Can the seeding rate of canola be reduced in the HRZ? Condingup 2022

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Key Messages

- Average establishment was 5, 8, 16 and 36 plants m^{-2} from seeding rates of 0.5, 0.9, 1.8 and 3.7 kg/ha.
- Differences in canopy cover (assessed by NDVI) persisted through to the start of flowering.
- The yield of the lowest seeding rate (2.8 t/ha) was significantly lower than the other seeding rates (3.4-3.6t/ha, not statistically different).
- Quadrat cuts indicated that yield reductions at low (e.g. 5 plants m^{-2}) plant densities were likely the result of bare areas rather than the inability of canola to compensate where 5 plants m^{-2} were established.
- Although plant stands of as low as 8 plants m^{-2} maintained yield relative to higher seeding rates, suboptimal or variable establishment that results in bare areas is likely to significantly reduce yield and so aiming for at least 20 plants m^{-2} is recommended.

Aim

To investigate the impact of reducing seeding rate (plant density) in canola in the high rainfall zone.

Background

High canola prices in recent years have driven an increase in the canola sowing area. Coupled with an increasing yield gap between open-pollinated and hybrid canola cultivars, this has put increased demand for hybrid canola seed. Issues in hybrid seed production have led to growers receiving lower quantities of seed than they budgeted for. In response, some growers are reducing seeding rate to seed larger areas with their preferred hybrid varieties. Although seeding rate (or plant density) is a well-understood agronomic lever, the pre-sowing environment of 2022 provided opportune context in which to test the impact of reduced seeding rates in a high yielding farming system.

Treatments

Four seeding rates to target four plant densities (5, 10, 20 and 40 plants m^{-2}) with six replicates.

Table 1: Seed source, seed packing and establishment at Condingup in 2022.

Seed source details	
Seed weight (mg)	5.24
Seeds per kg	191000
Viability (%)	95
Estimated establishment (%)	60

Seed packing and establishment		
Target plant density	**Seed rate (kg/ha)**	**Actual plant density#**
5 plants m^{-2}	0.46	4.5a
10 plants m^{-2}	0.92	8.4a
20 plants m^{-2}	1.84	15.6b
40 plants m^{-2}	3.68	36c

#Values with the same letter are not statistically different.

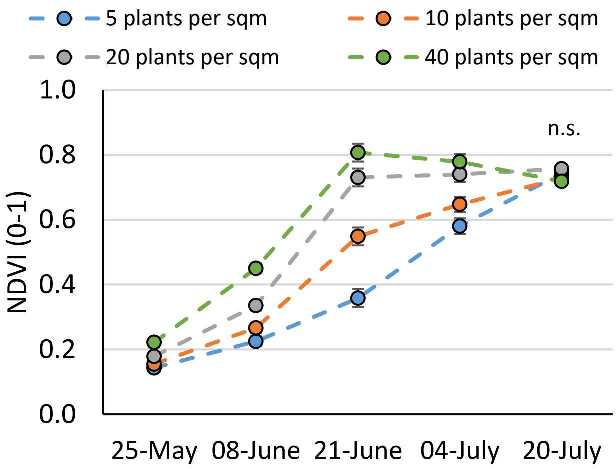

Figure 1: NDVI from three-leaf stage to early flowering for the four plant density treatments. Overlapping error bars indicate values are not statistically different.

Results

Seasonal conditions

After a very dry summer, significant rainfall fell in April (most notably 57mm from 12-14 April) to allow seeding into moisture (Figure 1). Following average rainfall in May (50mm) and slightly below average rainfall in June (30mm), the back half of July (66mm) and August (87mm) were wetter than average. September had average (41mm) rainfall but was generally cool, while 132mm fell in October, ensuring grain filling conditions through spring were optimal.

Establishment and in-season growth

The trial was sown on 26 April 2022 into moist soil with plants emerging within seven days of seeding. Plant establishment counts (3 x 0.514m^2 per plot) were conducted three weeks after seeding at the one- to two-leaf stage. Actual plant density was 80-90% of target density, which was likely due to seed viability being lower than expected (84% normal seedlings compared to 95% estimate) (Table 1).

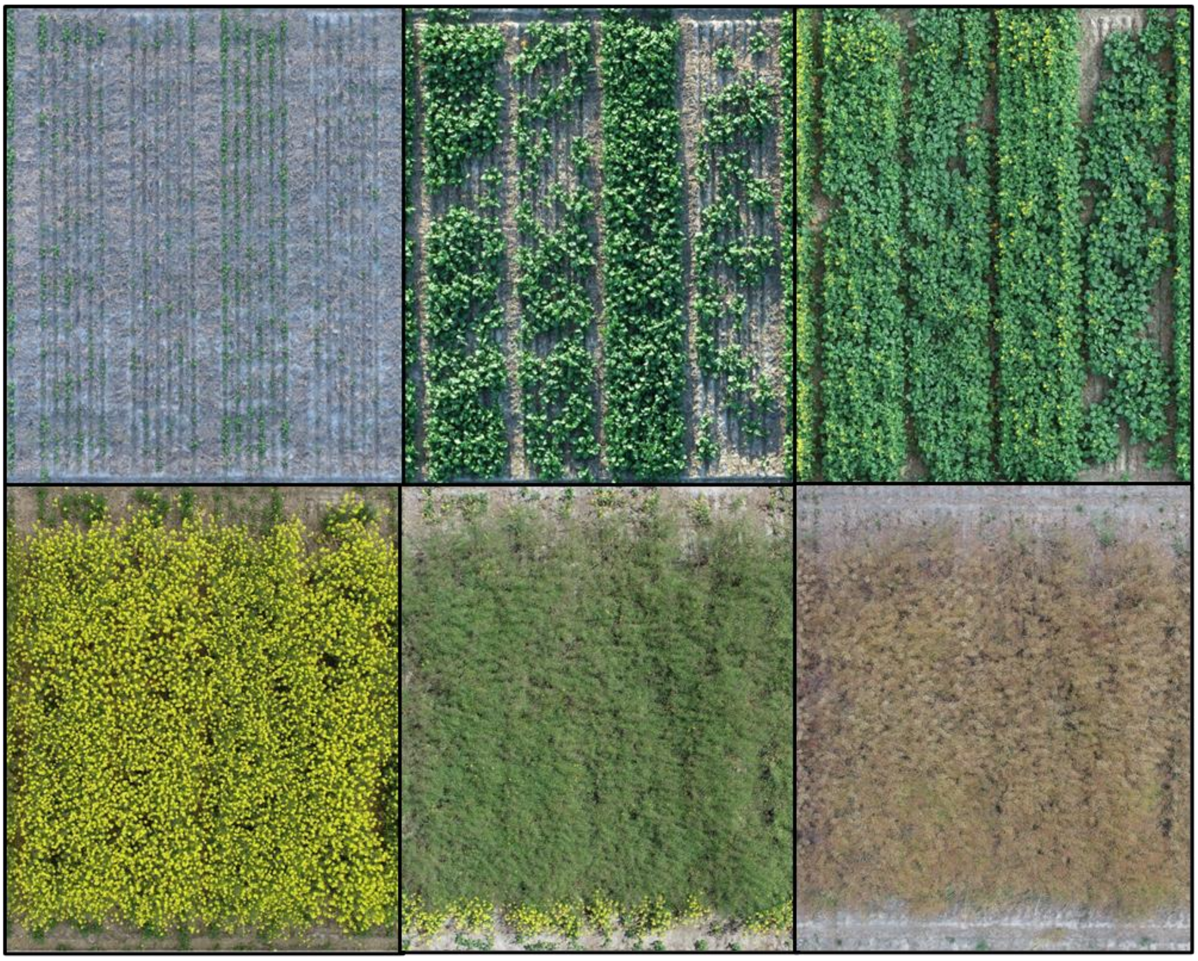

Figure 2: Drone photos taken of one field replicate on 25 May, 21 June, 20 July, 24 August, 21 September and 26 October 2022. Treatments from left to right: 20 plants m^{-2}, 10 plants m^{-2}, 40 plants m^{-2} and 5 plants m^{-2}. Plot ends were trimmed in early July and October.

NDVI measurements were taken for each plot every two weeks from the three-leaf stage (25 May) to early flowering (20 July) (Figure 1). As expected, each incremental increase in plant density recorded significantly higher NDVI readings until the onset of flowering. Although the higher plant densities were taller during stem elongation, but early September (as maximum height was reached), the highest plant density (40 plants m^{-2}) was 5-10cm shorter than the other densities (data not shown). There was minimal lodging at the site, although lodging ratings indicated that there was more stem leaning at the highest density (data not shown). The higher density plots commenced and finished flowering slightly earlier than the lower density plots and with less variation within plots (Figure 2).

Grain yield and biomass

Plant density significantly influenced yield (Figure 3), although only the 5 plants m^{-2} treatment was significantly lower than any other density, with differences between the 10 to 40 plants m^{-2} treatments not significant. Grain weight was reduced by around 4% in the 5 and 10 plants m^{-2} treatments compared to the 20 and 40 plants m^{-2} treatments. Although linear trends were identified for both oil and protein, differences were less than 1% and likely reflected yield dilution effects (data not shown).

Given variability in density across each plot (particularly for the lower densities), quadrat cuts ($1.02 m^2$ per plot) taken at maturity were targeted to areas representative of the target density of the plot. Interestingly, there was no difference in dry matter produced, seed yield or harvest index in these plots. This suggests that the yield deficit of the 5 plants m^{-2} treatment may result from plot areas with no or very low plant numbers, rather than the inability of canola to compensate from a density of just 5 plants m^{-2}. Assessments of the make-up of the biomass showed no difference in the stem, branch, pod or seed (i.e. harvest index) proportion amongst the different plant densities.

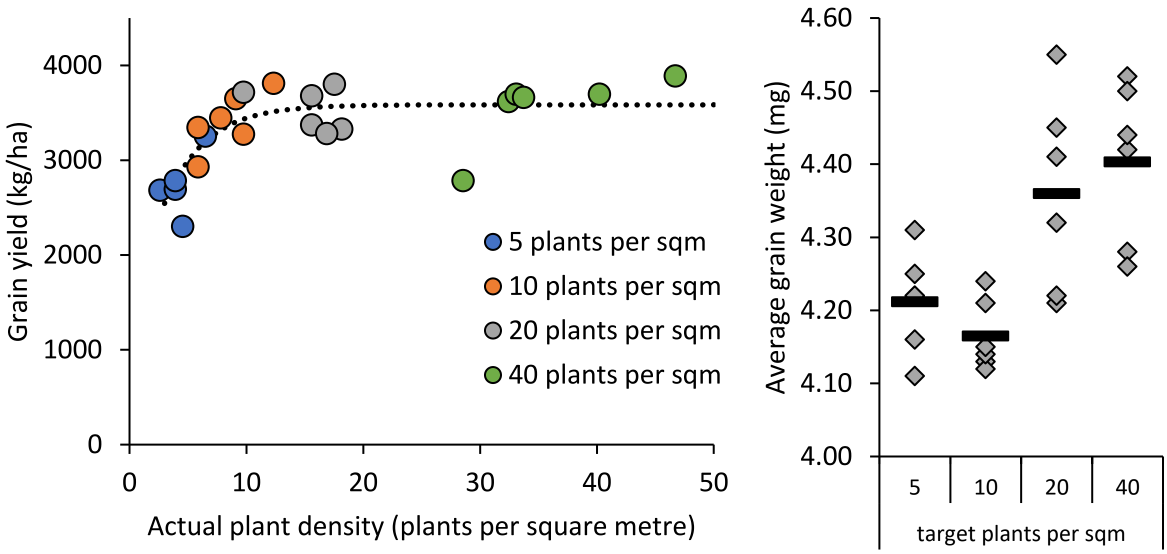

Figure 3: (Left) Grain yield (kg/ha, corrected to 8% moisture) plotted against measured plant establishment (plants per square metre) for four target plant densities (5 to 40 plants per sqm) at Condingup in 2022. (Right) Average grain weight (mg) for six field replicates (grey points) and mean (black bar) for each plant density treatment.

Comments

The density of plants established for each treatment was relatively close to target, with a 10-20% reduction due to reduced seed viability. Field establishment (proportion of viable seeds that emerged) was similar across plant density treatments and near to estimated establishment (average of 58%). Despite compensation, canopy cover (as indicated by NDVI) differed between densities throughout the vegetative period, with bare ground in the lowest plant density treatment evident even at the start of flowering. This may have implications for weed management, with significantly less crop competition in these treatments.

Grain yield was not significantly influenced by plant densities above 10 plants m^{-2}, while the 5 plants m^{-2} treatment had significantly lower yield than the other target plant densities. Interestingly, dry matter and seed yield assessments from representative areas of plot with close to target plant density did not show a significant difference, suggesting that canola can compensate quite well even at 5 plants m^{-2}, and that the yield deficit of this treatment may be due to areas with nil or very few established plants. Precision seeding equipment that achieves uniformity of seed placement would likely allow for plant density reductions with lower associated yield loss. Assuming seed costs of $30/kg, increases in grain yield easily covered costs of increasing seeding rate up to 20 plants m^{-2}.

Changing plant density resulted in large changes to plant architecture, with observations of thicker stems, more branching and lower branch and pod formation when plant density was reduced. Despite the significant changes to plant architecture, assessments of plant structure indicated the contributions of stem, branch, pod, and seed weight to total dry matter was similar across a given area (data not shown). Higher plant densities led to earlier flowering (with less variability within the plot) and earlier termination of flowering may explain the higher grain weights in plants in the higher density treatments (less reliance on later developing seeds). Although there was minimal lodging in this trial, the higher plant density treatments exhibited more leaning and it is expected that the thicker stems of the lower plant density treatments would resist lodging. This is traded off against significantly longer desiccation duration to allow dry stems for efficient harvesting.

In this trial, yield was maintained at plant densities as low as 8 plants m^{-2}. Significant rainfall in the lead up to seeding ensured that field establishment (of near to 60% of viable seeds) was achieved and seeding conditions were optimal with good moisture and no other notable risk factors (e.g. non-wetting, disturbed soil). Given canola establishment can often be under 50% of viable seeds under suboptimal conditions, maintaining higher seeds rates is prudent to ensure a buffer of viable seeds in case establishment is lower than expected.

Acknowledgements
This experiment has been conducted through the *Optimising high rainfall zone cropping for profit in the Western and Southern Regions* project, funded by GRDC and run through collaboration by DPIRD, CSIRO and FAR Australia. DPIRD gratefully acknowledge Andrew Fowler for generously providing the trial site, and his staff at Chilwell, particularly Clint Simpson and Deode Wilson for their assistance during the season. Thanks to Chris Matthews and the Esperance RSU for trial management and Helen Cooper for her technical assistance.

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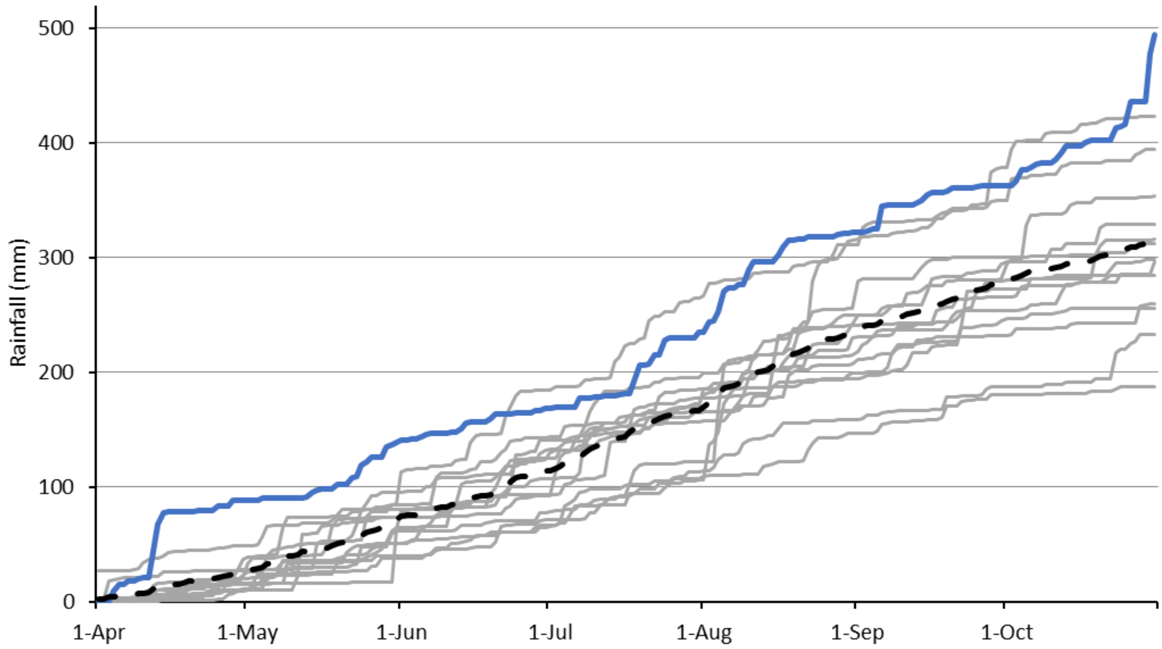
Appendix A: Trial details

Property	Willyama, Howick WA 6450.
Plot size & replication	2.0 m centres x 12 m sown x 6 reps
Soil type	Grey deep sandy duplex (sand over clay at ~35cm)
Sowing date	26 April 2022
Variety	Nuseed Condor
Sowing rate	As per treatment list.
Fertiliser (all plots)	26-April – 200kg/ha Summit Vigour Rich (10% N-14% P-10% K-5% S) 25-May – 100kg/ha Sulphate of ammonia (21% N-24% S) plus 259 kg/ha urea (46% N). 24-June – 87kg/ha urea (46% N). 27-June - 1kg/ha CuSO4 + 1kg/ha ZnSO4 + 4kg/ha MnSO4.
Herbicides and insecticides	IBS – 1.5 L/ha SpraySeed (135g/L paraquat + 115g/L diquat) + 2 L/ha TriflurX (480g/L trifluralin) PSPE – 1L/ha Pyrinex Super (400g/L chlorpyrifos + 20g/L bifentrhin) Post-em – 3-Jun 0.9kg/ha Roundup Ready Herbicide with PLANTSHIELD (690g/kg glyphosate) 16-June – 0.9kg/ha Roundup Ready Herbicide with PLANTSHIELD (690g/kg glyphosate) 12-August – 48g/ha Transform (500g/kg sulfoxaflor) + 10ml/ha Agral Desiccation - 03-November – 3L/ha Reglone (200g/L diquat) + 0.16% BS1000
Fungicides	26-April – 400ml/ha Impact (250g/L flutriafol) in-furrow 22-July – 450mL/ha Prosaro (210g/L prothioconazole + 210g/L tebuconazole) 12-August – 500mL/ha Aviator Xpro (150g/L prothioconazole + 75g/L bixafen)
Harvested	15^{th} November 2022
Growing season rainfall (April-October)	495 mm (DPIRD weather station at Mt. Howick, 10km WNW of trial site).

Appendix B: Soil test results taken at seeding at 10cm incremental depths (0-10cm – composite of 40 samples, 10-60cm – composite of six samples per 10cm).

Depth	**0-10cm**	**10-20cm**	**20-30cm**	**30-40cm**	**40-50cm**	**50-60cm**
pH (CaCl2)	6.0	5.0	5.2	6.4	5.6	6.4
pH (water)	6.6	5.9	6.5	7.0	7.5	8.2
P (HCO3) (µg/g)	22	22	14	6	3	3
K (HCO3) (µg/g)	48	80	118	180	236	336
N (NH4) (µg/g)	8	10	6	2	1	1
N (NO3) (µg/g)	8	9	5	2	2	1
S (µg/g)	6	20.1	13.8	17.3	14.8	16.1
Organic carbon (%)	0.82	0.59	0.48	0.37	0.35	0.31
PBI	17.6	41.1	53.3	62.8	55.3	65.7
Conductivity (dS/m)	0.084	0.115	0.106	0.128	0.156	0.164
Soil colour	GR	LTGR	BRGR	BROR	YWGR	GRYW
Hand texture	2.0	2.0	2.0	2.0	2.0	2.0
Gravel (% by weight)	0%	0%	0%	0%	0%	0%
Aluminium CaCl2	0.53	1.18	0.63	0.31	< 0.20	< 0.20
DGT-P	26.57	20.49	< 5.00	< 5.00	< 5.00	< 5.00



Appendix C: Cumulative growing season (Apr-Oct) rainfall from 2009-2022 at Mt Howick (DPIRD weather station). The 2022 (blue) and average of 2009-2022 (black, dashed) are highlighted. NB// The 2022 Condingup trial was located 10km ESE of the DPIRD weather station.

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