Improved canola establishment, yield and oil with large seed on sandplain soil in Western Australia

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Abstract

In Western Australia, where canola seed size is often small, the effect of sowing depth and seed size on canola establishment needed to be investigated in different field sowing situations. In 1998, the Grain Pool of Western Australia estimated that 5% (5,000 ha) of the Geraldton region canola crop had to be re-sown due to wind erosion from lack of stubble cover which lead to a loss of around $2.2 million.

Stubble retention is often mentioned as a source of problems for canola establishment although it is not always the case, for example, soil conditions left by different seed drills has an effect on establishment. This work measured the variation in seedling establishment, yield and seed quality at three sowing depths with three seed sizes in 2001 and 2002. In addition, the effect of seed drill and seed size on canola establishment and yield was examined with and without the previous wheat crop stubble at two locations in 2002 in the Northern Agricultural Region of Western Australia.

At Merredin in 2001, large seed (greater than 1.7 mm in diameter) produced more plants, matured earlier and produced a higher yield than small seed (85% or 0.45 t/ha more yield at the deepest sowing depth of 4.5 cm). At Mingenew in 2002, large seed (greater than 2.0 mm in diameter) yielded 19% more than small seed (1.6–1.8 mm) at 6 cm sowing depth but yields were similar at 2 cm sowing depth. Oil content was not affected by seed size at the high rainfall Mingenew site but at the low rainfall Mullewa site, the oil content was increased by 0.7% using seed 1.8–2.0 mm in size compared to 1.6–1.8 mm seed.

From the results of field experiments in 2001 and 2002 in the Northern Agricultural Region of Western Australia, sowing large seed (greater than 1.8 mm in diameter or greater than 4 g/1000) increased yield and oil content compared to small seed.

Retention of wheat stubble did not reduce establishment, yield or oil content.

A seeder that leaves a water harvesting 'V' on top of the row was also found to give the most reliable establishment with up to 59% more seed established.

Keywords: depth, stubble, seed drill, tines, discs, press wheel, chain

Introduction

Deeper than optimum sowing is often recommended as an option to provide soil moisture to the germinating seed, particularly in moisture limited sowing situations. In the season 2000, large seed (greater than 1.7 mm in diameter) improved canola establishment in four of five experiments conducted in sandplain farming systems in the Northern Agricultural Region of Western Australia (Alam *et al.* 2001). In the UK, large seed (greater than 2.0 mm in diameter) improved canola establishment from sowing deeper than three centimetres (Scott *et al.* 1999). In Canada, seed larger than two millimetres is used to reduce the effects of beetle damage (Elliott and Rakow *et al.* 1999). In Western Australia, where canola seed is often small, the effect of sowing depth and seed size on canola establishment needed to be investigated in different field situations. Stubble is often mentioned as a source of problems for canola establishment although is not always the case and soil conditions left by different seed drills has an effect on establishment (Alam *et al.* 2001, Bruce *et al.* 2001, Riethmuller *et al.* 2002).

This work aims to measure the variation in seedling establishment, yield and seed quality at three sowing depths with three seed sizes in two field locations and one glasshouse experiment. In addition, the effect of seed drill and seed size on canola establishment, yield and seed quality was examined with and without the previous wheat crop stubble at two locations in the Northern Agricultural Region of Western Australia.

Methods

The first field experiment was sown at the Merredin Research Station (lat. 31° 29'S, long. 118°

17'E) in the central Agricultural Region of Western Australia in 2001. This experiment was designed to test the establishment of canola at three sowing depths (1.5, 3.0 and 4.5 cm), using seed graded into three seed sizes (greater than 1.7 mm, 1.4 to 1.7 mm, and less than 1.4 mm in diameter). The experiment was sown immediately after 11.8 mm of rain. The stubble residue from the previous season was wheat. For each treatment, 160 seeds/m^2 were sown. New quality assured Karoo seed was obtained from Dovuro and graded on mesh sieves into the sizes. The proportion was 82.2%, 15.8% and 2.0% for greater than 1.7 mm, 1.4 to 1.7 mm and less than 1.4 mm respectively. The seed weights were 3.67, 2.46 and 2.12 g/1000 respectively. Only 6.7% (5.46 g/1000) of this seed was above two millimetres in diameter.

The field experiment was repeated in 2002 at Erregulla Plains, Mingenew (lat. 29° 18'S, long. 115° 24'E) to test if seeds would germinate from deeper depths on lighter soils. Second generation grower retained Surpass 501TT canola seed was graded into sizes (10% of the original seed was less than 1.6 mm), small 1.6–1.8 mm (41.5%), medium 1.8–2.0 mm (46%) and large >2.0 mm (2.5%) and three sowing depths (2, 4 and 6 cm) and was sown into wheat stubble. The seed weights were 3.1, 4.1 and 5.4 g/1000 and lab germination was 97, 98 and 99% respectively and 130 seeds/m^2 was sown for all treatments. Two extra treatments were added to test the hypothesis that small seed might be able to be sown at greater seeding rates to compensate for the small seed.

Two additional experiments in 2002 were designed to measure the establishment, yield and oil of canola in the Northern Agricultural Region of Western Australia, one at Mingenew and the other at the Mullewa Research Station (lat. 28° 36'S, long.115° 26'E). These experiments were designed to compare the 1.6–1.8 mm (3.1 g/1000) seed with 1.8-2.0 mm (4.1 g/1000) seed with and without wheat stubble using five different sowing techniques. For both, 130 seeds/m^2 were sown. Wheat stubble was raked off rather that burnt to avoid soil pH change and weed number changes. The air cone seed drill sowed 6 rows at 250 mm row spacings using an inter-changeable float with:

- 50 mm wide SuperSeeder points with the 80 mm wide ARP press wheels set at 2 kg/cm width.
- 50 mm wide SuperSeeder points with four 16 mm diameter links of chain following the presswheels (both ends looped together and held by a 13 mm pin diameter 'D' shackle).
- 50 mm wide SuperSeeder points with a Janke finger tine attached to the press wheel frame which covered the seed with loose soil from one side of the row.
- full cut or full disturbance was 180 mm wide steel points with a following Loxton rotary harrow.
- Walker triple disc.

A glasshouse experiment was also conducted at Merredin in June 2003 to test the response of seed size and sowing depth under Wyalkatchem wheat and Stirling barley stubble. Treatments were applied to 15 boxes (54 cm × 40 cm box size) of thoroughly wet Mingenew sandplain soil with nil, 2.5 t/ha wheat, 2.5 t/ha barley, 5 t/ha wheat and 5 t/ha barley stubble applied immediately after sowing. Each box had nine treatments (a randomised split plot design) of 30 seeds spaced one cm apart in the rows with three sowing depths 2, 4 and 6 cm and three seed sizes 2.3 (1.4–1.6 mm), 4.1 (1.8–2.0 mm) and 5.4 g/1000 (>2.0 mm). Watermark® gypsum blocks for light soil and a Measurement Engineering Australia GBReader® was used to measure soil tension (centre of the block 3 cm deep) as a guide to when watering was needed. Soil temperature at 4 cm deep was also measured with a stainless steel 110 mm long digital thermometer.

Results

Seed size × sowing depth, Merredin

The larger seed produced more plants than the smaller seed at the deeper sowing depths but was similar at the shallow 1.5 cm sowing depth (Table 27).

At the Merredin Research Station Field Day on 27th September 2001 it was clear that the small seed treatments were less advanced since they were still flowering where the largest seed treatments had finished flowering. The yield increased with increasing seed size and the 4.5 cm sowing depth was lower yielding than the 1.5 or 3.0 cm sowing depth (Table 28).

The oil content increased with increasing sowing depth. The lower oil content of the 1.5 cm depth treatments may be due to their later maturity. The smallest seed (<1.4 mm) had a higher admixture (1.63%) than the other seed sizes (average 1.15%) but there was no effect of sowing depth.

Seed size × sowing depth, Mingenew

The soil moisture at sowing was just enough but was drying. The largest seed sown six centimetres deep still managed to establish 53 plants/m^2 compared to the smallest seed at 23 plants/m^2 (Table 29).

Yield was significantly better with the medium and large seed compared to the small seed, at 4 cm and 6 cm sowing depths, but was similar at 2 cm sowing depth (Table 30). Increasing the seed rate with the small and medium seed reduced yields at the 4 cm sowing depth. The oil content of the small seed sown 6 cm deep was lower than all the medium seed treatments.

Seed size × stubble × seed drill

Stubble treatments had no effect on establishment so the plant numbers have been averaged. The large seed averaged 24% higher emergence than the small seed at both sites (Table 31). The SuperSeeder point with press wheels averaged 59% and 47% better emergence than the full cut rotary harrow and the triple disc respectively.

Large seed averaged 0.136 t/ha ($68/ha Mingenew) and 0.143 t/ha ($72/ha Mullewa) more yield than small seed (Table 32). Improved water harvesting ability of the SuperSeeder points with press wheels may be responsible for the better establishment and the triple disc was poor for unknown reasons, perhaps the increased fertiliser concentration below the seed. There was no significant effect of stubble or machine on yield, which may be due to having enough plants even with the lower establishment.

Table 27: Plants/m^2 with seed size and sowing depth measured on 11th June 2001

	Seed size		
Sowing depth (cm)	< 1.4 mm (3.4 kg/ha)	1.4–1.7 mm (3.9 kg/ha)	> 1.7 mm (5.9 kg/ha)
1.5	78.5	73.3	77.0
3.0	33.0	43.2	64.2
4.5	23.0	26.6	41.7

Treatment l.s.d. (P<0.05) = 10.5, coefficient of variation 24.3%.

Table 28: Karoo yield (t/ha) and oil (%) with seed size and sowing depth.

	Seed size		
Sowing depth (cm)	< 1.4 mm (3.4 kg/ha)	1.4–1.7 mm (3.9 kg/ha)	> 1.7 mm (5.9 kg/ha)
1.5	0.818 *(37.7)*	0.852 *(37.3)*	1.093 *(38.0)*
3.0	0.777 *(38.1)*	0.973 *(38.2)*	1.172 *(38.1)*
4.5	0.532 *(38.5)*	0.727 *(38.3)*	0.983 *(38.8)*

yield treatment l.s.d. (p<0.05) = 0.1035, coefficient of variation 13.9%.
oil depth l.s.d. (p<0.05) = 0.67, coefficient of variation 2.0%.

Table 29: Plant emergence (plants/m^2) with sowing depth and seed size measured on 10th June 2002.

	Seed size				
Sowing depth (cm)	Small (4.0 kg/ha)	Medium (5.3 kg/ha)	Large (7.0 kg/ha)	Medium (7.0 kg/ha)	Small (7.0 kg/ha)
2	74	77	94	-	-
4	61	82	93	110	133
6	23	48	53	-	-

treatment l.s.d. (p<0.05) = 24.0, coefficient of variation 21.0%.

Table 30: Yield (t/ha) and oil *(%)* with sowing depth and seed size harvested on 28th October 2002.

Sowing depth (cm)	Seed size Small (4.0 kg/ha)	Medium (5.3 kg/ha)	Large (7.0 kg/ha)	Medium (7.0 kg/ha)	Small (7.0 kg/ha)
2	2.03 *(45.7)*	2.09 *(46.6)*	2.05 *(45.6)*	-	-
4	1.91 *(45.4)*	2.18 *(46.6)*	2.19 *(46.4)*	2.03 *(47.0)*	1.88 *(45.1)*
6	1.76 *(44.7)*	2.05 *(45.9)*	2.09 *(45.1)*	-	-

yield treatment l.s.d. ($p<0.05$) = 0.087, coefficient of variation 2.9%.
oil treatment l.s.d. ($p<0.05$) = 1.2, coefficient of variation 1.9%.

Table 31: Plant emergence (plants/m^2) with seed drill and seed size (average of raked and stubble).

	Mingenew		Mullewa	
Seed size	1.6–1.8 mm	1.8–2.0 mm	1.6–1.8 mm	1.8–2.0 mm
Knife, Pressewheels (PW)	73	87	72	79
Knife, PW, chain	75	86	62	87
Knife, PW, finger tine	77	91	60	79
Full cut, rotary harrow	47	57	40	53
Walker triple disc	56	70	35	52
Average	66	78	53	70
l.s.d. (p<0.05) seed size	5.2		4.7	
l.s.d. (p<0.05) machine	8.2		7.4	
coefficient of variation (%)	16.1		17.0	

Table 32: Yield (t/ha) and oil *(%)* with seed size and seed drill type (average of raked and stubble).

	Mingenew		Mullewa	
Seed size	1.6 – 1.8 mm	1.8 – 2.0 mm	1.6 – 1.8 mm	1.8 – 2.0 mm
Knife, Presswheels (PW)	2.40 *(44.0)*	2.57 *(44.5)*	1.06 *(42.2)*	1.22 *(43.1)*
Knife, PW, chain	2.47 *(44.7)*	2.54 *(44.5)*	1.18 *(42.4)*	1.15 *(43.1)*
Knife, PW, finger tine	2.43 *(44.9)*	2.54 *(44.1)*	1.06 *(42.5)*	1.18 *(42.9)*
Full Cut, rotary harrow	2.37 *(43.1)*	2.57 *(44.7)*	0.91 *(41.2)*	1.15 *(42.3)*
Walker triple disc	2.48 *(44.5)*	2.62 *(44.8)*	1.02 *(42.2)*	1.24 *(42.4)*
Average	2.43 *(44.4)*	2.57 *(44.5)*	1.05 *(42.1)*	1.19 *(42.8)*
l.s.d. seed size (p<0.05)	0.0545 *(n.s.)*		0.0956 *(0.48)*	
coefficient of variation (%)	4.9 *1.8)*		19.1 *(2.5)*	

Glasshouse experiment

The 2003 glasshouse experiment showed that stubble type or level had no effect on emerged plant numbers but tended to increase the overall plant height. The plants were probably seeking more light but it was surprising that even small seed managed the stubble well. There was an interaction of seed size with sowing depth such that the 2.3 g/1000 seed gave lower plant numbers as the depth increased to 6 cm (Table 33). At 2 cm depth the emergence rate was similar but the 2.3 g/1000 seed plants were still much smaller than the 5.4 g/1000 seed plants. The 2.3 g/1000 seed was around five days later to achieve the same size as the 5.4 g/1000 seed.

Table 33: Glasshouse canola emergence (%) with seed size and sowing depth 16 days after sowing.

Seed size	depth 2 cm	4 cm	6 cm	Average
5.4 g/1000	95.7	79.3	46.9	74.0
4.1 g/1000	95.1	81.1	34.0	70.1
2.3 g/1000	89.1	53.3	10.7	51.0
Average	93.3	71.3	30.5	65.0

seed size x depth p = 0.005, l.s.d. ($p<0.05$) = 11.8%, c. of v. = 24.9%.

An interesting observation was the nil stubble treatments needed watering due to wilting around three days earlier than all the stubble treatments. The plants generally showed signs of wilting at around 30 kPa soil tension. Also the soil temperature at mid-afternoon was generally around two degrees warmer (23°C versus 21°C) in the nil stubble treatments compared to all the stubble treatments. This soil temperature is similar to that around the end of April at Mingenew.

Conclusions

Field experiments in 2001 and 2002 in the Northern Agricultural Region of Western Australia showed that large size (greater than 1.8 mm in diameter or greater than 4 g/1000) increased yield by up to 0.45 t/ha and oil by up to 0.7% over small seed. Large seed appears to be a good option for sowing at depth on sandplain, especially where there is a difficult start to the season, to chase moisture. There are also implications for variety experiments where sown seed should be uniform in size across all varieties.

Retention of wheat stubble did not reduce establishment, yield or oil content. This is important since wind erosion is a major problem in the Northern Agricultural Region of Western Australia and stubble retention is known to reduce soil erosion and reduce sandblasting of plants.

A seeder that leaves a water harvesting 'V' on top of the row was also found to give the most reliable establishment with up to 59% more seed established.

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