Horses for courses – benefits of adjusting canola sowing date and phenology choice based on fallow and in-crop rainfall.

Rohan Brill[1], Andrew Ware[2], John Kirkegaard[3], Don McCaffery[1], Colin McMaster[1], Rick Graham[1], Cameron Taylor[4].

[1] NSW Department of Primary Industries, rohan.brill@dpi.nsw.gov.au
[2] EP Ag Research (formerly SARDI)
[3]CSIRO
[4]Birchip Cropping Group

Abstract
Optimum start of flowering dates are established for canola across much of Australia but it is possible to flower at the optimum time by sowing slow varieties early or fast varieties later. We conducted 14 experiments across eastern Australia in 2017 and 2018 to determine the optimum sowing strategy (sowing date and phenology type) across a range of yield scenarios (0.4 to 5.7 t/ha). We found that early sowing of slow developing varieties was most successful at sites that had received high (>200 mm) fallow rainfall. At these sites there was also a consistent benefit of selecting a high vigour hybrid variety compared with a low vigour open-pollinated triazine tolerant variety. Later sowing of fast developing varieties was advantageous at low yielding sites and surprisingly at very high yielding sites. Canola growers can adjust their canola sowing strategy (sowing date and phenology type) based firstly on fallow rainfall and secondly on expected in-crop rainfall.

Key Words
Canola, phenology, sowing date, biomass, harvest index

Introduction
Rainfall in the cropping regions of southeast Australia has become less reliable in winter but has increased in summer months, with this observed trend being consistent with future climate projections (Shi *et al.* 2008). Growers have become increasingly aware of the need to conserve water from summer rainfall for use in the following winter crop, with the most important management factor being fallow weed control (Hunt *et al.* 2013). While there are clearly defined optimum start of flowering dates for regions across Australia (Lilley *et al.* 2019) there is little information comparing early sowing of slow spring varieties with later sowing of fast spring varieties (with synchronised flowering). APSIM simulations suggest higher yield potential of slow developing varieties at medium to high rainfall locations (Lilley *et al.* 2019). We conducted experiments across south-eastern Australia in 2017 and 2018 to compare 1) early sowing of slow developing spring varieties to later sowing of fast developing spring varieties and 2) the performance of open-pollinated triazine tolerant (OP TT) canola (low vigour) to hybrid non-TT canola (high vigour). We report the results of these experiments in the context of seasonal rainfall.

Methods
Each experiment was a split-plot design with sowing time (two) as main plot, and variety (six) and nitrogen rate (two) completely randomised within sowing time blocks (only results from the high nitrogen rate are reported here). Small amounts (<15 mm) of water were supplied to the plots (but only to the sowing furrow) where seedbed moisture was low at the target sowing date. This watering ensured crop establishment without contributing to the overall soil moisture profile.

All experiments had the same variety entries with a range in phenology and vigour:

- ATR Stingray – fast developing open-pollinated triazine tolerant (low vigour)
- Diamond – fast developing hybrid conventional herbicide (high vigour)
- ATR Bonito – mid-fast developing open-pollinated triazine tolerant (low vigour)
- 44Y90 CL – mid-fast developing hybrid Clearfield (high vigour)
- ATR Wahoo – slow developing open-pollinated triazine tolerant (low vigour)
- Archer – slow developing hybrid Clearfield (high vigour).

Seasonal rainfall and starting soil nitrogen (N) varied across the sites (Table 1).

Table 1. Site conditions (seasonal rainfall and soil mineral nitrogen availability at sowing), sowing dates and nitrogen applied at canola experiment sites in 2017 and 2018.

Year	Location	Rain N-M (mm)	Rain A-O (mm)	Avail. N (kg/ha)	SD 1	SD 2	N app. (kg/ha)
2017	Tamworth	362	264	94	12-Apr	5-May	360
	Ganmain	201	190	123	8-Apr	26-Apr	170
	Longerenong	120	402	85	8-Apr	28-Apr	200
	Lameroo	132	222	78	21-Apr	8-May	50
	Hart	215	326	21	27-Apr	15-May	130
	Yeelanna	108	255	51	12-Apr	8-May	200
2018	Tamworth	170	283*	110	13-Apr	7-May	200
	Canowindra	235	173	105	4-Apr	26-Apr	160
	Ganmain	253	145	183	6-Apr	26-Apr	180
	Wagga	310	162	227	4-Apr	27-Apr	195
	Longerenong	97	187	68	12-Apr	2-May	307
	Lameroo	85	125	22	16-Apr	7-May	146
	Hart	108	305	77	13-Apr	8-May	188
	Yeelanna	98	344	99	12-Apr	8-May	211

Rain N-M = Rain from November (of previous season) to March. Rain A-O = Rain from April to October. SD = sowing date. Avail. N = mineral N available in the soil profile at sowing. N app. = nitrogen applied.
*Includes 110 mm irrigation.

Results and discussion

The optimum sowing strategy varied across locations and seasons. At low yield potential sites (<1.5 t/ha, three sites), later sowing of the fast variety Diamond was higher yielding than early sowing of the slow variety Archer by an average of 0.3 t/ha (Figure 1). Low yield potential sites Longerenong, Hart and Lameroo (all 2018) had low fallow (November to March) rainfall and low in-crop (April to October) rainfall (with the exception of Hart). In this low yielding group, final biomass was generally similar for the two systems but the fast developing Diamond had a higher harvest index (data not shown). For this yield group we hypothesise that later sowing of the fast developing variety spared water for reproductive growth resulting in higher grain yield.

Between 1.5 and 3.5 t/ha (seven sites), there was an advantage from early sowing of slow developing varieties of (on average) 0.4 t/ha. These sites typically (with the exception of Lameroo 2017) had high fallow rainfall (>200 mm) and low–moderate in-crop rainfall. Within this medium yield bracket, it was only at the Lameroo 2017 site with a low proportion of fallow rainfall where the yield of later sown Diamond was greater than early sown Archer. There was generally higher final biomass from early sowing of the slow developing varieties, often with a slightly lower harvest index than the later sown fast varieties but the extra biomass outweighed the lower harvest index. We hypothesise that the early sowing allows the canola roots more time to access water stored deep in the soil profile, grow more biomass leading to a higher yield.
At high yield potential sites (four sites), later sowing of Diamond was consistently (average 1.2 t/ha) higher yielding than early sowing of Archer. This was surprising as we anticipated that the early sowing of the slow developing varieties would generate higher biomass and higher grain yield and this is what is predicted by APSIM. The later sown Diamond had similar final biomass as the early sown Archer, despite less time from sowing to maturity, suggesting a higher radiation use efficiency. Also the later sown Diamond consistently had a higher harvest index than the early sown Archer.

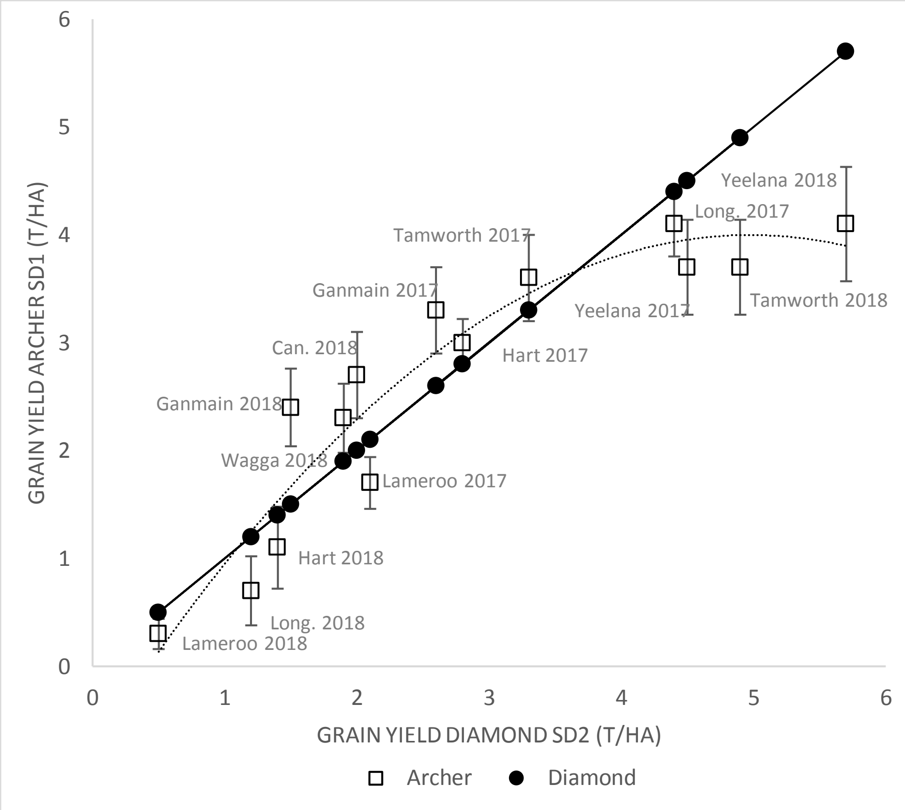

Figure 1. Grain yield of Archer sown early (early to mid-April) compared with Diamond sown at its optimal time (late April to mid-May). Error bars indicate LSD (*P*=0.05). Can. = Canowindra. Long. = Longerenong.

The high vigour (hybrid non-TT) varieties had a grain yield advantage over the low vigour varieties (OP TT) at 10, 11 and 13 (out of 14) sites in the slow, mid-fast and fast phenology groups respectively (sown in their optimum window). The high vigour varieties had no benefit across all phenology groups at the very low yielding Lameroo (2018) site and only in two phenology groups at the low yielding Hart (2018) site. The high vigour hybrid varieties had higher yield than the low vigour OP TT varieties at all sites with a high proportion of fallow rainfall, the same sites where there was a consistent benefit of the early sowing system.

Table 2. Grain yield (t/ha) advantage of high vigour hybrid canola over low vigour open-pollinated triazine tolerant canola across slow, mid–-fast and fast phenology groups where they were sown at their optimum sowing date at 14 sites in 2017 and 2018. Values are significant (*P*=0.05) unless reported as n.s. (not significant).

Year	Location	Slow	mid-fast	Fast
2017	Tamworth	0.9	n.s.	0.7
	Ganmain	0.7	1.1	0.6
	Longerenong	n.s.	0.6	0.5
	Lameroo	n.s.	0.4	0.3
	Hart	0.4	1.2	0.4
	Yeelanna	1.4	0.5	1.2
2018	Tamworth	0.5	0.7	1.5
	Canowindra	1	1.1	0.9
	Ganmain	0.4	0.5	0.5
	Wagga	0.9	0.9	0.4
	Longerenong	0.4	0.9	0.7
	Lameroo	n.s.	n.s.	n.s.
	Hart	n.s.	n.s.	0.6
	Yeelanna	0.7	0.7	2.6
	Average	*0.5*	*0.6*	*0.8*

Conclusion

Our experiments clearly showed the opportunity to adjust canola sowing strategies (date and phenology type) based on fallow rainfall and anticipated in-crop rainfall. As growers make variety and sowing date decisions before in-crop rainfall is known, it is recommended to base much of the decision on fallow rainfall with an estimate of in-crop rainfall based on the growing environment. The combination of early sowing and hybrid canola was particularly successful at sites with a high proportion of fallow rainfall to in-crop rainfall. With a general increase observed in out-of-season rainfall and improved fallow management, this strategy will become increasingly important to improve canola water-use-efficiency. Further research is required to understand how later sowing of fast developing varieties achieves higher grain yield than early sowing of slow developing varieties at very high yielding sites and determine if it is possible to integrate desirable traits (specifically harvest index) from the fast varieties into slower varieties. Canola growers would also benefit from better knowledge on improving canola establishment to increase the likelihood of success when sowing early.

References

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