Performance of canola after two years of wheat under no-till full stubble retention (NTSR) using different drill openers and row spacings at Coreen

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Key points

- Canola following two years of wheat yielded 2.08t/ha despite establishing 50% fewer plants than canola grown during 2009, which yielded 1.59t/ha. The higher yield achieved during 2011 was attributed to more stored soil moisture at sowing.
- The higher biomass produced with the narrower row spacing (22.5cm) did not translate into higher grain yield with the same yield achieved across the narrowest (22.5cm) and widest (37.5cm) row spacings.
- About 102-122kg nitrogen/ha was removed in aboveground biomass (straw and grain). There was no statistical difference in nitrogen off-take between the 22.5cm and 37.5cm row spacings.
- Water use efficiency (WUE) was similar at the 22.5cm and 37.5cm row spacings. There was evidence of slightly higher water loss from the soil in the smaller canopy associated with the wider row spacings, however this was offset by a better harvest index at the 37.5cm row spacing.

Location: Coreen, NSW

Rainfall:
- **Annual:** 599mm
- **GSR:** 187mm (April–Oct)
- **Stored moisture:** 87mm

Soil:
- **Type:** Clay loam
- **pH (H_2O):** 5.8
- **pH ($CaCl_2$):** 5.3
- **Colwell P:** 86mg/kg
- **Deep soil nitrogen:** 46kg/ha

Sowing information:
- **Variety:** 2.1kg/ha Hyola 502 RR (Roundup Ready)
- **Sowing date:** 3 May 2011
- **Sowing rate:** 2.1kg/ha
- **Fertiliser:** 170kg/ha SuPerfect
- **Sowing equipment:** Janke tine with Janke press wheel. Single disc opener.
- **Treatments:** Establishment method x row spacing

Row spacing: 22.5cm, 30cm, 37.5cm

Paddock history:
- **2010** — wheat
- **2009** — wheat
- **2008** — canola

Plot size: 44m x 3m

Replicates: 4 (disc) 8 (tine)

Overall goal

Improved water use efficiency (WUE) in no-till cropping and stubble retention systems in spatially and temporally variable conditions in the Riverine Plains.

Trial aim

The aim of this trial was to evaluate the performance of different drill openers at a range of row spacings following two consecutive years of wheat.

Method

A replicated experiment was established to test the effect of a range of drill openers and row spacings on the break of canola after two years of wheat as part of a five-year

cropping rotation trial. The 2011 canola crop was the third successive crop superimposed on the original no-till stubble retention trial site.

- 2008 — canola (farm crop)
- 2009 — wheat (first trial year)
- 2010 — wheat (second trial year)
- **2011 — canola**
- 2012 — wheat
- 2013 — wheat

Wheat stubble from the 2010 trial was chopped and spread at right angles to the direction of the plots. However due to the high stubble load resulting from the 2010 season, plots were raked before sowing to reduce the amount of surface trash.

Results

Crop establishment

The narrow (22.5cm) row spacing established significantly more plants/m^2 than the 37.5cm spacing for canola sown into second-year wheat stubbles (see Table 1). There was no statistical difference in establishment between the 30cm row spacing and the widest row spacing (37.5cm). A replicate trial established during 2009 (following two years of cereals on the other side of the track, 30m away on the same soil type) also generated significantly more plants/m^2 in the narrow spacing compared with the 37.5cm row spacing (see Figure 1).

Crop establishment during 2011 was almost half that of 2009 at the same growth stage (two true leaves emerged). This was due to a combination of germination issues, poor seedling vigour and heavy residue loading from the 2010 season.

There was a significant interaction between drill opener and row spacing despite no significant difference in plant establishment as a result of drill opener (P = 0.78) (see Figure 2). For reasons unknown, there was a decrease in establishment for the tine at the 37.5cm spacing. During 2009, when overall establishment was higher, there were significant differences generated as a result of drill opener, with an advantage to the disc opener at establishment (see Figure 3). Establishment this season with the disc opener was less affected by row spacing than the tine.

Dry matter production

i) Row spacing

Canola established with a 30cm row spacing produced significantly more dry matter (248kg/ha) by green bud than

TABLE 1 Plant establishment at the two-true-leaves-emerged stage assessed 38 days after sowing

Row spacing (cm)	Drill opener[1] Plant establishment (plants/m^2)		
	Disc	Tine	Mean
22.5	29	36	32
30.0	28	32	30
37.5	31	20	25
Mean	**29**	**30**	
LSD [row spacing]	5.1		
LSD [drill opener]	4.1		
LSD [disc[4]] [tine[8]]	8.3	5.9	
LSD [disc[4] vs tine[4]]	7.2		

[1] Tine treatments had eight replicates compared with four for the disc treatment.

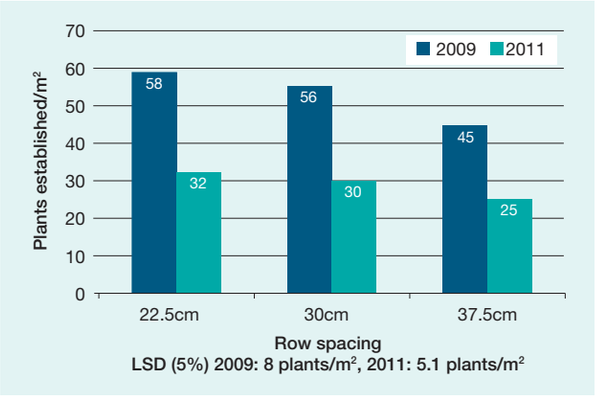


FIGURE 1 Influence of row spacing on canola plant establishment at the two-true-leaves-emerged stage during 2009 and 2011, measured 38 days after sowing*

* Mean of both drill openers

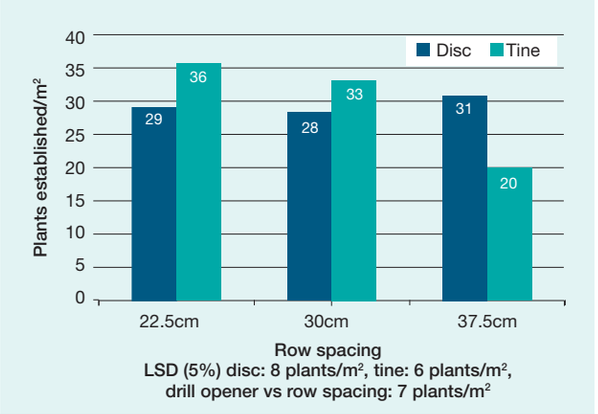
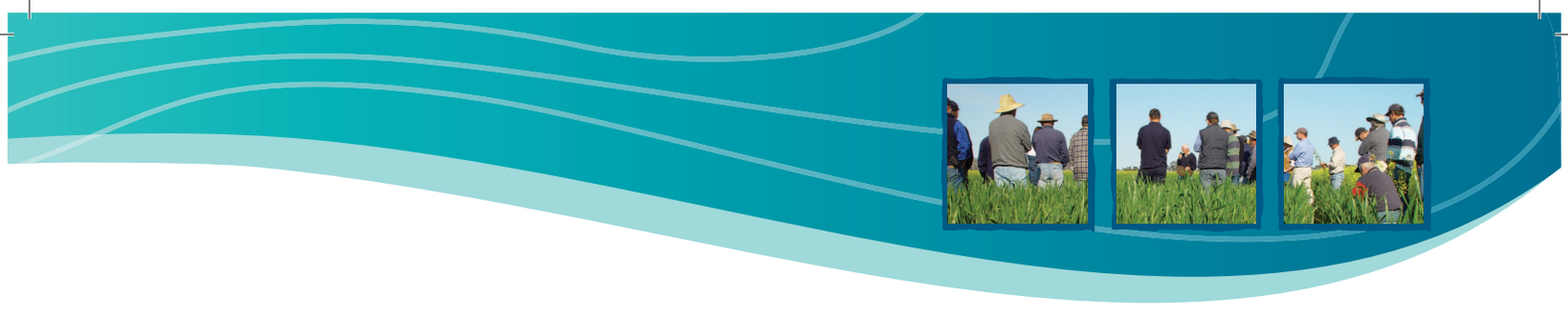


FIGURE 2 Influence of row spacing and drill opener method on canola plant establishment in 2011 measured at the two-true-leaves emerged stage 38 days after sowing



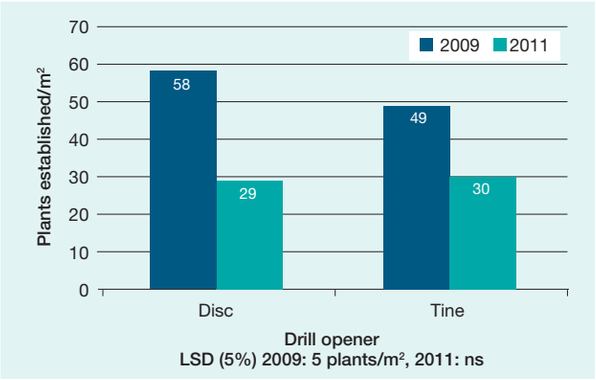


FIGURE 3 Influence of drill opener on canola establishment during 2009 and 2011, measured at the two-true-leaves emerged stage 38 days after sowing*
* Mean of three row spacings

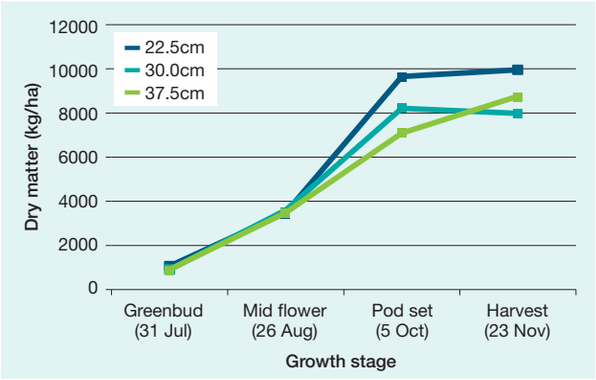


FIGURE 4 Influence of row spacing on dry matter production in canola*
*Mean of both drill openers (31 July – 23 November 2011)

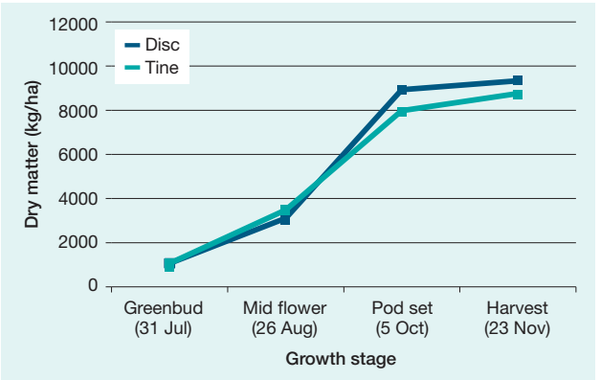


FIGURE 5 Influence of drill opener on dry matter production*
* Mean of three row spacings (31 July – 23 November 2011)

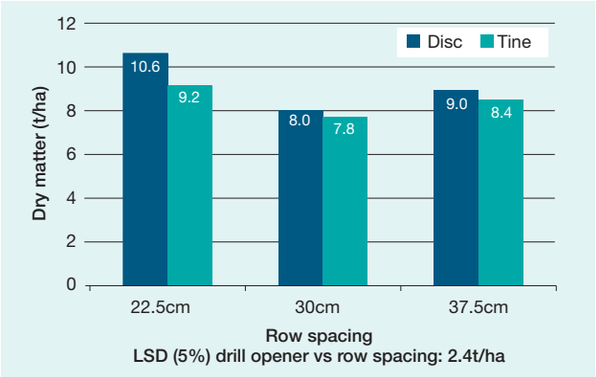


FIGURE 6 Influence of row spacing and drill opener on dry matter production at harvest

canola established at the wider row spacing of 37.5cm, which had produced 802kg DM/ha (see Figure 4). By pod set, the 22.5cm row spacing had produced the greatest amount of DM; significantly more than the 37.5cm row spacing. However, by harvest, total DM production was not significantly different (P = 0.07) between the row spacings, although there was a trend for the narrow row spacing to have the highest amount of DM.

ii) Drill openers

Drill opener did not significantly affect the amount of DM produced by greenbud, pod set or harvest. The disc opener plots, although initially behind in DM production, had produced the most DM by pod set and harvest (see Figure 5).

There were no significant interactions in the DM production between row spacing and drill opener throughout the season to harvest (see Figure 6).

Yield (t/ha)

i) Yield

The trial yielded an average of 2.08t/ha. This was about 0.5t/ha more than that recorded in an identical trial done at the same site during 2009 (cv Hyola 50), despite a much poorer establishment for the 2011 trial (20–36 plants/m^2) than the 2009 trial (45–60 plants/m^2). The main difference between the 2009 and 2011 trials was the amount of soil moisture available at the start of the growing season with nearly 90mm available during 2011 compared with virtually nothing during 2009.

Row spacing significantly influenced final yield (P<0.001) however the influence of row spacing on yield differed between 2009 and 2011 (see Figure 7). During 2009 the 30cm row spacing generated higher yields than the 22.5cm and 37.5cm row spacings. In contrast, there was no significant difference in yield during 2011 between the narrowest (22.5cm) and widest (37.5cm) row spacings. For reasons that are not clearly understood, the intermediate (30cm) row spacing gave significantly inferior yields. There is some evidence to suggest lower dry matter at harvest with the 30cm row spacing but in this trial the difference was not significantly different from the 37.5cm row spacing.

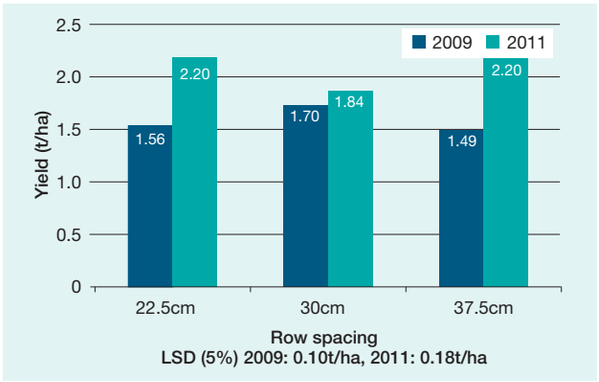


FIGURE 7 Influence of row spacing on yield during 2009 and 2011*

* Mean of both drill openers

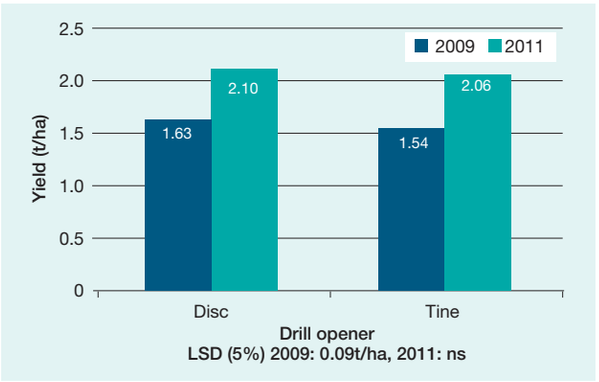


FIGURE 8 Influence of drill opener on yield during 2009 and 2011*

* Mean of three row spacings

The disc opener produced a significant yield advantage over the tine during 2009 but there was no difference between tine and disc opener during 2011 (see Figure 8).

There was no significant interaction between drill opener and row spacing, although there was a trend for the disc treatment to out-yield the tine treatment at each row spacing (see Figure 9).

ii) Oil content (%)

Neither row spacing nor disc opener had a significant impact on oil content.

There was no interaction between drill opener and row spacing. Figure 10 outlines oil content of the individual treatments, which ranged from 42.5–43%.

iii) Nitrogen off-take

Despite the 30cm row spacing having the highest nitrogen content in the harvest components (data not shown). The 30cm spacing had the lowest seed nitrogen removal, which was significantly less than the 22.5cm and 37.5cm row spacings. The 30cm spacing also produced the lowest amount of biomass; this resulted in significantly lower nitrogen off-take (see Figure 11).

Across all row spacings, the disc opener had higher nitrogen off-take than the tine. This difference was significant in the total off-take (P = 0.03) where the disc removed 117kg nitrogen/ha and the tine 109kg nitrogen/ha. All plots received 150kg/ha nitrogen during early August.

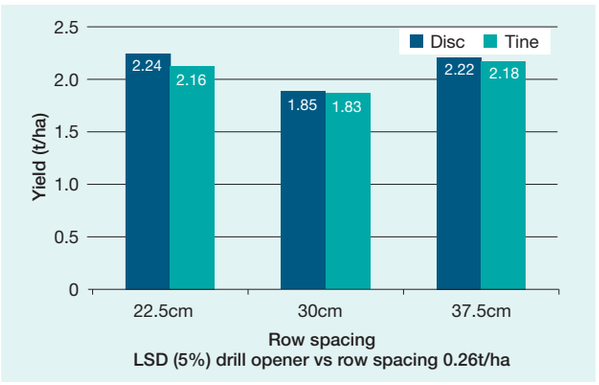


FIGURE 9 Influence of drill opener and row spacing on yield

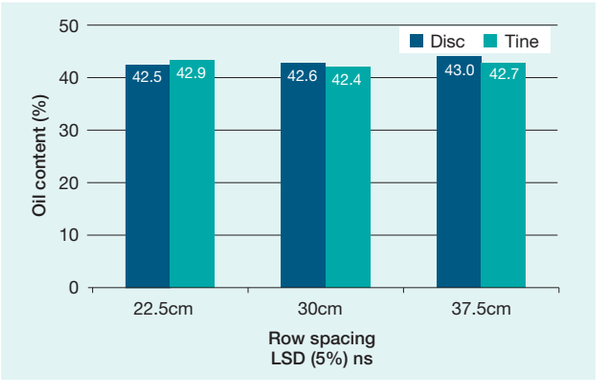


FIGURE 10 Influence of row spacing and disc opener on canola oil content

Observations and comments

Canola established at the 22.5cm row spacing produced the most above-ground biomass resulting in less evaporation from the soil but more transpiration (water loss) from the canopy itself. The additional biomass at 22.5cm did not however translate to a greater grain yield than that achieved at the 37.5cm spacing. This resulted in the 22.5cm row spacing generating the lowest harvest index and transpiration efficiency despite demonstrating the same overall water use efficiency as the crop established at the 37.5cm row spacing (see Table 2).

The highest transpiration efficiency (kg/ha of grain produced per mm of water) was achieved with the

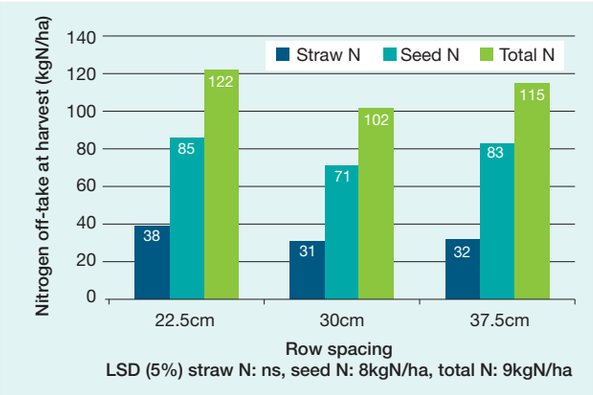


FIGURE 11 Influence of row spacing on nitrogen off-take in the straw and grain*
*Mean of two drill openers

widest row spacing, but resulted in slightly higher levels of unproductive water (water either lost from the soil as evaporation, drainage or water not used by the plant but still present in the soil at harvest).

In the 2009 trial, where canola was established without the benefit of stored soil moisture, the biomass produced at harvest was 40% less than during 2011 but with a 4.4% higher harvest index (on average).

In the 2011 trial the 22.5cm and 37.5cm row spacings resulted in a 16% higher WUE than the 30cm spacing. In the 2009 trial the 30cm row spacing had a 10% higher WUE than the 22.5cm and 37.5cm spacings.

TABLE 2 Biomass at harvest, yield, harvest index (HI), water use efficiency (WUE), transpiration, evaporation/drainage and transpiration efficiency (TE)*

Row spacing (cm)	Biomass (kg/ha)	Yield (kg/ha)	HI (%)	WUE[1] (kg/mm)	Transpiration[2] (mm)	Unproductive water[3] (mm)	TE[4] (kg/mm)
22.5	9881	2200	22.3	8.0	198	76	11.1
30	7916	1836	23.2	6.7	158	115	11.6
37.5	8727	2200	25.2	8.0	175	99	12.6

[1] Based on 187mm of GSR (April–October) + 35% fallow efficiency of 87mm for the January–March rainfall (total GSR + stored = 274mm) with no soil evaporation term included and assuming no drainage in periods of excessive rainfall
[2] Transpiration through the plant based on a maximum 50kg harvest biomass/ha.mm transpired
[3] Unproductive water (evaporation, drainage and water left unused at harvest) is the difference between transpiration through the plant and GSR (mm) + stored water at sowing
[4] Transpiration efficiency based on kg/ha grain produced per mm of water transpired through the plant
* Mean of both openers

SPONSORS

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