Performance of second wheat (wheat on wheat) after canola under no-till full stubble retention (NTSR) using different drill openers and row spacing at Coreen

Nick Poole[1], Tracey Wylie[1] and John Seidel[2]
In conjunction with Riverine Plains Inc
[1] Foundation for Arable Research Australia
[2] Agricultural Research Services

Key points

- Plant establishment at a 22.5cm row spacing was significantly superior to 30cm, which in turn was significantly higher than 37.5cm. The disc drill opener gave better establishment than the tine at the narrow (22.5cm) row spacing but not at the wider row spacing.
- Advantages with the narrow row spacing were seen early in the season in terms of plant population, dry matter (DM) and tiller production. These advantages did not translate to significantly higher yield in this rotation position. This result was identical to the results of the 2010 trial when wheat on wheat yields showed a similar, but not significant, trend for narrow row spacing (22.5cm) to be better than wide row spacing (37.5cm).
- The disc opener produced significantly (0.37t/ha) higher yields than the tine opener, and as a result had a better water use efficiency (WUE).
- Though the narrow row spacing had the highest WUE, the advantages to narrow spacing in second wheat crops have not been as great as those observed in first wheat crops (wheat after canola) where the yield loss associated with wide rows (37.5cm) was 12–13% (2009 and 2010) compared with the narrow row spacing (22.5cm).

Location: Coreen, NSW

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

Soil:
- **Type:** Clay loam
- **pH (H_2O):** 6.0
- **pH ($CaCl_2$):** 4.9
- **Colwell P:** 102mg/kg
- **Deep soil nitrogen:** 57kg/ha

Sowing information:
- **Variety:** Livingston
- **Sowing date:** 3 May 2011
- **Sowing rate:** 85kg/ha
- **Fertiliser:** 85kg/ha MAP + Intake
- **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** — canola
- **2008** — triticale (farm crop)

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.

Aim

The aim of this trial was to evaluate the performance of different drill openers at a range of row spacing in a second-year wheat crop.

Method

A replicated experiment was established to test the effect of a range of drill openers and row spacing on second-year wheat as part of a five-year crop rotation trial. The 2011 trial was the third successive crop superimposed on the original no-till stubble retention trial site.

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

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

Results

Crop establishment

The establishment of wheat into wheat stubble from the previous crop resulted in the narrow (22.5cm) row spacing giving significantly better establishment than crops sown at 30cm, which in turn established significantly better than the 37.5cm rows (see Table 1). This result is identical to the results from the second-year wheat established 30m away on the same site during 2010 (see Figure 1).

Across the row spacings the drill opener did not significantly affect establishment. This is in contrast to 2010 when the disc opener was superior (see Figure 2). Stubble loads were much higher for the 2011 season due to the better growing season experienced during 2010. To give an indication of stubble loadings, dry matter (DM) at the 2010 harvest (15t/ha) were almost double that of the 2009 harvest (8t/ha).

There was a significant interaction between row spacing and drill opener. The disc opener at the 22.5cm row spacing established significantly better plant populations than the tine opener, but there was no difference in establishment between disc and tine at the wider row spacings (see Figure 3).

Dry matter production

i) Row spacing

Second-year (wheat on wheat) crops established at the narrow row spacing (22.5cm) produced significantly more DM than crops established at 30cm and 37.5cm up to flowering (GS61), however by harvest there was no significant difference.

Measurements taken early in the season at first node (GS31) and flag leaf emergence (GS39) showed that crops established at 30cm row spacing produced significantly more DM than wheat grown at 37.5cm. There were no significant differences in DM production recorded from flowering to harvest.

TABLE 1 Plant establishment at the three-leaves-unfolded stage (GS13) assessed on 2 June 2011

Row spacing (cm)	Drill opener Plant establishment (plants/m²)		
	Disc	Tine	Mean
22.5cm	176	159	168
30.0cm	137	139	138
37.5cm	112	116	113
Mean	**142**	**138**	**140**
LSD [row spacing]	9		
LSD [drill opener]	7		
LSD [disc[4]] [tine[8]]	15	11	
LSD [disc[4] vs tine[4]]	13		

NOTE: Tine treatments had eight replicates compared with four with the disc treatment)

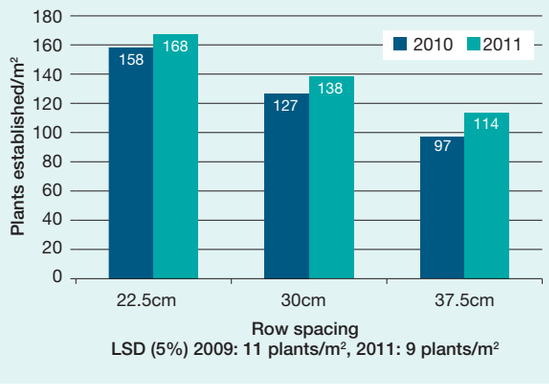

FIGURE 1 Influence of row spacing on plant establishment in second-year wheat crops (after canola) grown during 2010 and 2011 and assessed at the three-leaves-unfolded stage (GS13)*

* Mean of both drill openers

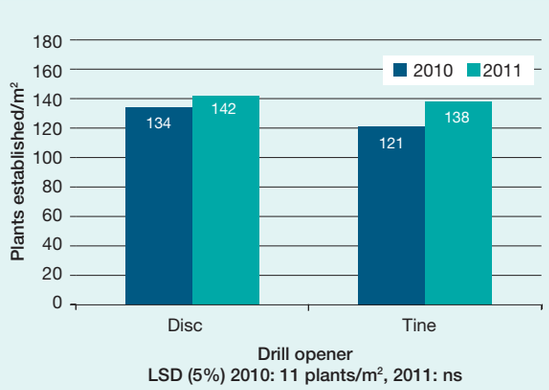

FIGURE 2 Influence of drill opener on plant establishment in second-year wheat crops grown during 2010 and 2011 and assessed at the three-leaves-unfolded stage (GS13)*

* Mean of three row spacings

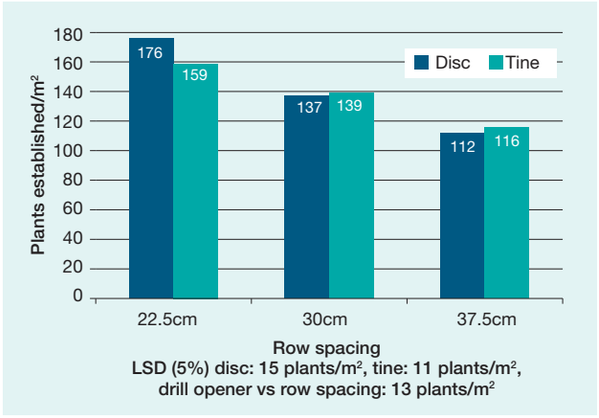

FIGURE 3 Influence of row spacing and drill opener method on plant establishment, measured at the three-leaves-unfolded stage (GS13)

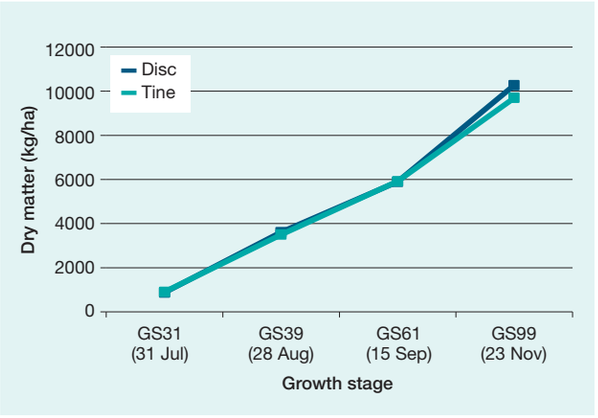

FIGURE 5 Influence of drill opener on dry matter production*
* Mean of three row spacings (31 July – 23 November 2011)

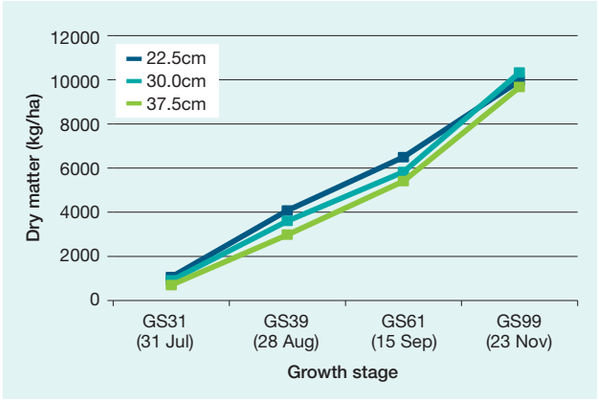

FIGURE 4 Influence of row spacing on dry matter production*
*Mean of both drill openers (31 July – 23 November 2011)

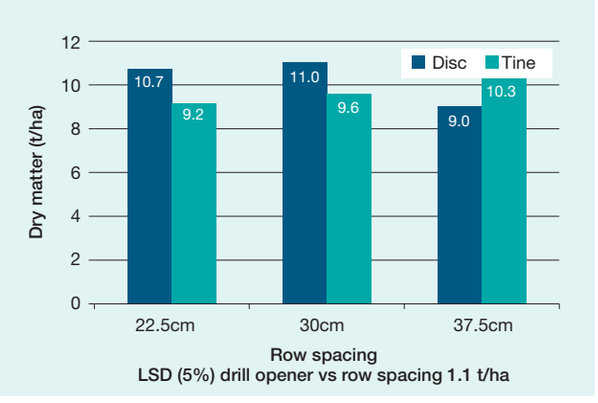

FIGURE 6 Influence of row spacing and drill opener on dry matter production at harvest

ii) Drill opener

Across the three row spacings there were no significant differences generated in DM production throughout the course of the season as a result of drill opener type (see Figure 5).

There was however a significant interaction between row spacing and drill opener on harvest DM (see Figure 6). For reasons that are not clear the tine opener produced inferior harvest DM to the disc at the narrow and middle row spacings but higher DM than the disc at the widest row spacing.

Crop structure

Despite significantly higher plant populations and tillers/m² (tillers assessed at GS31) at the 22.5cm spacing, this did not translate into more DM at harvest, a result that contrasts with previous trials at this site. One feature of the 2011 wheat on wheat trial at Coreen was the high tiller mortality in crops planted in the narrow rows (tillers present at the start of stem elongation that die before harvest without producing a viable head).

Tiller mortality was significantly higher at the narrow row spacing (31%) than at the 30cm (22%) and 37.5cm (16%) spacings, between which there was no difference (see Figure 7). The 22.5cm and 30cm row spacings had significantly more heads/m² than the 37.5cm spacing; however this did not translate into significantly different yields. It is unclear whether partial frost damage at mid flowering contributed to the yield results (see Figure 8).

Yield

i) Yield

The average trial yield was 3.09t/ha, which was 1.8t/ha less than the previous year's wheat on wheat crop grown at the same site.

Despite the early season DM advantage with the narrow row spacing, there were no significant differences in yield generated in the trial. This result is almost identical to

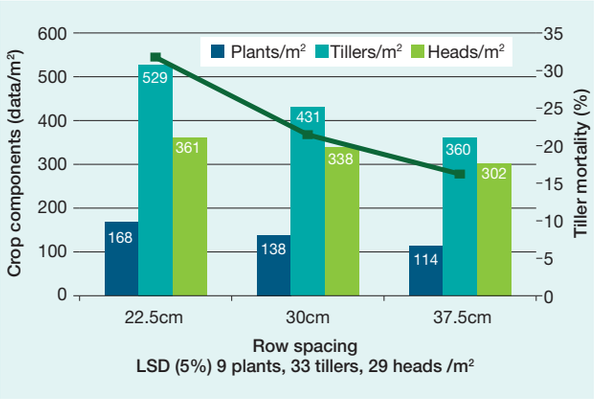

FIGURE 7 Influence of row spacing on crop structure*
* Mean of both drill openers

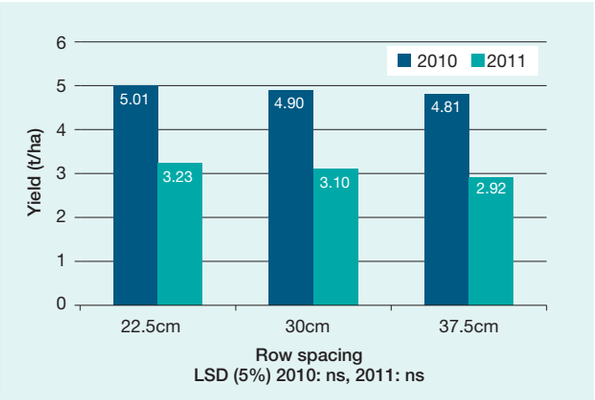

FIGURE 8 Influence of row spacing on second-year wheat (wheat on wheat) yields*
* Mean of both drill openers

the 2010 wheat on wheat trial where there was a trend for narrow row spacing to be higher yielding though the yield differences were not significant (see Figure 8). The lack of yield difference due to row spacing in the second-year wheat (wheat on wheat) rotation position is in contrast to the influence of row spacing on first-year wheat (wheat after canola) at the Coreen site (see Figure 9).

The drill opener had a significant effect on yield in this wheat on wheat trial. When averaged across the three row spacings, the disc opener produced 0.37t/ha more than the tine opener. These results were not seen in the previous wheat on wheat crop (see Figure 10).

Despite a significant interaction between row spacing and drill opener, there was no significant interaction in terms of harvest yields. Figure 11 shows there was a non-significant trend for the disc opener to be higher yielding than the tine opener at all row spacings.

ii) Nitrogen off-take and protein

Differences generated in protein content as a result of opener were small (see Figure 12) but significant ($P<0.01$). The average protein content of the tine was 13.7% versus 13.1% for the disc, a result likely to have been related to the higher yields obtained with the disc opener. Though not statistically different the highest yielding row spacing (22.5cm) had the lowest level of protein, with very little difference in the protein contents between the 30cm and 37.5cm row spacings. While there was no significant difference in yield or protein due to row spacing, the higher overall protein contents at the wider row spacings tended to be associated with slightly lower yields and visa versa for the narrow row spacing.

There were no significant differences in nitrogen off-take in the grain or straw generated by either the row spacing or the drill opener. All plots received 150kg/ha urea (69kg nitrogen/ha) during early August.

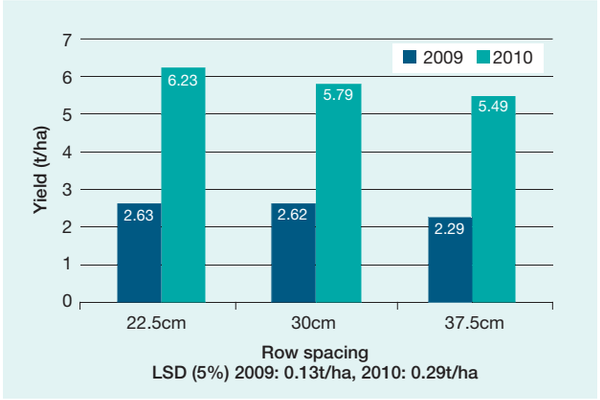

FIGURE 9 Influence of row spacing on yield in first-year wheat during 2009 and 2010*
* Mean of both drill openers

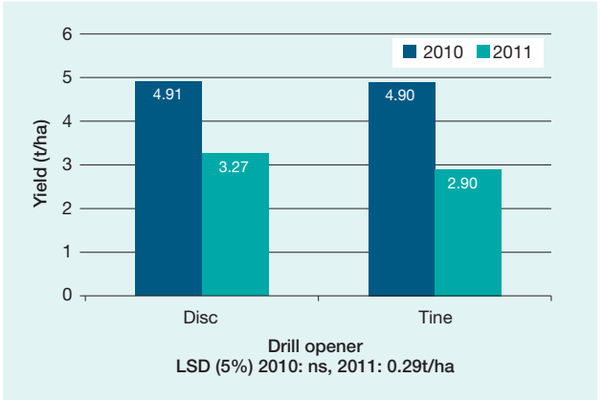

FIGURE 10 Influence of drill opener on wheat on wheat yields*
* Mean of three row spacings

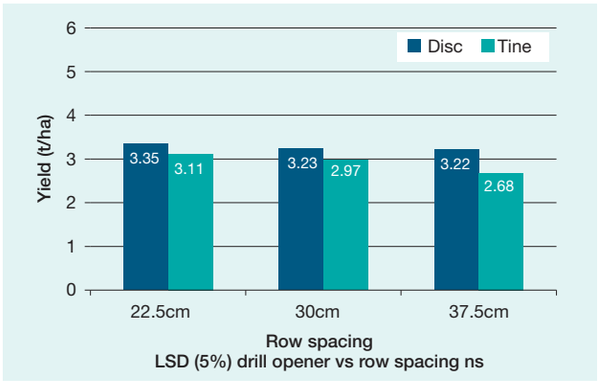

FIGURE 11 Influence of row spacing and drill opener on wheat on wheat yields

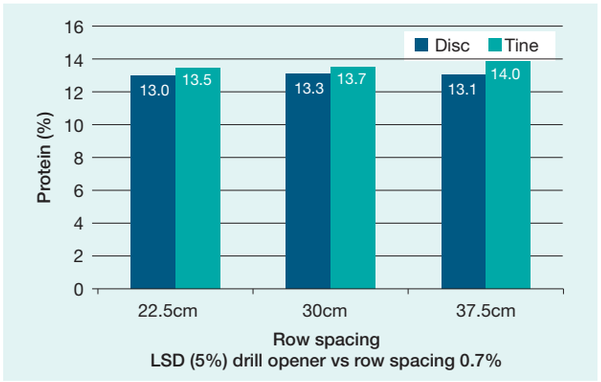

FIGURE 12 Influence of row spacing and drill opener on protein content

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	9950	3230	32.5	11.8	181	93	17.9
30	10324	3101	30.0	11.3	188	86	16.5
37.5	9667	2951	30.5	10.8	176	98	16.8

[1] Based on 187mm of GSR (April–October) + 35% fallow efficiency (87mm) for 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 55kg 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 drill openers

Water use efficiency

At harvest, the narrow (22.5cm) row spacing achieved the highest harvest index at 32.5% and the greatest WUE (11.8kg grain per mm of water available to the crop through the season). However, differences in WUE due to row spacing and drill opener were generally small this season. Despite lower grain yields during 2011 compared with the previous season, there was much better use of the soil water available, when unproductive water (water drained, evaporated or left behind at harvest) was estimated to be in excess of 300mm. This compares with less than 100mm unproductive water during 2011. As a consequence water use efficiency during 2011 was 24% higher than during 2010 (see Table 2).

The disc opener had a higher WUE than the tine opener at 11.9kg/mm and 10.7kg/mm respectively (data not shown).

SPONSORS

This trial was carried out as part of the Riverine Plains Inc GRDC-funded project *Improved WUE in no-till cropping and stubble retention systems in spatially and temporarily variable conditions in the Riverine Plains* (RP100007).

Thanks also go to farmer co-operators the Hanrahan family and John Seidel as trial manager.

CONTACT

Nick Poole
Foundation for Arable Research Australia
E: poolen@far.org.nz