SOWING FOR OPTIMISED ESTABLISHMENT

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TAKE HOME MESSAGES

- The precision planter achieved more uniform seed placement than the conventional seeder in both canola and beans.
- Optimal yields were achieved at 23 plants/m^2 and 16 plants/m^2 for canola and beans respectively.
- Precision planting technologies for winter crops are continuing to develop.

BACKGROUND

It is no secret that moisture is required to get crops out of the ground and making it rain is out of our control. The question is, what can be controlled by a grower that will give the best chance of crop establishment?

A survey of 35 paddocks across the Wimmera and Mallee in 2018 found average seedling establishment was 61% for canola and 78% for lentils. Seasonal conditions were tough, nevertheless there were individuals surveyed who managed to establish target densities even in these conditions (Browne and McDonald, 2019). Managing things such as target plant density, row spacing, and seeder setup can influence final crop establishment.

Research undertaken by BCG at Narraport in 2018, with tough seasonal conditions, found canola yield was more responsive to increasing planting density compared to lentils, suggesting optimising planting density in canola may have a greater effect on final yield than in lentils. In this tough season yield was optimised in canola at 27 established plants/m^2 and lentils at 64 plants/m^2 (Browne and McDonald, 2018). However, similar research undertaken in 2019 at Karyrie with a good start found the yield response to planting density to be more incremental in both canola and lentils, with the penalty for low plant densities having less impact than 2018, reaching optimal yields at 42 plants/m^2 and 105 plants/m^2 respectively for canola and lentils.

In both years row spacing did not have any impact on yield of canola (Browne and McDonald, 2019). It can be hypothesised from this that the ability for canola to compensate for a change in row spacing at a given sowing density would be enough to not significantly impact yield.

Seeders and technology can play a key role in final plant establishment. The afore-mentioned research compared precision planting and conventional seeding systems' seed placement capabilities and the effect this had on establishment and final yields. Precision planters place single seeds at equal distances along the seeding row resulting in more uniform crop stands (Browne and MacDonald, 2019). This is referred to as singlulation. It can reduce interplant competition for resources, potentially resulting in better establishment and the ability to sow at a lower sowing density without compromising yield as a result.

Research in 2020 looked to answer the question around how far sowing densities could be reduced with precision planting and conventional seeding systems before yields are compromised and economics of plant establishment optimised.

AIM

1. To determine the effect of sowing density and seeder type on plant establishment and grain yield in canola in the Wimmera.
2. To determine the effect of sowing density, row spacing and seeder type on plant establishment and grain yield in faba beans in the Wimmera.

PADDOCK DETAILS

Location:	Rupanyup
Crop year rainfall (Nov-Oct):	467mm
GSR (Apr-Oct):	309mm
Soil type:	Clay
Paddock history:	2019 lentils (canola trial), 2019 barley (faba bean trial)

TRIAL DETAILS

Crop type/s:	Canola and faba beans
Target plant density:	Refer to Table 1
Seeding equipment:	Refer to Table 1
Sowing date:	7 May 2020
Replicates:	Four (beans) and six (canola)
Harvest date:	3 December 2020
Trial average yield:	Beans 5.3t/ha, canola 3.5t/ha

TRIAL INPUTS

Fertiliser:	APP liquid fertiliser @50L/ha applied at sowing, 17 June urea @ 80kg/ha + 10 July urea @ 60kg/ha (canola only)

Trials managed as per best practice for weeds, pests and disease.

METHOD

Two replicated field trials were established (canola and faba beans) in adjacent paddocks using split plot designs. A precision planter and a conventional (cone) seeder were used to sow at different target densities (Table 1). Row spacing was also adjusted for comparison in faba beans. Sowing densities of recommended and lower than recommended rates were selected to assess the sensitivity of these crops to low densities.

Assessments included emergence rate counts every few days after sowing until establishment was reached, establishment counts, seedling depth measurements, measurement of interplant distance (distance between 30 adjacent seedlings in two crop rows), biomass at flowering, harvest index as well as grain yield and quality.

The statistical analysis of the trials used a method that took into account spatial variation across the trial areas. Treatment effects were assessed by a Wald test and a Tukeys test was used to examine the difference between treatment means.

Table 1. Treatment outline for the two trials.

Crop type (variety)	Target density (plants/m^2)	Row spacing	Seeder
Canola (44Y90 CL)	10 15 25 50	30.5cm (12 inch)	Precision (singulation) disc seeder Conventional (cone) disc seeder
Faba bean (Bendoc)	5* 10 20 30	22.9cm (9 inch) 45.7cm (18 inch)	

*This treatment was removed from analysis due to limitations of the precision planter to sow accurately at this target density. Density was too low to meter using the available metering disc.

RESULTS AND INTERPRETATION

CANOLA

Establishment

Although moisture was no issue at sowing, cool soil conditions resulted in slow crop emergence with full establishment not reached for four weeks.

The overall crop establishment was 91% in canola. There was no difference in the establishment between the two seeder types (P=0.09) and there was no effect of sowing rate on crop establishment.

Means of inter plant distances did not differ between the two seeders (P=0.16). However, an average measure of seed placement does not indicate consistency of interplant spacings within a treatment. To understand variability in placement we used the coefficient of variation (CV%) of the inter plant distance to assess uniformity of placement, with a low CV% indicating greater uniformity. This was substantially lower in plots sown with the precision planter, however, still indicates some level of variation in placement (Table 2).

Table 2. Mean interplant distance (cm) and variability (CV%) of plant spacings between seeder types across sowing densities in canola. Lettering indicates significant differences.

Seeder	Mean interplant distance (cm)	CV (%)
Conventional	2.8	98.9[a]
Precision	2.9	72.5[b]
Sig. diff.		
Seeder	**NS**	**<0.001**
Sowing Density	**<0.001**	**0.04**
Seeder x Density	**NS**	**NS**

Biomass and Yield

There was no significant difference in yield between the two seeders (3.62 t/ha with precision planter vs 3.40 t/ha with the conventional seeder, NS). There were differences in yield between sowing densities with yield optimised at 22 plants/m^2 established (Figure 1).

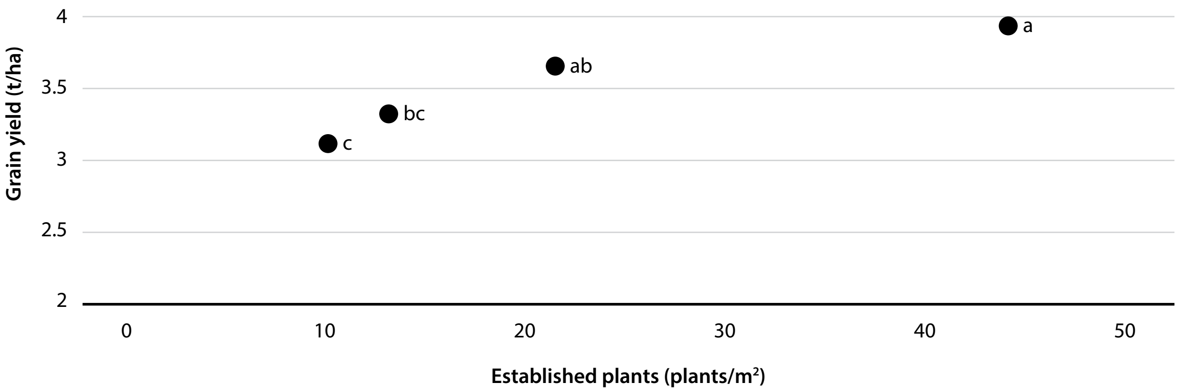

Figure 1. Mean grain yield (t/ha) for plant number established (plants/m^2) at the four sowing densities. Grain yield: density P<0.001. Lettering indicates significant differences.

Plant size was affected by sowing density. As the plant density declined, individual plant weight and grain yield per plant increased which highlights the ability for canola to compensate at lower sowing densities. However, yield did not fully compensate for the low plant numbers at the lowest sowing rate. Reducing plant number by one fifth from 50 plants/m^2 to 10 plants/m^2 resulted in a 4-fold increase in yield per plant, however ultimately resulted in a lower yield (Figure 2).

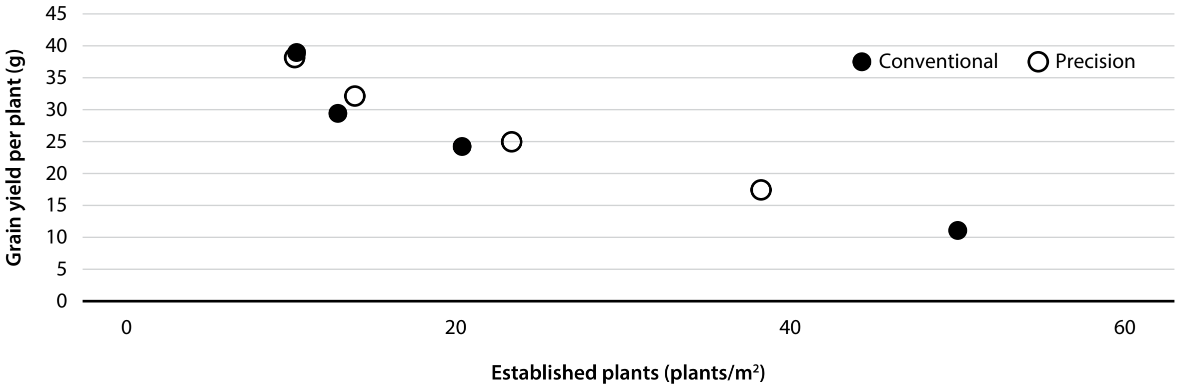

Figure 2. Mean grain yield per plant (g) for different plant populations of the two seeder types.

FABA BEANS

Establishment

With cool soil temperatures, establishment was slow. Differing from the canola, there was a difference between seeders on final establishment percentage ($P=0.003$). The precision planter established better plant numbers at 90% of target densities where the conventional seeder established an average of 68% across targeted densities.

Row spacing had no significant impact on final establishment. Good soil moisture will have contributed to this factor. As would be expected, changing row spacing did influence mean interplant distance with wider rows having seeds closer together ($P<0.001$).

The CV for interplant distance was much lower with the precision planter compared to conventional sowing, indicating the variability in seed placement along the rows was significantly lower (Table 3).

Table 3. Mean interplant distance (cm) and variability (CV%) of plant spacings between seeder types across sowing densities and row spacings in faba beans. Lettering indicates significant differences.

Seeder type	Mean inter-plant distance (cm)	CV (%)
Conventional	3.3^{a}	104^{a}
Precision	3.0^{b}	66^{b}
Sig. diff.		
Seeder	**P=0.002**	**P<0.001**
Row Spacing	**P<0.001**	**NS**
Density	**P<0.001**	**P= 0.018**
Seeder x Row sp.	**P=0.003**	**NS**
Seeder x Density	**NS**	**NS**
Row sp. X Density	**NS**	**NS**
Seeder x Row sp. X Density	**NS**	**NS**

Biomass and Yield

Bean yields were significantly higher using the precision planter than the conventional seeder ($P=0.001$).

A significant difference between densities was found with yields optimised at 16 established plants per square metre this season (20 plants/m^2 target) (Table 4). Average plant biomass measurements taken at maturity suggest that plants were significantly larger at the lowest density (10 plants/m^2) compared to the others. The greater growth per plant did not completely compensate for the fewer plants established, which resulted in a low yield at the lowest plant density (Table 4).

Table 4. Mean grain yield (t/ha), number of plants established (plants/m^2) and biomass at maturity (g/5 plants) across row spacings and different seeders in faba beans.

Target Sowing Density	Established plants (plants/m^2)	Biomass at maturity (g/5 plants)	Yield (t/ha)
10	9^{c}	541^{a}	4.4^{b}
20	16^{b}	419^{b}	5.2^{a}
30	20^{a}	367^{b}	5.6^{a}
Sig. diff.			
Seeder	**P= 0.009**	**P= 0.007**	**P= 0.001**
Row Spacing	**NS**	**NS**	**P<0.001**
Density	**P<0.001**	**P= 0.001**	**P<0.001**
Seeder x Row sp.	**NS**	**NS**	**P= 0.025**
Seeder x Density	**NS**	**NS**	**NS**
Row sp. X Density	**NS**	**NS**	**NS**
Seeder x Row sp. X Density	**NS**	**NS**	**NS**

An interaction was found between seeder type and row spacing with precision planter treatments yielding higher at narrow row spacing than conventional at narrow row spacing. From the data collected it is not fully understood what the reason for this interaction is but may have been influenced by more even inter plant spacings and lower inter plant competition from the precision planter.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Matching sowing densities to seasonal potential is an important step to optimising yields. Although both canola and beans showed the ability to compensate for low planting densities with biomass production, this biomass did not compensate for yield. In this season, yields were optimised in canola with 22 plants/m^2 established and 16 plants/m^2 established in faba beans. This emphasises the importance of taking into account the cost of seed when increasing sowing rates, especially if it is unlikely to increase grain yields (Table 5.).

Table 5. Partial gross margin for various sowing densities (ignoring capital cost of seeder). Canola seed price $25/kg and grain price of $551/t (22 December Murtoa). Faba bean seed price of $0.3/kg based on grain price of $300/t (22 December Murtoa). Lettering indicates significant difference.

Targeted sowing density (plants/m^2)	Established density (plants/m^2)	Seed cost ($/ha)	Grain yield (t/ha)	Income ($/ha)
Canola				
10	10^{c}	10	3.1^{c}	$1698
15	13^{c}	18	3.3^{bc}	$1800
25	22^{b}	28	3.7^{ab}	$2017
50	44^{a}	55	3.9^{a}	$2094
Faba beans				
10	9^{c}	18	4.4^{b}	$1302
20	16^{b}	35	5.2^{a}	$1525
30	20^{a}	53	5.6^{a}	$1627

While we only have one year of data for beans, across three seasons from 2018-2020 the average of the optimal target density in canola was 32 plants/m^2. While this research suggests that sowing rates could be dropped lower than is common practice without reduction in yield, it is important to note that these trials were well managed for weeds and lowering sowing rates in a weedy paddock may not have the same effect if not well managed.

When calculating seeding rates, it is important to target a number of plants to be established over an area rather than just selection of a kg/ha rate based on historic practice. To calculate this seeding rate, it is important to consider both average seed size and expected germination. This is likely to vary year to year due to seasonal and storage conditions.

From the three years of small plot research undertaken at BCG, the precision planter has consistently improved the uniformity of establishment indicating that precision planters may have a role to play in improving the uniformity of plant establishment. Stemming from its development for large seeded summer crops, it is noted that it is easier to achieve more accurate seed placement with a precision planter starting with larger seeds. This was observed in the less varied seed placement seen in faba beans compared to canola in this research and is also a factor, among others, that has contributed to the knowledge that using larger hybrid seeds when precision planting canola will give better results.

Purchasing precision planter technology is a large financial investment to make around $3000 per row unit. This technology is still in development for winter crops and no consistent yield benefit or seed saving has been reliably calculated from these research results.

Investing time into targeting optimum sowing densities, correctly calibrating your seeder, and setting up correctly for paddock conditions and target depths are opportunities to improve establishment without additional significant financial investment.

COMMERCIAL SCALE PRECISION PLANTING EXPERIENCES

(McDonald et al., 2021)

While still in its infancy when it comes to winter crops, precision planting has been used in summer crops with consistent success. As part of this project, interviews of early adopters of precision planting technologies in winter cropping systems across the southern and western regions were conducted to provide feedback on currently available precision planters and their performance on a large scale.

Improved yields were not the main driver of adoption for most of these growers, potential seed cost savings, improved establishment, early vigour and weed competition were some common themes highlighted as considerations leading to adoption.

While these positive impacts were seen in the paddock, growers highlighted several issues that arose with adoption such as:

- lack of technical support and advice available for growers using these technologies in the southern and western regions
- where older generation planters were purchased from northern regions originally used for summer cropping, adapting the equipment for winter cropping posed some challenges
- row unit spacing was not always suitable for sowing pulses and canola (too wide)
- limited or no ability to band fertiliser with seed
- no seed plates suited to singulation of winter crop seed shapes, sizes and sowing rates
- unsuitable capacity of row-hopper units for winter grain sowing rates
- the need to regularly check the system due to lack of technology providing real-time feedback
- speed and paddock roughness had a significant effect on planting performance.

When asked to provide advice for other growers investigating precision planters in winter cropping regions, these early adopters highlighted some valuable points for consideration.

- The benefits of seed singulation will not be realised unless seed placement (depth) is accurate. This can be influenced by technology features, operation, and setup as well as paddock roughness.
- Be sure to plan for the shift to precision planting. Address soil constraints, use clean and graded seed, prioritise paddock preparation and residue management and plan sowing logistics.
- Do some homework: talk to other growers, manufacturers and look internationally for up-to-date information.
- Be confident in your choice, ensure technological support is available. If you are not confident in your choice of planter, delay your decision until you are.

Where to from here for precision planting technologies in winter cropping?

Precision planting technologies continue to develop with a focus on increasing suitability to winter grain crops. These improvements include:

- improvement in singulation with further development of winter grain plates and metering accessories
- control and real time monitoring systems better suited to winter cropping seed rates
- ability to sow at narrower spacings (190-380mm)
- serrated disc blade technology for improved cutting of residues
- bulk fill systems for seed
- liquid and/or granular fertiliser banding options
- pressurised or belt guided seed delivery into furrow to allow high speed sowing.

There is also considerable development in transitional technologies to allow seed singulation row kits to be integrated onto air seeders. Developments of these intermediate technologies in the future could increase the versatility of precision planting in winter cropping systems in a range of soil conditions. Their mainstream adoption, however, will rely on them being practical, cost-effective and not affecting the timeliness of sowing within a cropping programme.

The potential performance of precision planters in low to medium rainfall zones with winter crops is still not fully understood. Mainstream adoption of precision planting technology not only relies on the current issues in winter grains being addressed but the technology also needs to be practical, cost effective and have no detrimental impact on the timeliness of sowing operations.

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