelling of *Optimum start to Flower*

This project involves APSIM modelling and validation by Dr Imma Farre. Dr Farre has simulated the long term (average) *Optimal Start to Flower* for a wide range of locations. The simulated optimum start to flowering includes consideration of risk from terminal drought and heat and frost. It is suggested that varieties should begin to flower within the Optimal Start to Flower (OSF) period. For Mullewa, the long term optimal start to flowering is between 20 June and 28th July, for a medium maturity variety (Table 6).

Table 6. Long term APSIM modelling for Mullewa

	Short maturity varieties	Medium maturity varieties	Long maturity varieties
Optimum start of flowering	20 Jun to 17 Jul	26 Jun to 23 Jul	26 Jun to 24 Jul

We found there was a good match between the simulated long-term optimal start to flowering time (Table 6) and the field flowering time (Figure 4), for the traditional time of sowing at the end of April (TOS 3). With early sowing, only the longer maturity varieties SF Ignite and ATR Wahoo began flowering in the optimal window, while the shorter season varieties had largely finished flowering by this time. With May sowing, all the varieties started flowering after the optimal window. However the two highest yielding treatments were sown outside the average optimum sowing time, likely due to the early sown opportunity changing the response.

Yield and seed quality

The highest yielding treatments in the trial were the April 8 seeding of InVigor T4510 (2.04 t/ha) and ATR Bonito (1.90), followed by April 29 seeding of InVigor T4510 (1.70) and April 8 seeding of Hyola 350TT(1.64) (Figure 5). For the shorter maturity varieties. April 8 sowing was the highest, with a reduction at earlier or later sowing times, and severely reduced yield at May 20 sowing. For the longer season varieties, SF Ignite and ATR Wahoo, yields decreased from the initial sowing time, were similar with other variety yields for this sowing time, but lower than for shorter season varieties at TOS 2 (8 April) (Figure 5)

There was a close match of income to the yield pattern. However the highest gross margins were slightly different with the lower cost seed of ATR Bonito contributing to the highest gross margin at ($1163/ha) and statistically similar with InVigor T4510 ($1147). Gross margin was calculated by removing the seed cost from yield and oil income. (Gross margin TOS P = 0.001, Variety P = <0.001, TOS.Variety P = <0.001, LSD 0.254)

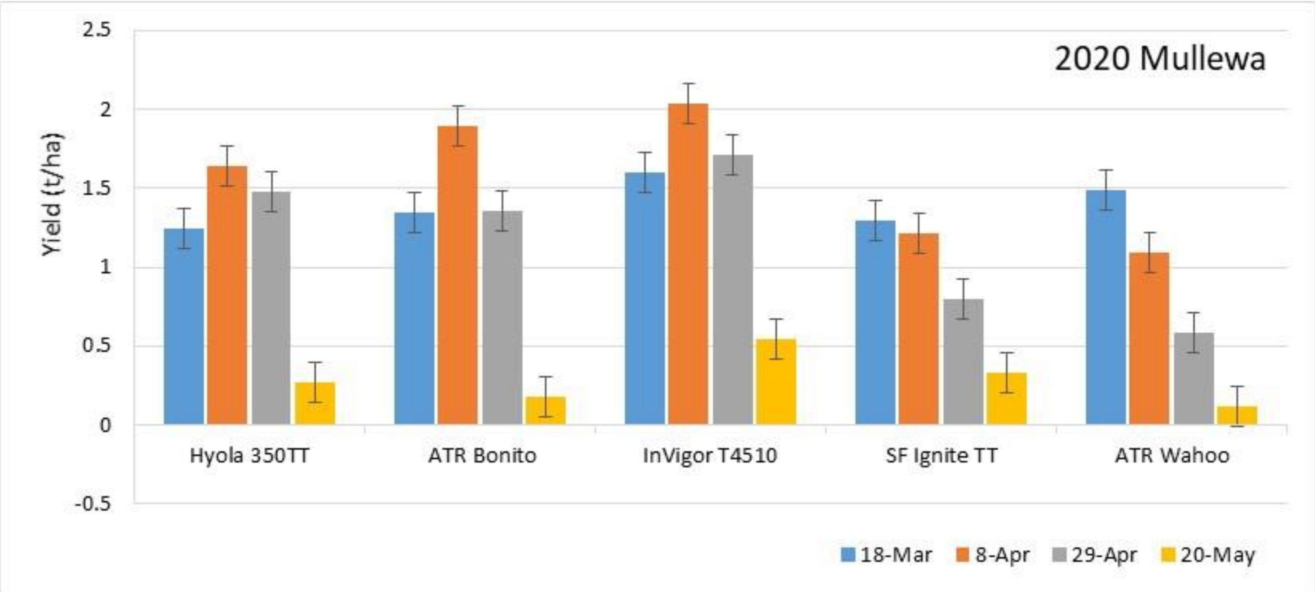

Figure 5.: Seed yield (t/ha) was highest at 8 April TOS for the early and early-mid varieties, but equal or higher for March sowing for the longer season varieties at Mullewa in 2020. (TOS P = 0.001, Variety P = <0.001, TOS.Variety P = <0.001, LSD 0.254)

There was a significant response to harvest index for TOS, variety and the interaction. InVigor T4510 at TOS2 had the highest HI (0.51) followed by the same variety at TOS3 (0.46) and ATR Bonito at TOS2 (0.43).As expected, the lowest harvest index results were generally from TOS4, including InVigor T4510 HI of 0.15 at TOS4. (Figure 6)

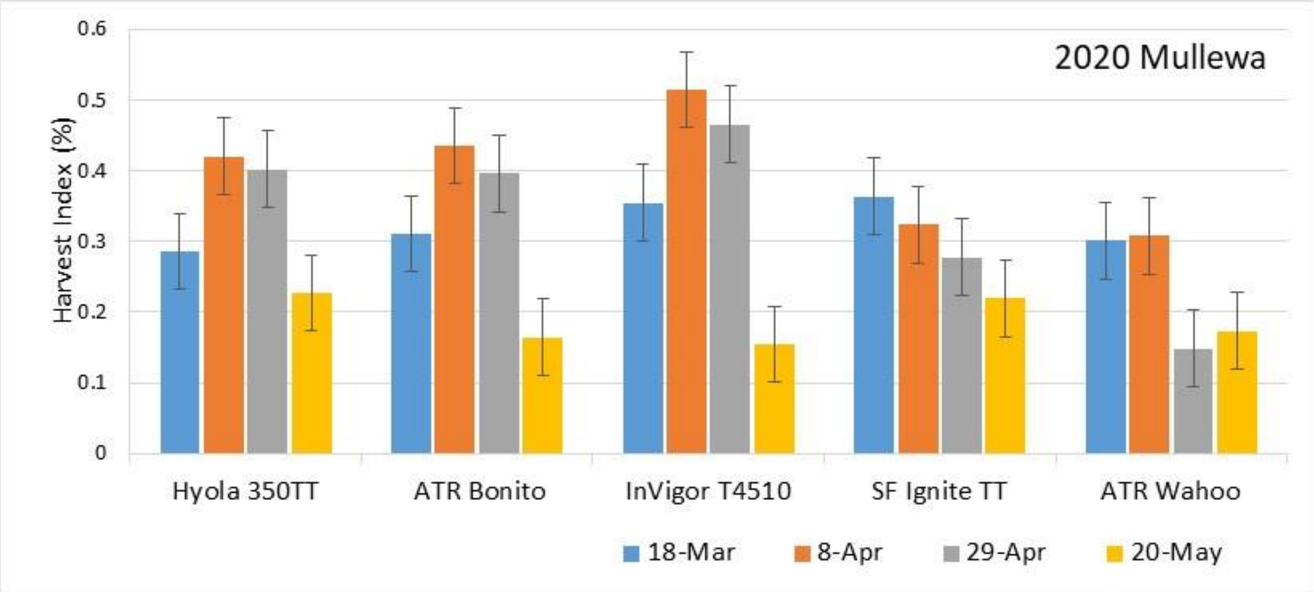

Figure 6: Harvest Index at Mullewa in 2020. (TOS P = 0.019, Variety P = <0.001, TOS.Variety P = <0.001, LSD 0.108)

There was a significant response to water use efficiency (WUE) for TOS (P=0.003), variety (P=<0.001) and the interaction (P=<0.001). The highest WUE matched the highest yielding varieties, InVigor T5410 at TOS2 (7.7 kg/mm/ha), ATR Bonito at TOS2 (7.5) Invigor T4510 at TOS3 (7.2) and Hyola 350TT at TOS3 (6.6). Overall the WUE was highest for TOS2 (0.4), followed by TOS3 (0.34), TOS 1 (0.32) and TOS4 (0.19).

APSIM simulations

Dr Farre simulated the trial conditions within APSIM to produce simulated phenology and yield results. The simulated results for time to flowering (days after sowing) were a good match with observed trial results for 50% bloom, at the traditional time of sowing, near Anzac day (Figure 7). However, the simulated phenology did not fully capture the observed differences in phenology with very early sowing, nor the longer time taken to flower for the shorter maturity varieties (Hyola 350TT and ATR Bonito) with later sowing.

The APSIM simulated yields were similarly an excellent match with the Anzac day sowing (29/4) and were generally a reasonable fit with other results although underestimating yields with early sowing and over estimating yields with later sowing. There was a poor fit with observed field results for ATR Wahoo, which dropped sharply after TOS1 (18/3), compared with the simulated response which had highest yields at TOS 3 (29/4) (Figure 8).

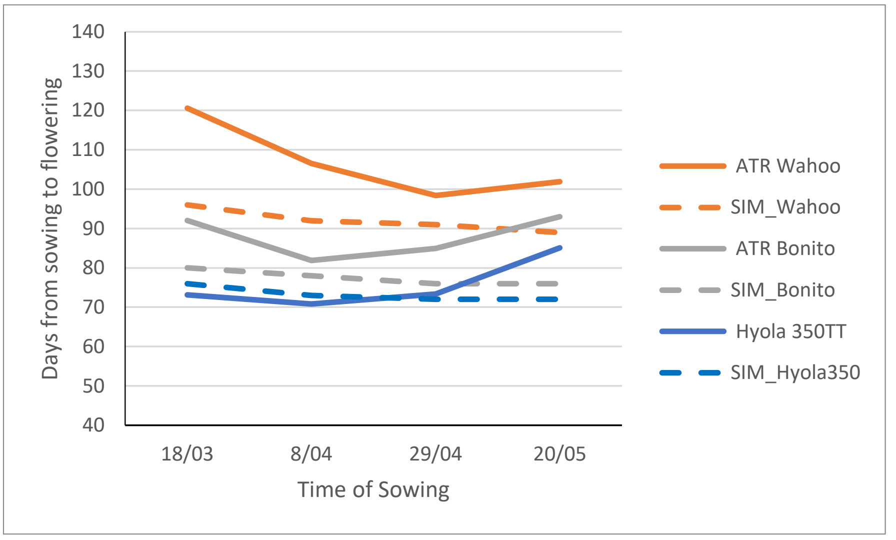

Figure 7. APSIM simulation of time to start of flowering (dashed lines) compared with observed trial results

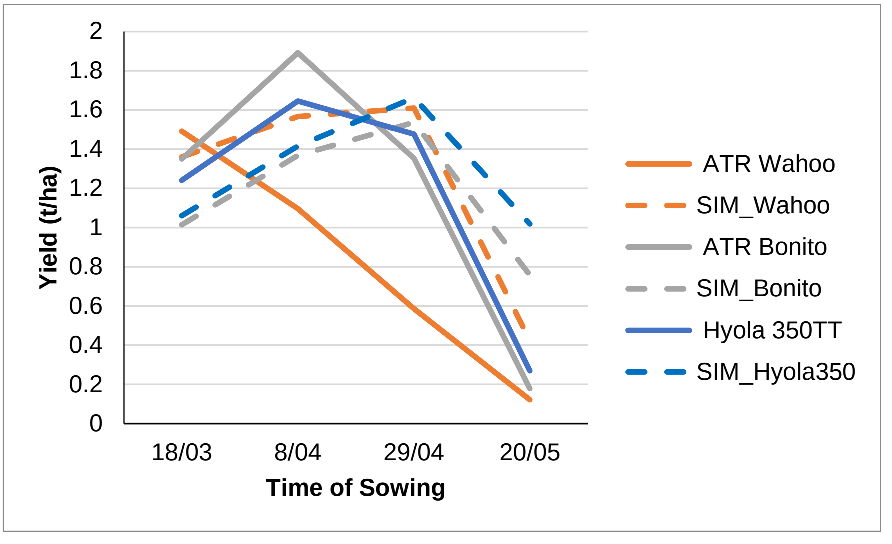

Figure 8. APSIM simulation of yield (dashed lines) compared with observed trial results

Conclusions

A profitable canola crop can be grown from March seeding. Early sown canola had normal growth and development, albeit starting to flower earlier.

There was a longer flowering period with earlier sowing time, for all varieties. This is likely to be a key contributor towards potential yield.

In this trial, the highest yields and gross margins were achieved from the early April seeding of InVigor T4510 (2.04 t/ha) and ATR Bonito (1.90). Yields from earlier (March 8) and Later (April 29) sowing were similar to each other, although lower than TOS2. Yields were severely reduced by seeding on May 24. The yields of the short maturity variety Hyola 350TT followed a similar pattern, although slightly lower yields. The longer maturity varieties had a different yield pattern: yields from March sowing were similar to other varieties, but yield declined with later sowings.

In this trial, the early-mid varieties had highest overall yields and proved to be more adaptable than the long season varieties. The early-mid varieties had similar yield to the longer maturity varieties with March sowing, but significantly outyielded them for early April sowing. This indicates there may be no need to source long season varieties for early sowing in this short season environment.

Trial series Conclusions

This trial was part of a series, with trials in both 2019 and 2020 at Mullewa, Wongan Hills, Beverley (West Dale) and Grass Patch. Results from the Grass Patch trials followed a similar pattern to the others but are not posted on OFT, as there were some problems with these trials.

Overall conclusions from the trial series were that sowing in March did not produce higher yields than sowing in April, generally produced similar yields and provides further sowing opportunities for growers to consider. Once the crop is established, there appeared to be no physiological disadvantages from early sowing and an early start to flowering.

Climate change is causing a negative effect on Western Australian dryland cropping. The changes are manifesting as less regular autumn rainfall, reduced rainfall during the growing season and increased temperatures in spring. In the context of canola farming, this means fewer opening rain events. Yields are likely to be reduced in parallel with reduced growing season rainfall, also from higher temperatures during the critical period (at the start of flowering), and further yield reductions from earlier and greater terminal drought, caused by the combination of lower growing season rainfall and higher temperatures

Sowing canola early may mitigate many of the negative effects of climate change. Increasing the range of potential seeding dates would increase the opportunity of securing a good break, as there will be less regular autumn rainfall.   Sowing early brings the flowering period and maturity earlier in the season. , which reduces the risk of critical temperatures at the end of flowering as well as the effect of more extreme terminal droughts from the combination of higher temperatures and reduced in-season rainfall

Risk factors of early sowing include an increased reliance on follow-up rain, low or staggered field emergence (due to higher temperatures at seeding), frost at end of flowering, insects (especially DBM and green peach aphid, which are both likely to build up in situations suited to very early sowing) and animal predation and disease. Growers should evaluate risks in their system, including seasonal outlook, heat conditions at seeding, if in a frost area or frost prone paddock, green bridge or insect host availability, likely presence of nearby canola paddocks, to alleviate predation pressure, and the presence of known predator populations, past disease pressure and rotation for disease risk management. Where growers are considering March sowing, reduce risk by seeding only part of the canola program at this time, increase the sowing rate of OP canola and monitor for pests and disease.

Early sowing magnified phenology differences between the varieties. Long maturity varieties need to be sown early for best yields. However, the high yielding early-mid maturity variety, InVigor T4510 proved to be adaptable to most seeding situations, generally yielding similar to long maturity varieties with early seeding while also yielding higher or similar to shorter maturity varieties with later seeding.

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OD ESW GRDC 2019-2021/Final trial reports/DPIRD- very early sowing of canola at Mullewa in 2020.docx