Evaluating the importance of sowing rate, depth and time of sowing on canola emergence

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Key findings

- There was no crop establishment penalty for canola that remained in dry soil for an extended period of time (6-7 weeks) prior to the season break on May 30.
- Low density crops may be able to yield similarly to crops where target densities are achieved if seasonal conditions are favourable, however drought conditions experienced at Hart in 2024 resulted in poor seed set for all canola. Bird damage and severe weather events prior to harvest prevented canola trials from being harvested.
- A complementary trial showed that seed size (small vs. large) of HyTTec Trophy canola did not impact establishment (plants/m2) at Hart in 2024, however it did affect early vigour (NDVI) and biomass production (t/ha).

Background

Across the Mid North of South Australia in 2024, most broadacre crops were sown into dry soils due to unusually dry autumn conditions, with areas receiving less than 20 mm across three months (March-May).

Risks surrounding dry sowing have been associated with reduced plant establishment in marginal moisture conditions, with further information required on the impacts of this low establishment on profitability and productivity. The rewards of dry or early sowing have been seen as potential yield gains by earlier emergence increasing season length of crops and improving water use efficiency. Although poor establishment can lead to a reduction in yield, trials conducted across the Mid North have found that favourable growing conditions may allow lower density crops to perform similarly to those where establishment is high (Morgan et. al. 2023). In 2024, a canola time of sowing (TOS) trial was implemented at Hart, SA to investigate the relationship between plant establishment and yield at various plant densities. A secondary and complementary trial at Hart explored the impacts of low establishment on productivity to develop a response curve between canola establishment and grain yield.

These trials provide information on the effects of early and dry sowing, establishment conditions, seed size and plant density target to better understand the risk and reward associated with this management practice.

Methodology

Canola TOS

In 2024, a replicated canola trial was sown to Enforcer CT on a clay loam soil at Hart. The trial was a factorial split-split plot design with three sowing dates between late April and early July, three sowing depths (shallow (10 mm), standard (20 mm) and deep (30 mm)) and three plant densities (23, 45 and 68 seeds/m2) (Table 1). Sowing rates represent standard practice (45 plants/m2) +/- 50% target density. The low sowing rate (50% of standard practice) of 23 plants/m^2 was included to quantify the effects of poor establishment when sown at different times of sowing (TOS) and depths.

Plant counts were conducted to determine the effect of treatment on establishment (plants/m^2). Soil moisture in the top 10 cm was recorded with a hand-held moisture meter at sowing and monitored until final emergence of all TOS. Normalised Difference Vegetation Index (NDVI) was measured twice after emergence to monitor early plant growth and timing of key phenological events (e.g., flowering) was recorded for all plots (data not shown). This trial was not harvested due to drought conditions and bird damage affecting grain yield results. Hand harvested yield estimates from quadrats were both low yielding (<150 kg/ha) and highly variable, therefore no grain yield data is presented. All data was analysed using a REML spatial model (Regular Grid) and differences between means were assessed using Bonferroni test, in Genstat 24th Edition.

Table 1. Canola trial details for Enforcer CT at Hart, SA.

Enforcer CT	**TOS 1**	April 18	**Seeding fertiliser:**	DAP Zn 1% + Flutriafol @ 80 kg/ha
	TOS 2:	June 4		
	TOS 3:	July 3		
	Seeding depth:	10, 20 and 30 mm		
	Sowing rate:	23, 45, 68 plants/m^2		

Canola seed size x density

A replicated trial was sown at the Hart field site using HyTTec Trophy (Table 2). This trial was set-up as a two-way factorial design with two seed sizes by seven densities and three replicates. Trial seed was graded into small seed (294,118 seeds/kg) and large seed (188,679 seeds/kg) and sown at target densities of 5, 10, 20, 30, 40, 50 and 60 plants/m2. Crop establishment was measured as plants/m^2 and NDVI was recorded four and eight weeks after emergence. Interplant distance (cm) was measured between 20 plants in each plot to measure plant spacing uniformity between treatments. Plant height (cm) and branching (number of branches/plant) was recorded at the end of flowering to determine effects of seed size and plant density on the size of individual plants.

Crop biomass (t/ha) and grain yield (t/ha) estimates were calculated using harvest index cuts; however one replicate was removed from analysis due to bird damage. Data was analysed using a REML spatial model (Regular Grid) and differences between means were assessed using Bonferroni test, in Genstat 24th Edition.

Table 2. Trial details for HyTTec Trophy canola seed size x density trial at Hart, SA.

HyTTec Trophy	**Plot size:**	1.75 m x 10.0 m	**Seeding fertiliser:**	DAP Zn 1% + Flutriafol @ 80 g/ha
	Seeding date:	June 5		
	Seed weight (small):	3.4 g/1000 seeds		
	Seed weight (large):	5.3 g/1000 seeds		
	Crop history:	Oaten Hay (2023)		

Results

Canola TOS trial

Despite the dry start, crop establishment was high (75-90%) with no difference in final establishment recorded among the three TOS (Table 3). TOS 1 was sown into dry soil (<2% soil moisture) on April 18 and remained dry until the opening rains six weeks later on May 29 to June 1. Soil moisture remained below permanent wilting point (PWP) until the first week of June with TOS 1 emergence on June 11, almost one week after soil moisture exceeded the PWP (Figure 1). Despite this long dry period, crop establishment was not reduced.

Time of sowing two was sown into approximately 20% moisture and achieved similar establishment to TOS 1 despite the differences in soil moisture conditions. Emergence of TOS 2 occurred on June 18, emerging only one week after TOS 1. Soil moisture remained low throughout emergence of TOS 1 and TOS 2 and had not reached field capacity (FC) by the end of July.

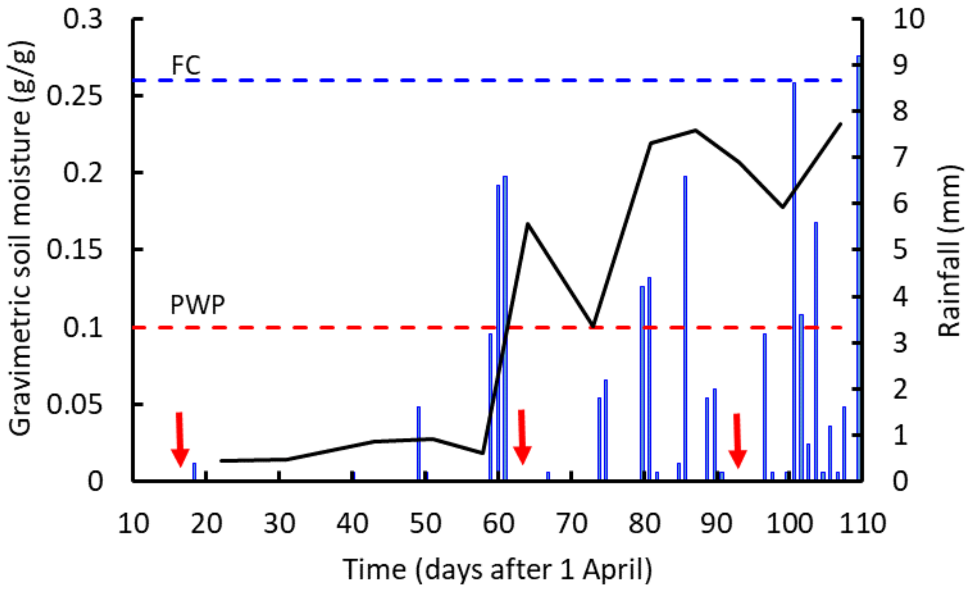

Figure 1. Soil Moisture Content (—) and rainfall ( ) in relation to the three times of sowing at Hart in 2024 (↓). The field capacity (FC) and permanent wilting point (PWP) moisture content shown are based on the moisture release curve for Hart soil (not shown).

Establishment counts showed that deep sowing canola to 30 mm slowed emergence, however this had no effect on final plant establishment (Table 3). Increasing sowing rate increased plant number proportionately, with differences between all three rates observed.

Depth of sowing effects on crop biomass are shown in Table 4. While deep sowing did not affect final plants/m^2, there was a penalty to early growth associated with deep sowing, possibly related to the delayed emergence.

Table 3. Treatment effects on final plant establishment (plants/m^2) and establishment (Est %) for canola. Significant differences in plant establishment between treatments are indicated by different letters after plant count (plants/m^2). Shaded values indicate the treatments with the highest plant establishment.

Effects of sowing date			Effects of sowing depth			Effects of sowing rate		
Sowing date	**Plants (m^2)**	**Est %**	**Sowing depth**	**Plants (m^2)**	**Est %**	**Sowing rate**	**Plants (m^2)**	**Est %**
April 18 (TOS1)	37	82	**Shallow**	40	89	**23/m^2**	17^a	74
June 4 (TOS2)	34	76	**Standard**	37	82	**45/m^2**	37^b	82
July 3 (TOS3)	41	91	**Deep**	34	76	**68/m^2**	58^c	85
P-value (≤0.05)	**NS**			**NS**			**<0.001**	

Table 4. Sowing depth and sowing rate effect on early biomass as measured by NDVI conducted eight weeks after emergence. Significant differences are indicated by different letters. Shaded values indicate best performing treatments.

Sowing depth	NDVI	Sowing rate	NDVI
Shallow	0.37[c]	23/m^2	0.29[a]
Standard	0.34[b]	46/m^2	0.36[b]
Deep	0.30[a]	68/m^2	0.37[b]
P-value (≤0.05)	**<0.001**		**<0.001**

Canola seed size x density trial

Seeding density had an impact on both plant establishment (plants/m^2) (Figure 2) and interplant distance (cm) in the canola density trial at Hart in 2024. As seeding rate increased, the distance between plants was reduced, as expected. Increased crop density reduced the ability of canola to branch out and maximise individual plant productivity due to greater competition, which was compounded by drought conditions in 2024.

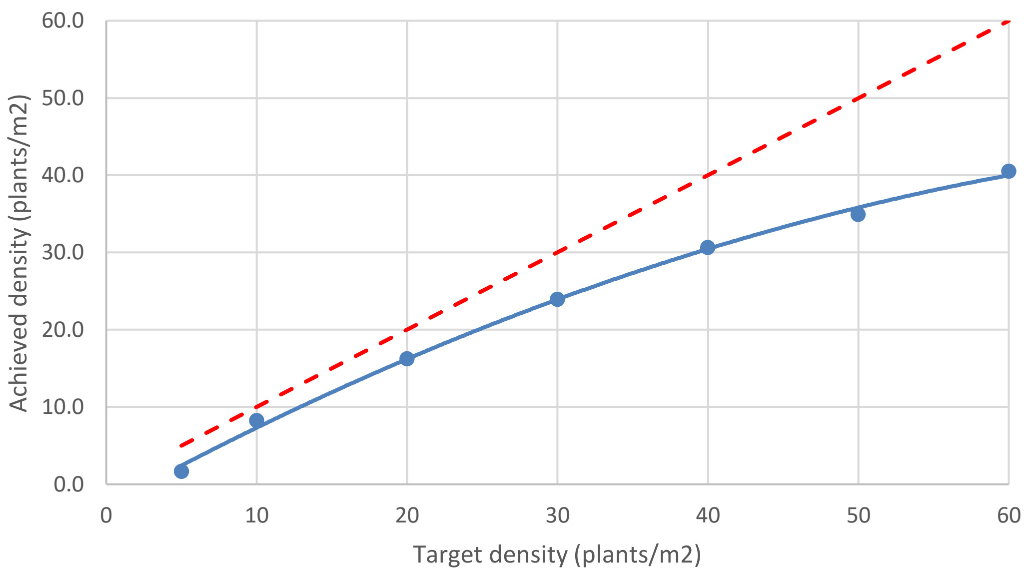

Figure 2. Target density (plants/m^2) and achieved plant establishment (plants/m^2) curve. The red line shows 100% plant establishment relevant to the target density. At higher plant densities, the gap between target and achieved yield is increased.

There was no effect of seed size on plant establishment or interplant distance (cm), however early ground cover measured as NDVI at eight- and twelve-weeks post-emergence, showed improved early vigour in large seed treatments (Table 5). This increase in early growth translated to biomass at maturity, with higher biomass (t/ha) observed where larger seed was used (p=0.021).

Despite these differences, large and small seed treatments yielded similarly for oilseed grain yield at Hart in 2024. It is important to note that drought conditions during the growing season resulted in low grain yields (>350 kg/ha).

Seeding density impacted biomass production, with higher density treatments producing more crop biomass (t/ha) than the 5 and 10 plants/m^2 treatments (Table 5). Despite biomass increasing with density, plant competition effects can be clearly identified by differences in plant weight (g/plant). Individual plants in the 5 plants/m^2 treatment weighed three times the amount of standard sowing density (40 plants/m^2), however increased plant density resulted in higher biomass production (t/ha) resulting from more plants per m^2.

Similarly, plants in low density treatments (5 plants/m^2) produced twice as much grain per plant (data not shown) as standard sown treatments (40 plants/m^2). Despite this result, no differences were noticed in grain yield (kg/ha), as higher density treatments offset reduced grain per plant through increased plant number.

Table 5. Impacts of seed size and seeding density on productivity as measured by NDVI, biomass (g/plant and t/ha) and grain yield (kg/ha). Significant differences are indicated by different letters. Shaded values indicate best performing treatments.

Treatment	NDVI 1	NDVI 2	Plant weight (g/plant)	Crop biomass (t/ha)	Grain yield (kg/ha)
Small seed	0.22	0.46	8.49	1.33	243
Large seed	0.26	0.50	9.50	1.51	208
P Value (≤0.05)	**0.01**	**0.006**	**0.007**	**0.021**	**NS**
5 plants/m^2	0.16^a	0.25^a	19.69^c	0.46^a	66
10 plants/m^2	0.17^a	0.35^b	13.3^b	1.12^{ab}	186
20 plants/m^2	0.24^b	0.48^c	8.14^a	1.23^{abc}	235
30 plants/m^2	0.26^b	0.55^d	6.68^a	1.5^{bc}	220
40 plants/m^2	0.25^b	0.57^d	5.22^a	1.96^{bc}	298
50 plants/m^2	0.31^c	0.56^d	5.22^a	1.64^{bc}	228
60 plants/m^2	0.31^c	0.58^d	4.68^a	2.02^c	349
P Value (≤0.05)	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**NS**

Plant height and number of branches were recorded post-flower to identify sowing density and seed size effects. When sown at a target density of 5 plants/m^2 each canola plant produced on average 24 branches, however when sowing density exceeded 20 plants/m^2 branching was reduced to 4-6 per plant (Figure 3). In addition to reduced branching, plant height was significantly affected by increasing plant density, with a 30 cm reduction in height between the lowest (5 plants/m^2) and standard (40 plants/m^2) sowing rates.

Severe water stress throughout the growing season resulted in extreme differences in plant size between treatments (Figure 4). Despite increased branching and plant size in lower density treatments, drought conditions resulted in poor grain fill in all cases, therefore yield (t/ha) estimates from harvest index cuts were less than 350 kg/ha for all densities and showed no significant differences (Table 5).

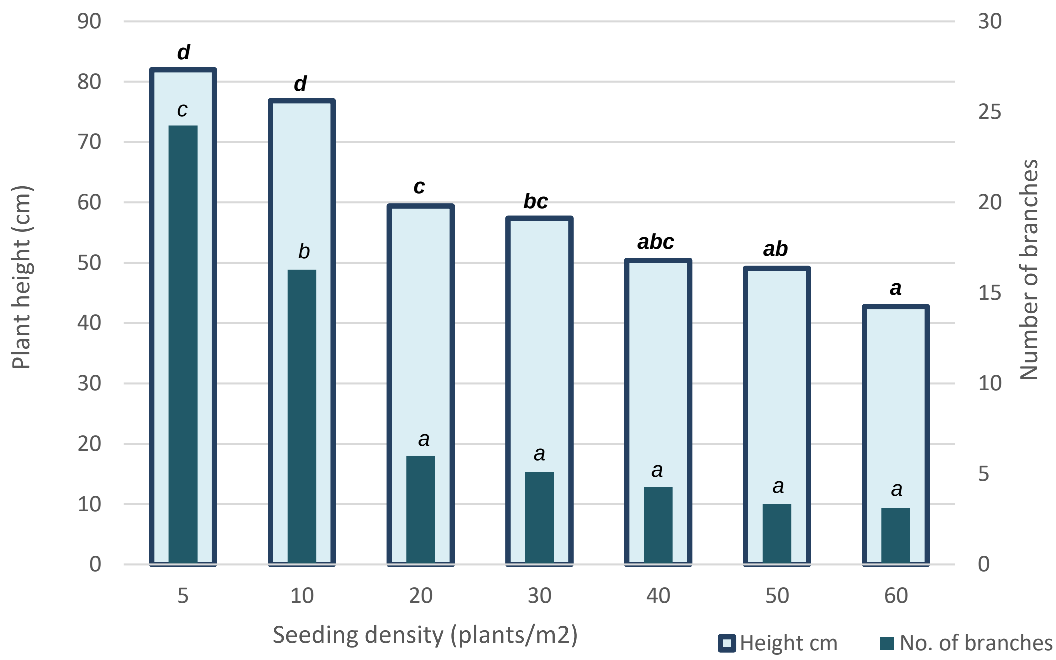

Figure 3. Plant height (cm) (□)and number of branches (■) for seven seeding densities (plants/m^2). Significant differences between treatments are indicated by different letters above columns on the graph.

5 plants/m^2 **10 plants/m^2** **20 plants/m^2** **30 plants/m^2** **40 plants/m^2** **50 plants/m^2** **60 plants/m^2**

Figure 4. Plant size when sown at seven densities. The red line indicates the 50 cm mark on a 1 m ruler for plant height comparison.

Summary

Variable and poor plant establishment are two of the biggest risks associated with dry or early sowing. In a season where establishment occurs early, it is expected that lower density crops, particularly canola, may be able to yield similarly to crops with higher plant populations, as they are able to effectively fill in space to increase production per plant. This has been observed across previous canola field research.

The experiments showed that canola seed can remain viable over long periods of time in dry soil without any adverse effect on crop establishment, with similar results observed in 2024 pot experiments. Sowing deeper than 20 mm has shown to delay emergence and slow early crop vigour.

In 2024, severe moisture stress was experienced across all trials at Hart, resulting in low grain yields for all treatments. Even under these harsh conditions, canola growth showed considerable ability to adjust to differences in plant density, even if this was not translated into yield.

Where canola establishment was low, reduced competition increased biomass production per plant, however severe water stress during reproductive development and grain fill stages resulted in very low yields. Drought conditions reduced plant size, particularly where there were higher plant densities resulting in very low grain yields, regardless of late season rain.

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References

Morgan, K., McDonald, G., Allen, R., Faulkner, M., Trengove, S., (2023) Evaluating the importance of sowing rate, depth and time of sowing on emergence and yield – wheat and canola. *2023 Hart Trial Results Book.*