Precision placement of canola seed, can we get the same or better yield from less seed?

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Key messages

- Yields at very low seed rates of 0.3 and 0.5 kg/ha were comparable to yields at higher seed rates of 1.0 and 2.5 kg/ha when using a precision seeding machine
- Yields in excess of 2.0 t/ha were achieved when sowing at 50 cm row spacing
- These results suggest we should continue investigating more precise seed delivery systems

Aims

1) To test if growers will benefit from using precision seeding technology
2) To test very low seed rates of canola

Background

There are two main reasons to test precision seeding technology. Firstly previous studies in both Western Australia and in Canada show that yields of lupin and canola can be improved when plants are sown in a more uniform distribution. Canadian researchers reported up to 32% increase in yield from uniform plant arrangements compared to non-uniform arrangements when working with 20 plants/m^2 and yields of approximately 1.0 t/ha (Yang et al 2014). Secondly seed costs for canola production have increased for growers who have switched from open pollinated to hybrid varieties by around $30/kg. Using better seed placement methods and avoiding intra-species plant competition may enable seed rates to be lowered without compromising yield.

Method

Two trials were conducted in the Northern Agricultural Region; one at Binnu (Northern Agri Group trial site Ralphs Rd) and the other at Ogilvie (Wepowie farm) using the variety Hyola 404RR. The seeder used was an Agricola Italiana K series pneumatic precision drill. This type of seeder is commonly used to plant coarse grains such as corn or soybeans and in horticultural production. The machine is designed to place seed at equal distances along the crop row such that the spatial distribution of the plants is even. The machine used had seven planter boxes spaced 50 cm apart (50 cm row spacing) hence plots were 3.5 m wide and they were 25 m long. There were four treatments of different seeding rates; 0.3, 0.5, 1.0 and 2.5 kg/ha. The trial was arranged in four replicates of randomised complete blocks. The Ogilvie site was sown on April 15 and the NAG site on April 16.

Measurements included establishment counts, plant cuts taken at peak biomass, yield component analysis and seed yield and quality. Yield component analysis was done by measuring the width of 20 plant stems in each plot, using Vernier callipers and calculating the average stem diameter of each treatment. A single plant of the corresponding average stem diameter was then taken from each plot and dissected from the base upwards in increments to determine the proportion of yield from each part of the main stem.

Results

Seasonal conditions

The mean average rainfall for Binnu Bureau of Meteorology station is 340 mm and for Ogilvie 386 mm, rainfall at both sites exceeded this (Table 1). Significant rain occurred prior to the traditional mid-April sowing date, Binnu 160.2 mm and Ogilvie 174.9 mm. Both trials were sown on soil moisture from over 40 mm received from April 7 to April 11. On the days of sowing the temperature was close to 30°C causing the soil to dry rapidly. Long periods without rain occurred throughout winter: April 12 to May 17 (1.2 mm), May 19 to June 16 (3.6 mm) and June 22 to July 20 (1.6 mm).

Table 1. 2015 monthly rainfall (mm) from BOM Binnu weather station (8010) and Ogilvie weather station (8104)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Binnu	6.0	15.4	103.0	41.8	32.0	53.2	89.4	21.8	5.4	0.0	-	-	373.4
Ogilvie	4.0	8.2	100.2	67.0	17.4	48.0	100.4	43.8	3.0	6.0	-	-	398.0

Establishment and Plant growth

Establishment was lower than targeted at both sites. This occurred because conditions at seeding were not ideal with temperatures close to 30°C causing the seed bed to dry rapidly. Plant densities followed the expected trend given the seeding rates and there were significant differences in plant density between most treatments, although not between the two lowest seeding rates at either site (Tables 2 and 3).

Plants cuts were taken at peak biomass on August 8. Despite the differences in plant density the total biomass production did not differ between the treatments at either site at this time (Tables 2 and 3). This occurred because there were large differences in the single plant weight between treatments. Plants in the lowest seed density treatments were approximately 6 times heavier than those in the highest density treatment at NAG and 7 times at Ogilvie. This response was also observed from stem diameter measurements taken at crop maturity, the average stem diameter of plants in the lowest density treatment was approximately 3 times greater than plants in the highest density plots (Tables 2 and 3).

Table 2. Northern Agri Group site: target distance between the seeds (cm), target and actual Plant density p/m^2, total biomass production (g/m^2), single plant weight (g/plant) and stem diameter (mm).

Seed rate (kg/ha)	Target dist btw seeds (cm)	Target p/m²	Actual p/m²	Biomass 10/8 (g)	Plant. wt. 10/8 (g)	Stem dia 14/9 (mm)
0.31	37	6	3	690	177	33
0.54	22	10	6	823	146	25
1.01	11	20	15	843	104	17
2.50	4	45	36	706	20	11
Lsd			9		47	4
F Prob			P < 0.001	NS	P < 0.001	P < 0.001

Table 3. Ogilvie site: target distance between the seeds (cm), target and actual plant density p/m^2, total biomass production (g/m^2), single plant weight (g/plant) and stem diameter (mm).

Seed rate (kg/ha)	Target dist btw seeds (cm)	Target p/m^2	Actual p/m^2	Biomass 10/8 (g)	Plant. wt. 10/8 (g)	Stem diameter (mm)
0.31	37	6	5	730	157	37
0.54	22	10	8	833	118	26
1.01	11	20	15	751	59	20
2.50	4	45	40	733	22	12
Lsd			5.21		36	4.5
F Prob			P < 0.001	NS	P < 0.001	P < 0.001

Seed yield and quality

Mean seed yield was 1814 kg/ha at the Northern Agri Group site and 2322 kg/ha at Ogilvie. At both sites there was a trend of decreasing yield from high to low seeding rate, although the reduction in yield was less than expected given the very low plant density in the low seed rate treatments. At the Northern Agri Group Site this was a significant response with the 0.31 and 0.54 kg/ha seed rate treatments yielding less than the 1.01 or 2.50 kg/ha seed rates (Table 4). It should be remembered that the 0.31 and 0.54 kg/ha treatments had very low plant density of 2.5 and 6.0 plants/m^2 respectively at this site. At Ogilvie while there was a trend of lower yield at lower seeding rates this was not statistically significant (Table 5). Another interesting point to note is that the trials were on 50 cm row spacings and yields of over 2.4 t/ha were achieved. This yield is well above the long term average for canola in the district and indicates that in this environment canola can yield well in favourable seasons when sown at wide row spacings.

As previously discussed there was a high level of plant plasticity to the density treatments (Figure 1). At the time of writing yield component analysis was not complete however initial measurements of pods per plant indicate that there were significantly more pods on plants in lower density plots, over ten times as many on plants in the 0.31 kg treatment compared to the 2.5 t/ha treatment (Tables 4 and 5).

Seed quality was unaffected by the seed rate (Tables 4 and 5). At both sites seed oil% was high, as would be expected from Hyola 404, with no significant difference between treatments. Seed weight was also unaffected by seed rate.

Table 4. Northern Agri Group site: Seed Yield (kg/ha), Oil%, 1000 seed weight (g)

Seed rate (kg/ha)	Yield (kg/ha)	Pods per plant	Oil%	1000 seed weight (g)
0.31	1490	1369	48.2	4.1
0.54	1697	993	47.8	4.1
1.01	2014	396	47.9	4.1
2.50	2057	133	47.5	4.1
Lsd	299	327		
F Prob	P < 0.05	P < 0.001	NS	NS

Table 5. Ogilvie site: Seed Yield (kg/ha), Oil%, 1000 seed weight (g)

Seed rate (kg/ha)	Yield (kg/ha)	Pods per plant	Oil%	1000 seed weight (g)
0.31	2198	1622	47.6	3.8
0.54	2315	790	47.6	3.8
1.01	2312	357	47.8	3.8
2.50	2463	136	47.5	3.9
Lsd	280	258		
F Prob	NS	P < 0.001	NS	NS

Figure 1. Plant of average stem diameter from NAG 0.31 kg/ha left and NAG 2.5 kg/ha right

Gross margin

At the NAG site the gross margin of the 2.5 kg/ha and 1.0 kg/ha treatments were similar, indicating that $47/ha could be saved in up-front costs without impacting final profit (Table 6). At seed rates lower than 1.0 kg/ha gross margins declined. At the Ogilvie site gross margin was similar for the 2.5 kg/ha, 1.0 kg/ha and 0.5 kg/ha treatments - again suggesting that up-front costs could be reduced without impacting profit (Table 7).

Table 6. Northern Agri Group site: seed costs ($/ha), total costs ($/ha), income ($/ha) and gross margin ($/ha)

Seed rate kg/ha	Seed costs ($/ha)	Total costs $/ha	Income $/ha	Gross Margin $/ha
0.3	$10	$380	$831	$451
0.5	$16	$391	$941	$550
1.0	$32	$416	$1,119	$703
2.5	$79	$467	$1,136	$669

Table 7. Ogilvie site: seed costs ($/ha), total costs ($/ha), income ($/ha) and gross margin ($/ha)

Seed rate kg/ha	Seed costs ($/ha)	Total costs $/ha	Income $/ha	Gross Margin $/ha
0.3	$10	$397	$1,217	$820
0.5	$16	$406	$1,281	$875
1.0	$32	$423	$1,283	$860
2.5	$79	$476	$1,359	$883

Conclusions

Yields were impressive given the low seed rates and difficult establishment which resulted in very sparse populations. In both of these trials canola plants demonstrated remarkable plasticity to seeding density, this highlights that re-sowing of canola should only be done if establishment is very poor. The early sowing date and good seasonal conditions are likely to have contributed to this response.

The results of this preliminary work suggest that precision sowing may enable sowing at lower seed rates and that this is concept worth pursuing with further research in canola and other species. However, we realise that establishment rates of canola and other small grains can be low (~ 50% of sown seed) particularly in difficult conditions and on non-wetting soils. Hence there will always be limitations to how uniform the plant population is regardless of how accurate the seed delivery system is.

References

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Key words

Canola, density, seeder, precision

Acknowledgments

Thanks to Stephanie Boyce, Jo Walker and the Geraldton RSU for trial management and measurements and to Ben Cripps, Nolan Harris and the NAG group for providing the trial sites.

GRDC Project Number: 88801194

Paper reviewed by: Andrew Blake