Modelling canola yield for current cultivars and early sowing times in Western Australia

Farre I[1], Harries M[2], Bucat J[3], Power S[4], Blake A[2]

[1] Department of Primary Industries and Regional Development (DPIRD), 1 Nash st WA 6000 Perth; Email: Imma.farre@dpird.wa.gov.au

[2]DPIRD Geraldton, [3]DPIRD South Perth, [4]DPIRD Northam

Abstract
Time of sowing canola trials, including very early sowings in March, were used to validate the APSIM-Canola model for current cultivars and Western Australian conditions. The model satisfactorily simulated flowering dates for a range of sowing dates with RMSE of 6-10 days across cultivars. The RMSE for grain yield was large (400-500 kg/ha), but the general trend of yield decline with delay in sowing was satisfactorily simulated. Simulation for yield was better for open pollinated cultivars than for hybrid cultivars. The model can be used to explore the yield response to sowing times but more work is needed to account for the extended flowering and grain filling period in modern hybrid canola cultivars under favourable spring conditions.

Keywords
APSIM-Canola model, validation, flowering, open pollinated, hybrid

Introduction

In the past decade, there has been a trend towards earlier sowing of canola by Western Australian (WA) growers, with dry-sowing as early as April (Fletcher et al., 2016). However, there is limited experimental yield data on very early sowings in March. While the APSIM-Canola model has been validated for WA for the traditional sowing window starting on Anzac Day and for older varieties (Farre et al., 2002), further model validation was needed to extend the use of the model for very early sowings and current varieties. In this project, field trials conducted in four locations over the past two years with different sowing times were used to validate the APSIM-Canola model for current conditions. A simulation study using climate data for the past 21 years was used to place the past two years of trials in the context of the long-term climate.

Past simulation studies identified the optimal sowing window (OSW) required to maximise yield for different locations in WA (Farre et al., 2019; Lilley et al., 2019).

Methods

Field trials and model simulation

Field trials were conducted at four locations in Western Australia (Mullewa, Wongan Hills, Dale and Grass Patch) in 2019 and 2020. Eleven Triazine Tolerant (TT) varieties (open pollinated (OP) and hybrids (Hy)) of canola with a wide range of maturity types were used (from early to mid-late). Trials included 4-5 times of sowing ranging from March to June, at 21 day intervals. Pre-sowing irrigation was applied to simulate different break of season dates. In 2019, March and April sowings had significant amounts of supplementary irrigation applied to help crop establishment in hot conditions (see Bucat et al., 2021 paper in these proceedings for more details).

The crop simulation model APSIM-Canola (v.7.10) (Farre et al., 2002; Keating et al., 2003) was run with 2019 and 2020 climate data and management conditions for the four locations to validate the model.

Long-term simulation study

A long-term simulation study was conducted for the four trial locations using the APSIM-Canola model and climate data for the period 2001-2020 (20 years). Simulations were run with the same times of sowing (20

March, 10 April, 1 May, 22 May and 12 June), cultivars, soil moisture at sowing and post-sowing irrigation amounts as in the 2019 field trials.

Results

Model validation

The APSIM-Canola model satisfactorily simulated the flowering dates for three generic cultivars (early, mid and late season length types), five times of sowing and four locations (Figure 1a). In 2019, the error in simulating flowering date (root mean square error=RMSE) was 5.7, 6.6 and 10.1 days for ATR Stingray, ATR Bonito and ATR Wahoo, respectively. The RMSE for hybrids Hyola350, Hyola559 and Hyola725 was 6.8, 7.5 and 10.4 days, respectively.

Canola yields were simulated with an error of 482, 443 and 396 kg/ha for ATR Stingray, ATR Bonito and ATR Wahoo, respectively (Figure 1b). The error in the yield simulations was greater for early sowings, but overall the slope of the yield to sowing time relationship was satisfactorily simulated (Figures 2 and 3).

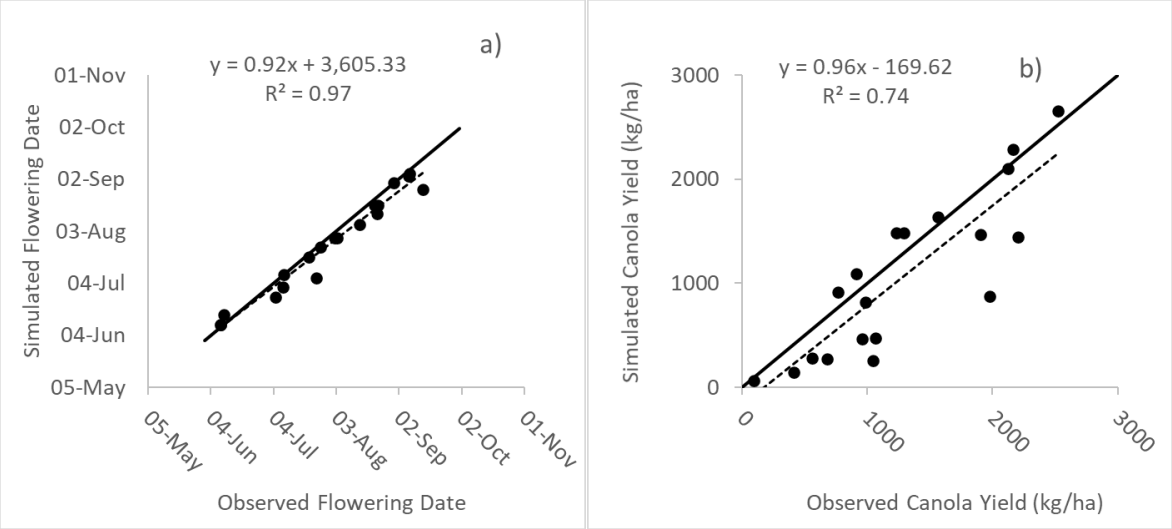

Figure 1. Observed versus APSIM simulated a) flowering date (y= 0.92x + 3605; R^2 = 0.97) and b) canola yield (y= 0.96x + 170; R^2 = 0.74) for canola cultivar ATR Bonito at four locations and five sowing dates in 2019 (20 March, 10 April, 1 May, 22 May and 12 June). Solid line is 1:1 line. RMSE for flowering was 6.6 days and for yield was 443 kg/ha.

In the 2019 Mullewa trial, when the model was run with the same soil moisture and irrigation amounts as in the trial, simulated yields were close to the observed yields (Figure 2). Running the model with observed initial soil moisture but without post-sowing irrigation, gave simulated yields of 620 and 1097 kg/ha for the March and April sowings, respectively, compared to yields of 1637 and 1482 kg/ha with the actual irrigation amounts applied in the trial (Figure 2). These results demonstrate that the high yield achieved in the March sowing in the 2019 Mullewa trial would not have been possible without the post-sowing irrigation.

The canola yield response to sowing times in the 2019 and 2020 Dale trials for cultivar ATR Bonito (Figure 3) was satisfactorily simulated by the APSIM-Canola model, with peak yields from the mid-April sowing. For sowings after 1 May, the model simulated a yield decline of 20 kg/ha for each day delay in sowing.

In the 2020 trial in Dale (medium rainfall location), ASPIM simulated the canola yields of open pollinated (OP) cultivars such as ATR Bonito and ATR Wahoo satisfactorily (Figure 4a). The slope of the yield response to sowing date after early April sowing was adequately simulated by the model. However, modern hybrid (Hy) cultivars such as Hyola350TT and InVigorT4510 produced peak yields for sowing in late April and yields only declined for May sowings (Figure 4b). This was attributed to an extended flowering and grain filling period under the favourable spring climatic conditions. APSIM was unable to simulate the

extended grain filling period and associated high yield for late-April sowing for the hybrid cultivars, and instead simulated peak yields for early-April sowing (Figure 4b).

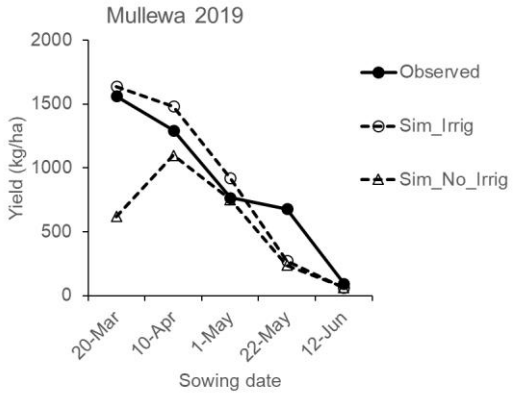

Figure 2. Observed canola yields in the 2019 Mullewa field trial (solid line with full circles) and APSIM simulated yields (dotted lines with empty symbols) with and without supplementary irrigation, for cultivar ATR Bonito. See text for explanation on irrigation.

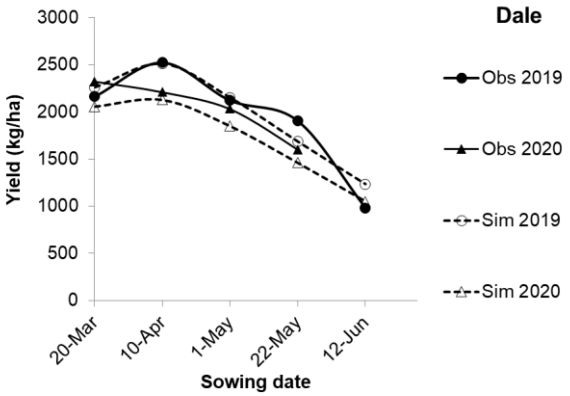

Figure 3. Observed canola yields versus sowing dates for the Dale field trails in 2019 and 2020 (solid lines with full symbols) and APSIM simulated yields for 2019 and 2020 (dotted lines with empty symbols) for cultivar ATR Bonito.

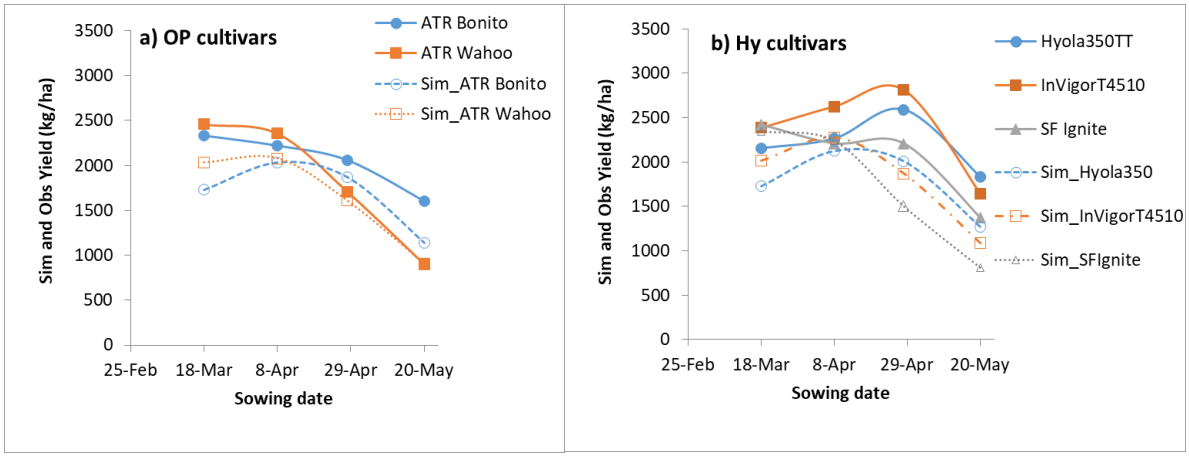

Figure 4. Simulated and observed canola yields for a) Open pollinated (OP) cultivars and b) Hybrid (Hy) cultivars for 2020 Dale time of sowing trial. Solid lines are observed yields and discontinuous lines are simulated yields.

Simulation study

The long-term runs for the period 2001-2020 showed large (above 1000 kg/ha) year to year variability for yield (Figure 5). Mullewa simulations were sorted into above (wet) and below (dry) median growing season rainfall (Apr-Oct), with the yield response to sowing date differing between wet and dry seasons (Figure 5). The simulation study demonstrated the importance of playing the season and adjusting management and inputs according to yield expectations (informed from starting soil moisture, sowing date and season forecast) to maximise profitability.

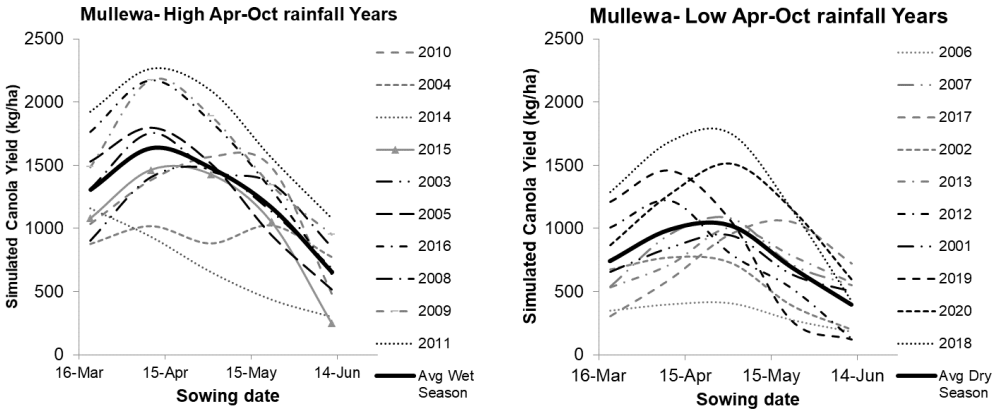

Figure 5. APSIM simulated canola yields for Mullewa for a) years with seasonal rainfall (April-October) above the median and b) years with seasonal rainfall below the median. Simulations for the period 2001-2020 for the same sowing dates, initial soil moisture and supplementary irrigation as the 2019 field trial at Mullewa, for cultivar ATR Bonito. Black solid line is the average of the 10-year simulations.

Conclusions

The APSIM-Canola model can satisfactorily simulate flowering dates and yield response to sowing date for current OP and Hybrid cultivars across locations and sowing dates in WA. The model can be used to explore the yield response to sowing date but more work is needed to account for the extended flowering and grain filling period in modern canola hybrid cultivars in favourable spring conditions. Crop simulation can help agronomists and growers make informed decisions about crop management to maximise profitability.

In the field trials, it was possible to obtain economic yields with very early sowings in March with supplementary irrigation, but in field conditions, it might be difficult to establish canola in very hot conditions in March.

References

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Acknowledgments

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