# Evaluation of the benefits of precision planting in canola at Hart

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**Key findings**

- Data collected across four years of trials suggest that precision planting of canola provided an average yield benefit of approximately 10% compared to conventional sowing.
- Yield benefits from precision planting tended to be greater at low plant populations.
- Precision planting significantly improved the uniformity of canola stands, although it was still well below the ideal uniformity of a perfect placement.
- Precision planting of canola could allow a reduction in plant density without a loss of grain yield, with potential savings on seed costs of $24/ha, confirming grower experiences to date.

**Why do the trial?**

Precision planting technologies are designed to place seeds at a consistent interplant distance and depth to promote uniform emergence and minimise interplant competition. In principle, minimising interplant competition allows each seedling to achieve its potential growth, thereby improving crop yield.

Precision planters were developed to improve yields of summer row crops where expensive hybrid seed is planted at relatively low densities. However, over the past decade there has been interest in using precision planting in small grain crops and especially in hybrid canola to reduce seed costs. This was prompted in part, by results of experiments in canola from Canada that found increases in grain yield of 20 – 30% at low plant densities in stands of equally-spaced plants, compared to unevenly-spaced plants. This has been supported by work from WA on plant arrangement that has shown equally-spaced plants can produce a higher yield than unequally-spaced plants at low densities.

Smart seeding technology is rapidly evolving with precision planter technology, allowing real-time monitoring of seed bed conditions and seeder performance. Machinery manufacturers are also showing increasing interest in developing precision planters suitable for winter grain crops, requiring adaptation for narrow row spacing, high population seed rate and bulk feeding of singulation row units. A small number of growers, particularly in Victoria and NSW, are using precision planters in their winter cropping programs and there have been reported benefits in canola and faba bean.

Over the last four years, trials have been conducted at the Hart field site to investigate the potential benefits of precision planting in canola and pulses, as part of a national program to examine the potential value of precision planting in winter crops. Trials compared the growth and yield of crops sown with a conventional cone seeder and a precision planter at a number of plant densities. In some experiments the effect of row spacing was also examined.

This article summarises the results of precision planting technologies at Hart for canola between 2018 and 2021.

**How was it done?**

The trials were sown with a purpose-built small plot disc seeder that had the ability to sow plots as a conventional disc seeder (with centralised cone metering) or as a precision planter (with singulation row metering). The seeder was built by Spot-on-Ag (Boort, Victoria) with Harvest International brand double disc openers, Precision Planting Inc. electric drive (vDrive) and vSet vacuum meters controlled by 20/20 SeedSense system.

In each year, a range of target plant densities were compared. In 2021 an experimental planter using Horsch Sprinter tynes was developed by UniSA with support from Muddy River Ag to operate as both a conventional air seeder (centralised metering) or precision planter (using Horsch Maestro singulation units controlled with E-Manager) and was included in the trial to allow a comparison between tyne and disc-based precision planters. A tyne precision planter was expected to combine the benefits of a fully tilled furrow and seed singulation. Treatments for each trial are listed in Table 1.

Trials were sown between early and mid-May following 20 – 50 mm of rainfall in the 2 weeks leading up to sowing (Table 2). Targeted seeding depth was in the range of 10 – 20 mm.

In 2021 some plots were sown at high densities with the tyne seeder and hand thinned to provide a treatment with consistently equal spacing between individual plants, and at equivalent established plant densities as the conventional and precision planted treatments. This represented an ideal arrangement of plants that minimised variation in interplant competition and provided a benchmark to assess the value of maximum stand uniformity.

*Table 1. Precision planting experiments conducted at Hart between 2018 and 2021.*

| | | | |
|---|---|---|---|
| | **2018** | | |
| **Plot size** | 1.37 m or 1.52 x 12 m | **Seeder** | Cone tyne seeder and precision disc planter |
| **Row Spacing** | Narrow = 22.9 cm (9"),<br>Wide = 30.5 cm (12") | **Variety** | Pioneer 44Y89 (CL) |
| **Plant densities** | 15, 25, 35, 45, 55, 65 plants/m$^2$ | | |
| **Seeding date** | May 10, 2018 (May 17 for wide precision planter) | | |
| | **2019** | | |
| **Plot size** | 1.37 m or 1.52 x 12 m | **Seeder** | Cone and precision disc planter |
| **Row spacing** | Narrow = 22.9 cm (9"),<br>Wide = 30.5 cm (12") | **Variety** | Hyola 559TT |
| **Plant densities** | 15, 25, 35, 45, 55, 65 plants/m$^2$ | | |
| **Seeding date** | May 14, 2018 (May 15 for wide precision planter) | | |
| | **2020** | | |
| **Plot size** | 2.0 m x 12 m | **Seeder** | Cone and precision disc planter, plus perfect placement |
| **Row spacing** | 25 cm (10") | | |
| **Plant densities** | 15, 25, 40 plants/m$^2$ | | |
| **Seeding date** | May 5, 2020 | **Variety** | Hyola 350TT |
| | **2021** | | |
| **Plot size** | 2.20 m x 12 m | **Seeder** | Disc and tyne seeders; conventional and precision plus perfect placement |
| **Row spacing** | 25 cm (10") | | |
| **Plant densities** | 15, 25, 35, 45 plants/m$^2$ | | |
| **Seeding date** | May 27, 2021 | **Variety** | Hyola 350TT |

Crop establishment (%) was estimated a number of times from first emergence by counting emerged seedlings along a three metre length of row, over two rows. The uniformity of stand establishment was assessed by measuring the interplant distance between 30 consecutive seedlings per row in two rows per plot at full establishment and calculating the coefficient of variation (CV%) for the interplant distance. Early crop cover was also measured using a hand-held Normalised Difference Vegetation Index (NDVI) sensor (Trimble GreenSeeker). Crop biomass at podding (t/ha), harvest index, calculated as the ratio of grain yield to total above-ground crop biomass at maturity, grain yield (t/ha) and grain quality (1000 grain weight) were also conducted.

*Table 2. Summary of rainfall in canola trials 2018 – 2021.*

| Year | Sowing date | Rainfall (mm) | | |
|---|---|---|---|---|
| | | April-October | 2 weeks before sowing | 2 weeks after sowing |
| 2018 | May 10 | 219 | 20 | 18 |
| 2019 | May 14 | 240 | 39 | 19 |
| 2020 | May 5 | 324 | 53 | 8 |
| 2021 | May 13 | 267 | 20 | 29 |

## Results and Discussion

Sowing canola with a precision planter did not consistently affect the number of plants/m$^2$ achieved at sowing (Figure 1). Average crop establishment across the trials was lowest (50%) in 2020 which had the least rain post-seeding but reached up to 75 – 80% in more favourable years. No significant effect was observed on crop establishment as a result of precision or conventional planting when both technologies used the same disc row system (Table 3). This differed in 2018 when the tyned conventional seeder outperformed the precision disc.

*Table 3. Summary of the main effects of sowing method on crop establishment, the uniformity of stand establishment and average grain yield. Asterisks after the values for the precision planter indicate the value is significantly different from conventional sowing (* P≤0.05; *** P=0.001) and NS indicates the difference is not significant.*

| Year | Crop establishment (%) | | Interplant distance CV (%) | | Grain yield (t/ha) | |
|---|---|---|---|---|---|---|
| | Conventional sowing | Precision planter | Conventional sowing | Precision planter | Conventional sowing | Precision planter |
| 2018 | 90 | 65*** | 101 | 77*** | 1.38 | 1.39$^{NS}$ |
| 2019 | 67 | 64$^{NS}$ | 103 | 66*** | 0.54 | 0.61* |
| 2020 | 48 | 52$^{NS}$ | 94 | 59* | 1.01 | 1.06$^{NS}$ |
| 2021 | 72 | 82$^{NS}$ | 87 | 74$^{NS}$ | 0.79 | 0.84$^{NS}$ |

The uniformity of seed placement was increased substantially with the precision planter with the CV% for interplant distance significantly lower when compared to the conventional sowing treatment in three of the four trials (Table 3).

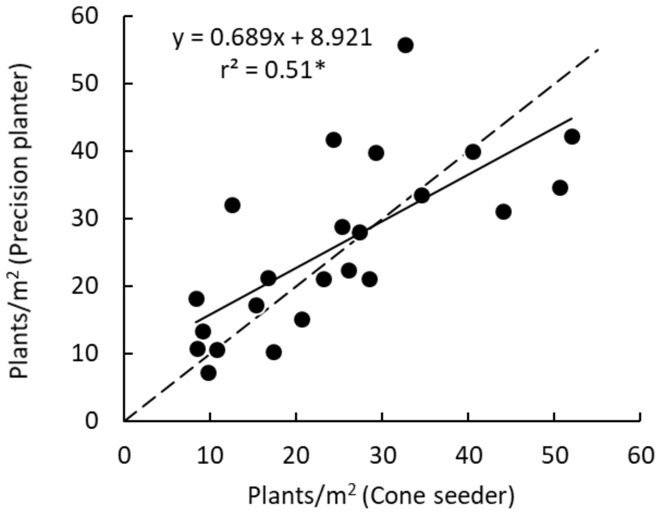


*Figure 1. Established plant populations for canola sown with a cone seeder or precision planter. The data points represent different plant density treatments (n=23) across all trials. The dashed line is the 1:1 line which represents equivalent plant densities for respective cone seeder and the precision planter treatments.*

Variation in plant density was the main cause of differences in NDVI among treatments. Where there was a significant effect of the sowing method on NDVI, this was associated with differences in plants/m². There was no consistent difference in biomass production at podding between the seeding methods and similar amounts of biomass (both from the NDVI measurements and the quadrat samples) were produced under both seeding systems (data not presented).

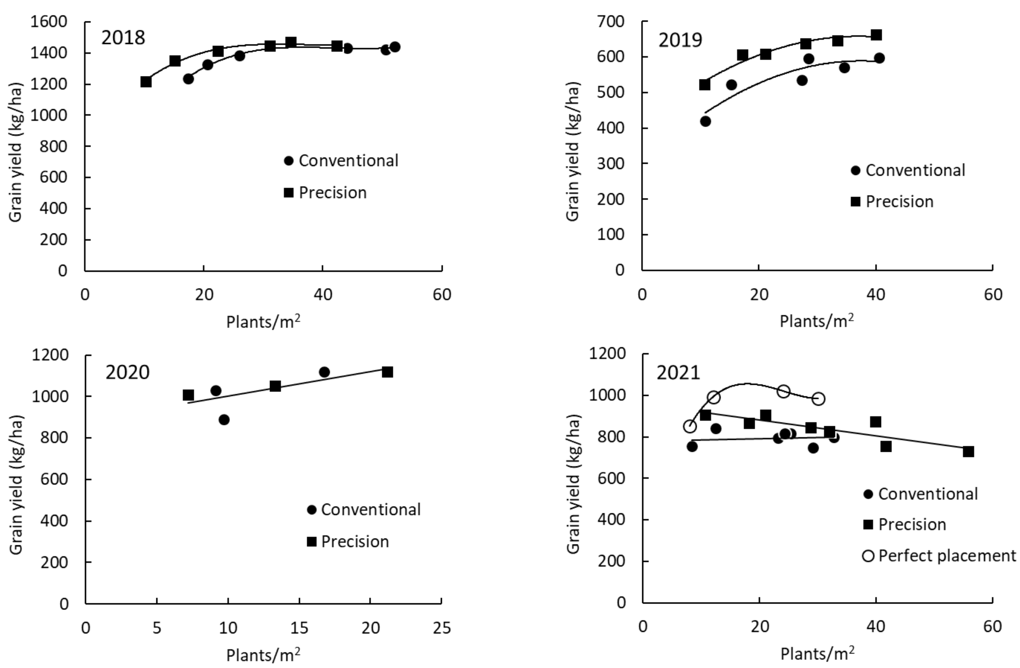


*Figure 2. The yield responses to plant density in canola trials at Hart between 2018 and 2021. Plant number is the established plant population in each year. Data for precision planting in 2021 include the disc and tyne seeders.*

The most consistent influence on grain yield was plant density, with significant effects measured in each year (Figure 2). Reductions in yield occurred below a plant density of about 20 – 30 plants/m$^2$, but precision planting was better able to maintain yields at these low densities compared to the conventional cone seeder. This was seen in 2018 and 2021 when yields with precision planting tended to be higher at low plant densities while in 2019 yields were consistently higher with precision planting over all plant densities. Within this range, reducing plant populations by about 10 plants/m$^2$ by precision planting had little effect on yield. In 2020 there was no difference in yield between the two methods of sowing.

The results suggest it may be feasible to reduce plant populations by about 10 plants/m$^2$ with a precision planter without an effect on yield. Assuming 70% field establishment and 95% germination, this is equivalent to a reduction in sowing rate of 0.8 kg/ha (assuming 180,000 seeds/kg). At a seed cost of $30/kg for hybrid seed, this is a potential saving of $24/ha.

There was an average yield benefit from precision planting of 10%, or 80 kg/ha, over the three years (2018, 2019 and 2021) where there was a difference in the response to plant density between seeding method (Figure 3). Including the 2020 results reduced the yield benefit to 6% or 26 kg/ha. There was a trend in each experiment for the benefit of precision planting to be greater at low plant densities.

The potential value of improving crop uniformity was demonstrated in 2021: the highest yields were achieved with the perfect placement treatment (Figure 2). Hand thinning established a highly uniform crop with each plant equally spaced (CV% for interplant distance = 0% compared to 60 – 75% typical value range for precision planter treatments and 90 – 100% value range for conventional seeder treatments, measured over the 4 years at Hart) which resulted in a further average yield benefit of 18%, or 150 kg/ha, over precision planting at 20 and 30 plants/m$^2$.

While these results are encouraging, the yield responses to precision planting varied considerably among the experiments and many of the yield differences (as kg/ha) were small. At the present time these effects may not be sufficient to warrant the use of precision planting technology.

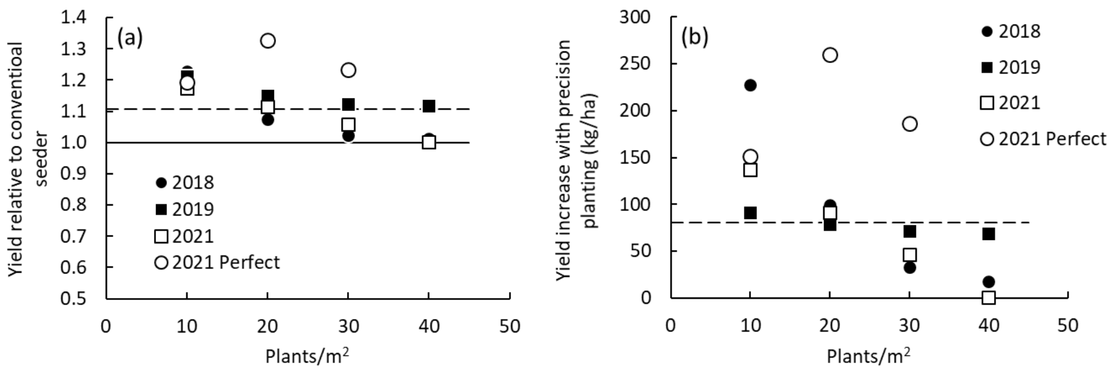


*Figure 3. The yield advantage of precision planting over conventional sowing at four plant densities at Hart in 2018, 2019 and 2021 and the yield advantage of perfect placement in 2021 showing (a) the relative yield of precision planting or perfect placement over conventional sowing and (b) the yield increases from precision planting or perfect placement. To allow comparisons to be made at the same plant density, the yields are the predicted values at 10, 20, 30 and 40 plants/m2 from the response curves fitted to the data in Figure 2. Data from 2020 were not included because the responses to plant density with conventional sowing and precision planting were the same. The dashed lines are (a) the average relative yield and (b) the average yield increase.*

There was a tendency for precision planting to increase the number of harvested seeds/m$^2$ by up to 15%. Average seed weight was similar for all seeding systems. These results suggest that the effect of improving crop stand uniformity occurred though improvements in podding and seed set rather than in seed filling. The perfect placement treatment also produced the highest number of harvested seeds/m$^2$ but average seed weight was slightly lower compared to the conventionally-sown treatments. High grain yields across the four years was most strongly associated with high rainfall during August, a period when canola biomass was increasing as it approached flowering and the yield potential of the crop was being set. Reducing the degree of interplant competition during this phase of growth may result in increased yields, but further work is required to verify this.

*Figure 4. (L-R) Canola plot thinned to 30 plants/m$^2$ and canola sown with conventional disc seeder. (actual establishment of 30 plants/m$^2$) sown to target 45 plants/m$^2$ at Hart in 2021.*

Currently, all commercial precision planters are disc seeders, however, having a tyned precision planter may be a more attractive option for many growers. A comparison of the tyned precision planter and the disc precision planter in 2021 found few differences between the two seeders. Plant establishment was higher with the tyned planter, but the uniformity of the plant stand was not improved when compared to the disc precision planter. Yields for the tyned seeder were not significantly different from those with the disc seeder.

**Conclusions**

Precision planting of canola did not consistently affect crop establishment relative to conventional seeding, but improved the uniformity of the crop stand. While there was considerable variation over the four years of the project, the project data suggested an average benefit in grain yield of 6 – 10% from precision planting over conventional seeding, although the benefits tended to be greater at low plant densities. Precision planting tended to maintain yields at low plant densities, which may allow a reduction in sowing rate and savings in seed inputs costs. This finding is consistent with reported grower experiences claiming significant canola seed cost savings achievable with precision planting.

The results from the perfect placement treatment also demonstrated that substantial improvements in grain yield are possible by maximising the uniformity of the crop stand under exact and consistent plant spacing. The project data indicate that the uniformity of inter-plant spacing of precision planters, while significantly better than that of conventional seeders, is still below the ideal perfect placement case and this is in part due to establishment being less than 100% even with precision planting, resulting in gaps along the row. While the results are encouraging, the economics of precision planting technology in canola cropping would need to integrate seed savings over sufficient area contracted per year and less reliance on grain yield responses alone.

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