Narrowing the gap between seeding rate and emergence of canola and lentils

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Location
Birchip (Barber's)
Rainfall
Av. Annual: 333 mm
Av. GSR: 234 mm
2019 Total: 231 mm
2019 GSR: 197 mm
Yield
Actual: Canola 2.2 t/ha, Lentils 3.2 t/ha
Paddock history
2018: Birchip West: fallow, East Barley
2017: Birchip West: lentils, East lentils
2016: Birchip West: barley, East oats

Key messages

- **The conventional disc seeder yielded the highest in the seeder demonstration.**
- **The precision planter had a higher establishment percentage, but this did not translate into extra grain yield in the seeder demonstration.**
- **Across a variety of seeders, it was found that seeder set up had a greater impact on establishment than seeder age or type, highlighting that seeder set up is crucial to get everything right.**
- **Establishing greater than 45 plants/m^2 in canola or 100 in lentils did not increase yield (small plot trials).**

Why do the trial?

The aim of the first trial was to compare performance of commercially available seeding systems on a large scale at two sowing rates of canola, assessing establishment and subsequent grain yield. The second trial aimed to determine the effect of sowing density, row spacing and seeder type on plant establishment and grain yield in canola and lentils.

A survey of 35 grower paddocks was conducted across the Wimmera and Mallee to assess plant establishment of canola and lentils in 2018. Results found average canola establishment of 61 per cent of target density and 78 per cent in lentils, however individual growers achieved much higher establishment rates. Tough seasonal conditions in autumn 2018 may have contributed to these results, but it highlights the potential of improved plant establishment as an area of focus for growers to reduce unnecessary seed waste. If every seed sown was established, significant seed savings could be made.

Research undertaken in 2018 showed lentils were better at reaching target densities than canola. This suggests it might be more critical to get plant establishment right in canola than lentils. The 2018 trials found canola yields were more responsive to plant densities than lentil yields. There was no consistent impact from seeder type (conventional or precision) on establishment and yield.

There is increasing interest in precision planters for winter crops. They are designed to place single seeds at a consistent spacing along the row at a precise and uniform depth. This results in every seed having an equal area to establish and makes it less likely to compete with its neighbour (Gutsche 2015). When sowing high value seed crops it is important to get high, uniform establishment to minimise seed losses. Given the increased interest in precision planters, it is important to understand which farming systems and sowing conditions they perform well in, as well as their limitations.

Two trials were conducted in 2019 to compare establishment and yield at different plant densities in conventional seeders and precision planters. One trial compared six commercial seeders using canola as the test crop. The second set of trials examined responses to a range of plant densities in canola and lentil in small plots.

How was it done?

Trial 1 Seeder demonstration

The first trial consisted of a comparison of six commercial seeders at Birchip. The six seeders included four conventional air seeders and two precision planters (Table 1). Three of the seeders were tyned and three were disc systems.

The trial was sown into a dry seedbed on 12 April 2019 at two target densities – 109 and 55 plants/m^2, equivalent to 3.5 kg/ha and 1.75 kg/ha – using grower-retained Stingray canola. The Stingray had a germination of 98% and seed size was 318,470 seeds/kg, which is on the smaller side for canola seed.

As a demonstration, one precision planter also sowed canola at 35 plants/m^2 (1.1 kg/ha). Each seeder sowed two runs of 50 m in a randomised complete block design with three replicates. Fertiliser at sowing was MAP (10:22:0:0) at a rate of 40kg/ha. The same seed and fertiliser was used across all seeders (one precision planter used liquid fertiliser with matched nutrition). The depth specified by BCG was 2 cm. Apart from the sowing rates and fertiliser rates no other specifications were given for how to sow the trial. Decisions on seeder set up and speed of sowing were made by each operator. Ideally, each seeder was operated under 'optimal' conditions with decisions about seeder set-up and seeder operation made by each grower. No herbicides were applied before sowing to minimise the risk of any interaction with seeders. The trial was managed during the season along with the surrounding crop.

Assessments included establishment counts five days apart after the first sign of emergence, final establishment counts and interplant spacings. Interplant spacings were measured once the canola had fully established and grain yield was collected with a plot header.

Trial 2 Small plot trials

The second trial involved two replicated field trials sown using a split plot design, with the canola in the fallow paddock and the lentils on adjacent barley stubble (Table 2). Fertiliser was applied IBS due to limitations of the plot seeder. Sowing occurred on 16 May after the site received 38 mm of rain during the first half of the month. Sowing densities were adjusted to account for the canola seed germination of 93% and lentils of 98%.

Assessments included emergence counts five days apart from the first sign of emergence until full establishment was reached. Interplant distances were measured once the canola and lentils had fully established and grain yield was measured using a plot header on 1 November.

Table 1. Seeder information for the six seeders used in the trial.

Seeder	Type	Row spacing (cm)	Fertiliser placement	Seeder age (years)
Flexicoil 820	Tyne	30.5	With seed	22
Horsch 18NT sprinter	Tyne with coulters	25.0	With seed	1
Horwood Bagshaw scaribar	Tyne with coulters	37.5	Below seed	15
Morris RAZR disc	Disc	25.0	Below seed	1
Precision Planter (Spot on Ag)	Disc precision planter	33.3	Liquid only	1
Horsch Maestro	Disc precision planter	25.0	Demo machine (fert was broadcast prior to sowing)	1

Table 2. Sowing rates (target density) for lentils (Hurricane) and canola (Hyola 559 TT), seeder type and row spacings used.

Canola sowing rates target density (plants/m^2)	Lentils sowing rates target density (plants/m^2)	Seeder	Row spacings
15	40	Precision (singulation) disc seeder	
25	60		22.9 cm (9 inch)
35	80		
45	100		30.5 cm (12 inch)
55	120	Disc seeder, press wheels	
65	140		

What happened?

Trial 1 Seeder demonstration

There was an average of 63% canola establishment, with establishment ranging from 41 to 93%. There were significantly different establishments between seeders. The precision planter sowing at 35 plants/m^2 achieved 100 % establishment. This highlights that precision seeders can achieve very high establishment at low plant density.

The precision seeders had a smaller interplant distance (average 6.8 cm) than the conventional seeders (average 8.2 cm). The CV% of the interplant distance indicates the uniformity of the plant stand. Using precision planters resulted in more uniform stands than sowing with conventional air seeders: average CV% for the precision planters was 83% and the CV% for the conventional seeder was 91% (P=0.038).

The measured sowing depth ranged from 1.1 cm to 1.8 cm and did not differ significantly between the precision planters and conventional seeders. Differences in sowing depth were observed between individual seeders e.g. the seeding depth for the Horsch tyne machine was deeper due to it being set up for cereals at the time of sowing.

The conventional disc at low sowing density had the highest yield (Table 3), which was 0.4 t/ha higher than the next seeder, a precision planter. The average yield of the conventional seeders was 0.1 t/ha higher than the precision planters. The disc seeders in the trial yielded 0.2 t/ha more than the tyne seeders (P<0.006).

Yields varied from 2.3 t/ha to 3.0 t/ha. The conventional disc (at both densities) yielded the highest (Table 3). The dry sowing conditions at sowing favoured disc systems, which is why they worked well in these trials. In a commercial setting and wet conditions, sowing logistics may become more challenging with a disc.

Sowing density did not affect grain yield (P=0.818) of 2.50 t/ha at 55 plants/m^2 compared to 2.48 at 109 plants/m^2. This highlights an opportunity to reduce sowing rates without sacrificing yield. The canola sown with the precision planter at 35 plants/m^2 had an establishment of 103% and yielded 2.3 t/ha. Precision planters generally operate better with larger size seed, due to their seed singulation capabilities. Hybrid seeds are often larger than the seed used in this trial and generally are more costly and vigorous. Similar yields can be achieved at lower sowing rates using larger seed.

Table 3. Canola plant establishment (%) and interplant distance (IPD) (cm) and grain yield (t/ha) for the six seeders. Different letters indicate significant difference.

Seeder	Target (plants/m^2)	Plant establishment (plants/m^2)	Establishment (%)	Interplant distance (cm)	Grain yield (t/ha)
Conventional tyne 1	55	40^{bcd}	74	8.8	2.4cd
	109	63^{bc}	58	5.4	2.3d
Conventional disc 1	55	41^{bcd}	75	10.3	3.0a
	109	47^{bcd}	43	5.6	2.9ab
Conventional tyne 2	55	31^{cd}	56	10.2	2.4cd
	109	101^{a}	93	3.6	2.3d
Conventional tyne 3	55	26^{c}	47	14.7	2.4cd
	109	46^{bcd}	42	7.0	2.5cd
Precision planter 1	55	25^{d}	45	10.2	2.5cd
	109	56^{bcd}	51	4.9	2.6bc
Precision planter 2	35	36^{bcd}	103	7.7	2.3d
	55	37^{bcd}	68	8.3	2.3d
	109	67^{b}	61	4.3	2.3d
Seeder (P=0.05)		*<0.001*	<0.001	<0.001	<0.001
LSD		*15*		1.3	0.3
CV		*18.1*	26.3	19.1	6.9%
Conventional		50	60	8.2	2.5
Precision		46	58	6.8	2.4
Seeder type (P=0.05)				*0.038*	*<0.001*
LSD		*ns*	*ns*	*1.2*	
CV %		*36.6*	*36.7*	*42.5*	

Investing time in seeder set-up for particular crops can optimise establishment. The trial results indicated good establishment can be achieved using conventional equipment. There appears to be no strong relationship between plant establishment and final grain yield. This suggests establishment percentage is not the only factor influencing grain yield - other aspects of the seeders that were not assessed might contribute to yield. The paddock survey carried out in 2018 showed there is room for improvement in establishment.

Trial 2 Small plot trials

Lentils

Average plant establishment in the lentils was higher from the conventional seeder with 120 plants/m^2 compared to the precision seeder's 76 plants/m^2 (Table 4). Wide row spacing had higher plant establishment of 108 plants/m^2 compared to narrow row spacing with 88 plants/m^2 (P<0.001). Emergence was quicker with the conventional seeder. At 11 days after sowing, the precision sown had reached 40% of the targeted 120 plants/m^2 and the conventional sown had reached 74% of targeted establishment (Figure 1).

All target sowing densities were achieved in lentils with the conventional seeder. The precision seeder did not quite reach any of the targeted densities (Table 4).

Break Crops

Table 4. Lentil establishment (plants/m^2) (number in brackets is % establishment) and interplant distance (cm) for lentils at six sowing densities with two seeders (conventional, precision) and two row spacings (cm).

Lentil sowing rates (target density)	Establishment (plants/m^2) (number in brackets is % establishment)		Interplant distance (cm)	
	Conventional	Precision	Conventional	Precision
40 plants/m^2	65 (162)	39 (97)	7.5	10.5
60 plants/m^2	76 (126)	55 (91)	5.2	7.6
80 plants/m^2	105 (131)	74 (92)	3.8	6.1
100 plants/m^2	124 (124)	87 (87)	3.3	4.8
120 plants/m^2	174 (145)	118 (98)	3.0	4.5
140 plants/m^2	174 (124)	85 (60)	3.1	5.1
Average	120 (133)	76 (84)	4.3	6.4
Sig. diff. Density	*<0.001*		*<0.001*	
Seeder	*<0.001*		*<0.001*	
Seeder x density	*0.003*		*ns*	
LSD (P=0.05) Density	*18*		*0.6*	
Seeder	*10*		*0.3*	
Seeder x density	*25*		*0.9*	
CV%	*10.4*		*1.27*	

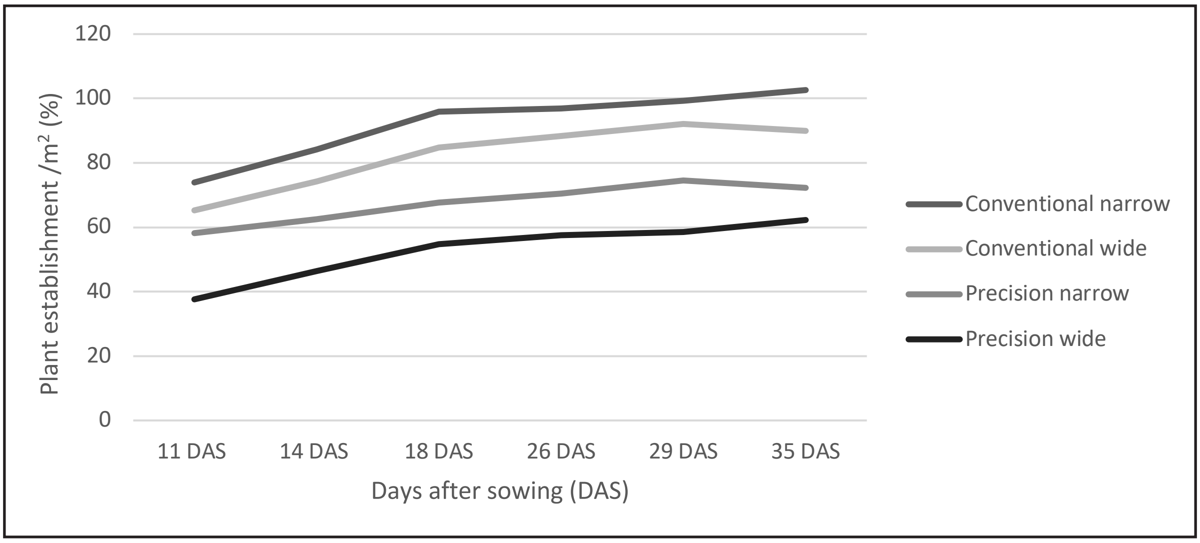

Figure 1. Lentil establishment (%) at days after sowing (DAS) for the 120 plants/m^2 treatment.

Lentil yield was affected by establishment density: the target densities of 100, 120 and 140 plants/m² all had the same grain yield, which was higher than the 40, 60 and 80 plants/m² (Figure 2). The response to plant density was the same in the precision and conventional seeders. This shows no yield advantage to sowing lentils higher than the targeted 100 plants/m². The conventional seeder yielded 3.4 t/ha, which was 0.2 t/ha higher than the precision seeder.

Canola

Establishment numbers varied depending on canola sowing rate. The sowing densities of 55 and 65 plants/m² both recorded the same establishment numbers (Table 5). A greater number of plants was established under the wider row spacing (40 plants/m²) than the narrow row spacing (32 plants/m²).

Canola had greater establishment under the conventional seeder (39 plants/m²) than the precision seeder (33 plants/m²). The canola sowing rates were based on a germination of 93% and assumed field establishment of 100%. The sample size means canola in some cases had a germination percentage of greater than 100. Likewise, sowing into a moist seedbed may have contributed to higher establishment which is consistent with results from the 2018 paddock survey.

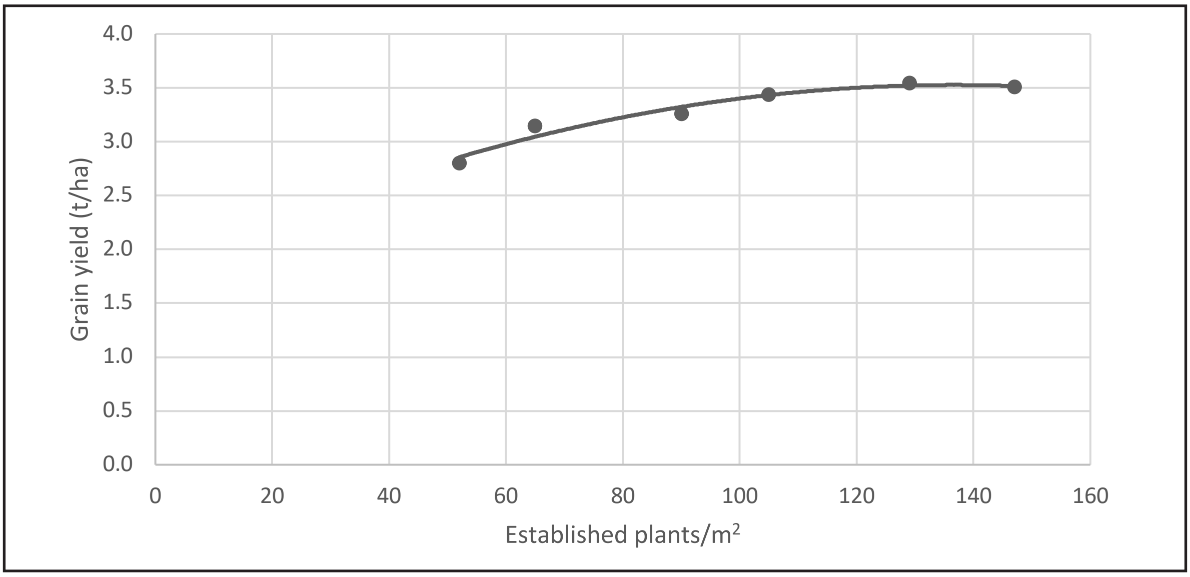

Figure 2. Grain yield response (t/ha) to number of plants established (plants/m²) averaged over both seeders and row spacings in lentils. Density (P<0.01, LSD=0.2 t/ha).

Table 5. Canola establishment (plants/m²) at six sowing densities and two seeder types and two row spacings (cm), letters indicate significant difference.

Canola sowing rates (target density)	Conventional (plants/m²)		Avg Establish-ment (%)	Precision (plants/m²) (%)		Avg Establishment (%)
	Narrow	Wide		Narrow	Wide	
15 plants/m²	21[hijk]	20[hijk]	136	1[0k]	14[jk]	79
25 plants/m²	30[fgh]	26[ghi]	112	16[ijk]	25[ghij]	84
35 plants/m²	30[fgh]	42[cde]	103	24[ghij]	34[defg]	83
45 plants/m²	41[cdef]	50[bc]	101	33[efg]	45[bcd]	87
55 plants/m²	*39[cdef]*	*66[a]*	*95*	*44[cde]*	*43[cde]*	*79*
65 plants/m²	*48[bc]*	*56[ab]*	*80*	*42[cde]*	*62[a]*	*80*
Sig. diff. Density	*<0.001*					
Row spacing	*<0.001*					
Seeder	*0.002*					
Seeder x density x row spacing	*0.017*					
LSD (P=0.05) Density	*6.0*					
Row spacing	*3.4*					
Seeder	*3.4*					
Seeder x density x row spacing	*11.7*					
CV%	*23.7*					

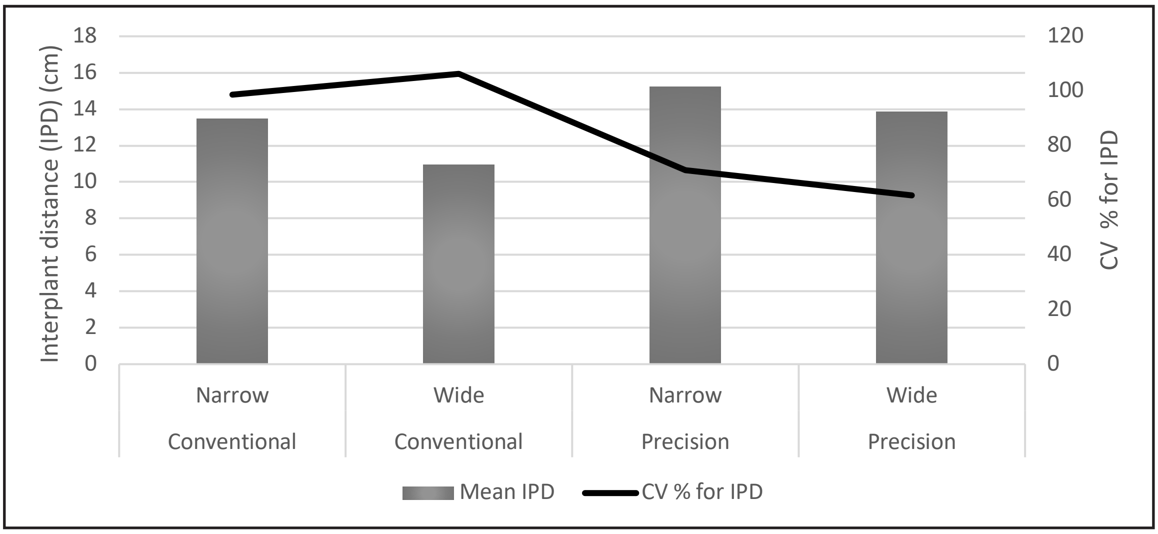

Figure 3. Mean interplant distance (cm) and CV (variation) % for the interplant distance.

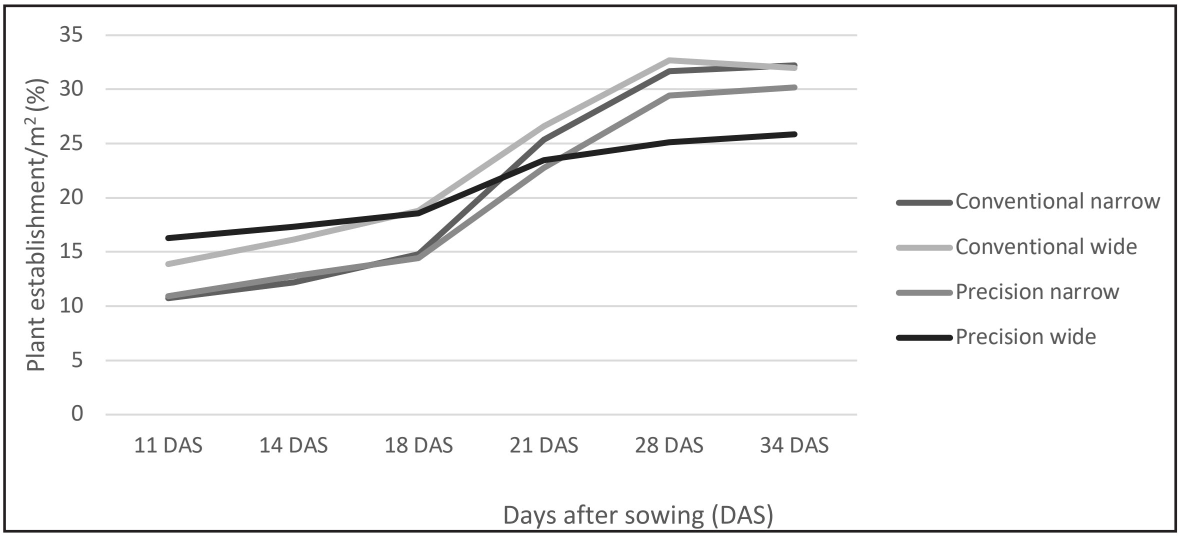

Figure 4. Canola establishment (%) at days after sowing (DAS) for the 35 plants/m² treatment.

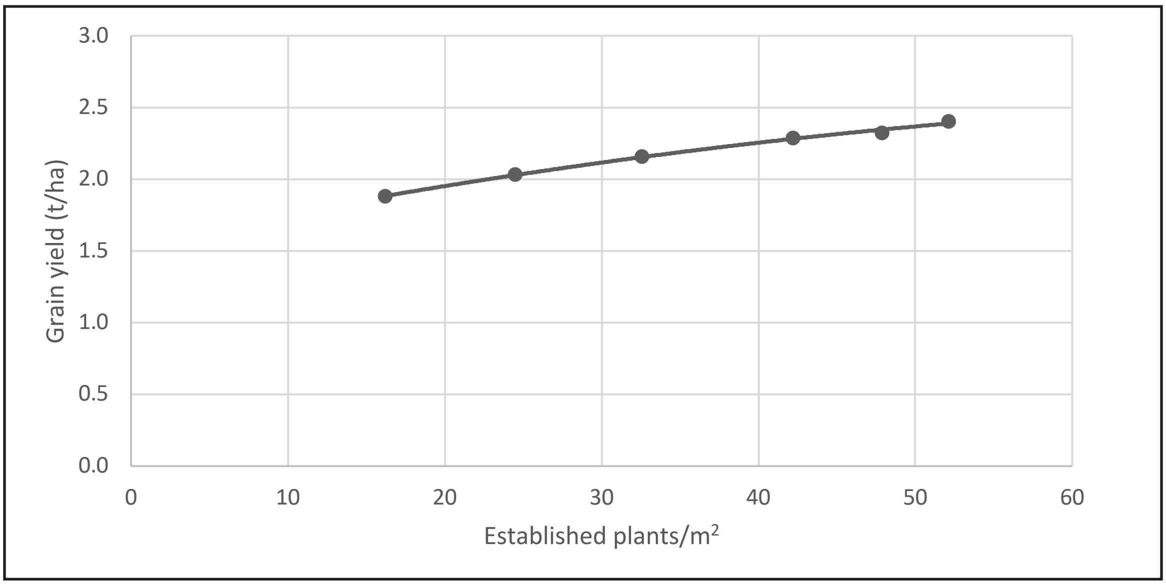

Figure 5. Grain yield response (t/ha) to number of plants established (plants/m²) averaged over both seeders and row spacings in canola. Density: yield P<0.001, LSD 0.16 t/ha.

Break Crops

Table 6. Partial gross margin for various sowing densities (ignoring capital cost of the seeder). Lentil seed $0.67/kg based on grain price of $670/t (7 January 2020), canola seed price $25/kg and grain price $590/t Birchip, letters indicate significant difference.

Targeted sowing density (plants/m^2)	Seed cost ($/ha)	Grain yield (t/ha)	Income ($/ha)
Lentils			
80	21	3.2bc	2123
100	26	3.4ab	2252
120	31	3.5a	2314
140	37	3.5a	2308
Canola			
25	45	2.0cd	1135
35	65	2.2bc	1233
45	82.5	2.3ab	1275
55	102.5	2.3a	1255

The conventional seeder had an average interplant distance (IPD) of 12 cm, and the precision seeder had an average interplant distance of 15 cm (Figure 3, see bars). The variation in these distances was 106% in the conventional wide seeder and 61% (Figure 3, see line) in the precision wide seeder. While the conventional seeder had a smaller average interplant distance, it also had more variation within the data set, highlighting that they were not as evenly spaced.

The canola reached an average establishment of 13 plants/m^2 11 days after sowing (DAS). The conventional seeder established faster than the precision planter. At 34 DAS, the conventional seeder, narrow and wide spacings, had 32 plants/m^2 established and the precision seeder wide row spacing had 26 plants/m^2 (Figure 4).

Grain yield

Canola yield was not different when comparing seeder type, however it differed between the various sowing densities and row spacings ($P<0.001$). Narrow row spacing (2.3 t/ha) yielded 0.2 t/ha more than the wider row spacing (2.1 t/ha), despite wide spacings having higher plant establishment. Canola grain yield was the same for the targeted 45, 55 and 65 plants/m^2 treatments (Figure 5). The targeted densities of 35 and 45 plants/m^2 did not differ in grain yield.

What does this mean?

This project aims to narrow the gap between what is put into the ground and what comes out of the ground. The commercial scale seeder demonstration averaged 58% establishment from conventional seeders and 77% from precision seeders. This shows there is room for improvement in both systems in a low rainfall environment. Establishment was better in the small plot trial that was sown into a moist seedbed, however canola yields were lower than in the seeder demonstration.

In the 2018 small plot trials all canola sowing densities failed to reach full establishment – the highest was just 40% of target. This can be attributed to a dry start and less than optimal field conditions. Conditions in 2019 were more favourable. The lowest observed establishment of 79% of targeted density highlights the importance of good soil moisture at sowing.

When calculating seeding rates, it is important to consider both seed size and expected germination percentage. In the case of the seeder demonstration, seed size was small. Choosing a sowing rate from a previous year's kg/ha target can result in much higher or lower plant numbers than expected from variation in seed size. Calculating the number of seeds for a given weight is essential. Seed quality/germination tests also should be considered so allowances can be made for seed that will not emerge, even under optimal field conditions. When calculating seeding rate, expected field establishment needs to be based on soil moisture and previous experience.

Matching sowing rate to season potential is an important step to optimising yield. The two sowing rates of canola in the seeder demonstration ultimately yielded the same, based on their actual establishment of 33 and 63 plants/m^2. This was contrary to the small plot trials where yield differed across sowing densities. This suggests that if at least 45 plants/m^2 canola is achieved, the crop can compensate for lower plant numbers in yield. However, it might be seasonally dependent as research in 2018, a much drier season, showed canola had a strong yield response to increasing sowing densities. The slightly poorer vigour of the later sown crops might have stopped it from compensating for the lower density as much as the earlier sown crops. Earlier sowing, and the capture of early rain, in the seeder demonstration would have contributed to plants being more vigorous than the small plot trials.

The response of lentils to sowing density showed no yield benefit from sowing at a density higher than 100 plants/m^2 this season. However, visual assessment suggested higher sowing densities may contribute to erectness of the crop which could increase harvestability. In 2018 conditions, there was no yield increase seen in lentils above a planting density of 60 plants/m^2.

In small plot trials a comparison of precision and conventional seeding systems influenced grain yield in 2019, which differs from the results in the dry season of 2018. It was found that the interplant distance with a precision planter was less variable than that sown with a conventional seeder. This may be due to the singulation system in a precision seeder which gives more evenly spaced seeds less competition and greater access to moisture and nutrients. The performance of precision planters in the low rainfall zone is still being tested in winter crops.

Soil moisture is a major driver of seed germination and seedling growth, so establishment of canola and lentils can vary in different seasons. The findings from this year's research are somewhat different to those from last season. As a result, more research is required before decisions are made about significant investments in machinery. Both seasons have highlighted there is room for improvement in the establishment of canola and lentils in the Mallee.

Investment in machinery is a significant capital cost for a farm business. When considering purchasing a new seeder it is important to choose what is best suited to your system based on factors such as row spacing, rotation, stubble load and trash handling ability. The seeder demonstration showed no financial benefit from having one seeding system over another, among those trialled. It also indicated no impact from seeder system or age, instead highlighting the importance of seeder set-up and operation for crop type and conditions.

Higher sowing density of high value crops can increase initial seed costs. Lentil partial gross margin - based on seed cost and grain yield - delivered income of $2312/ha when sown at a density of 120 plants/m^2 (Table 6). But yield at this sowing density was not higher than the sowing rate of 100 plants/m^2. Canola at 45 plants/m^2 had the highest partial income of $1275/ha. There was no increase in yield or income from higher sowing rates. This emphasises the importance of taking into account the cost of seed when increasing sowing rates, especially if it's unlikely to boost grain yield or income.

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