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

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Key points

- Gauntlet wheat sown as the second wheat crop after canola yielded between 3.84–4.44t/ha with 232mm of growing season rainfall (Apr-Oct) and an estimated 118mm of stored water at sowing (total 350mm).
- Moving from a narrow row spacing (22.5cm) to 30cm and 37.5cm row spacings reduced yield by 13% and 11% respectively in the 2012 season. In 2011, moving from a 22.5cm spacing to 30cm and 37.5cm spacings reduced yield by 4% and 10% respectively for the second wheat trial grown in the same paddock.
- It was estimated that the narrow row spacing (22.5cm) resulted in better water use efficiency (WUE) than the widest spacing (37.5cm), despite having a lower harvest index (44% vs 47%) than the widest rows.
- Wider rows produced relatively more grain for the crop biomass produced, but the biomass produced was significantly lower overall. This indicates that water available to the crop was not used as effectively as in the narrower rows.

Location: Bungeet, Victoria

Rainfall:
- Annual: 621mm (2012)
- GSR: 232mm (Apr–Oct)
- Stored moisture: Estimated 118mm (estimated at 35% fallow efficiency)

Soil:
- Type: Loam over clay, Wattville No.205
- pH (H_2O): 6.0 (2011)
- pH ($CaCl_2$): 5.5 (2011)
- Colwell P: 65mg/kg (2011)
- Deep soil nitrogen: 55kg/ha (2011)

Sowing information:
- Variety: Gauntlet
- Sowing date: 22 May 2012
- Sowing rate: 85kg/ha
- Fertiliser: 85kg/ha MAP + Intake
- Sowing equipment: Janke tine with Janke presswheel. Single disc opener.
- Treatments: Establishment method x row spacing

Row spacing: 22.5cm, 30cm, 37.5cm

Paddock history:
- 2011 — wheat
- 2010 — canola
- 2009 — wheat

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 spacings in the second wheat crop (wheat on wheat) after canola.

Method

A replicated experiment was established to test the effect of a range of drill openers and row spacings on a second wheat crop after a break crop of canola. The trial is part of a four-year cropping rotation trial carried out on

the same trial site at Bungeet, Victoria. Two trials were established in two successive seasons (2009 and 2010) to give two time replicates for the rotation. Second wheat established during 2012 was the fourth successive crop superimposed on the original plots laid down during 2009 (time replicate one), with treatments being laid down on the same treatments each season.

Time replicate one

- 2008 wheat (farm crop)
- 2009 wheat
- 2010 canola
- 2011 wheat
- **2012 wheat**

Time replicate two

- 2008 wheat (farm crop)
- 2009 faba beans (farm crop)
- 2010 wheat
- 2011 wheat
- **2012 canola**

Crop stubble from the previous year's first wheat crop trial was chopped and spread at right angles to the direction of plots.

Results

Results from the 2012 second wheat crop (from the time replicate 1 trial) are reported below.

Crop establishment

The row spacing and drill opener interaction created significant differences in crop establishment in the second wheat crop (wheat on wheat) after canola. Plant establishment at the 22.5cm row spacing was significantly superior to the 30cm, which in turn was significantly superior to the 37.5cm spacing at both assessment timings (see Table 1 and Figure 1). The result was identical to that observed in the second wheat trial established during 2011 in the same paddock (time replicate two), although with higher overall establishment during 2012.

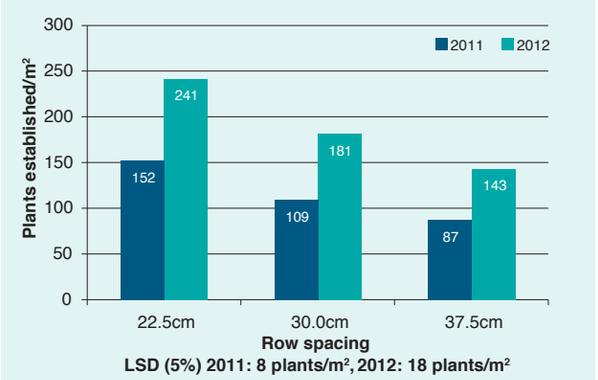

FIGURE 1 Influence of row spacing on plant establishment in the second wheat rotation position during 2011 (time replicate two) and 2012 (time replicate one) assessed at the three-leaves-unfolded stage (GS13)*

* Mean of both drill openers

There was no significant difference generated in crop establishment as a result of drill opener used (see Figure 2). This lack of difference due to drill opener was also observed in the 2011 second wheat crop (time replicate two).

There was a significant interaction (p=0.03) between row spacing and drill opener at the one-leaf-unfolded stage (GS11) (see Figure 3), suggesting increasing to wider row spacings has less influence on plant establishment with the disc opener compared with the tine. This interaction was not evident at the three-leaves-unfolded (GS13) assessment. The germination of plants with the disc opener was more protracted than was observed with the tine.

TABLE 1 Plant establishment at one-leaf-unfolded stage (GS11) and two to three-leaves-unfolded stage (GS12–13), 32 and 39 days after sowing

Row spacing (cm)	Drill opener Plant establishment (plants/m²)					
	23 June 2012			30 June 2012		
	Disc	Tine	Mean	Disc	Tine	Mean
22.5	190	223	206	238	245	241
30	166	149	157	191	173	181
37.5	119	129	124	143	144	143
Mean	158	166		190	187	
LSD [row spacing]	15			15		
LSD [drill opener]	18			18		
LSD [opener x row]	25			26		
Interactions — drill opener x row spacing	*			ns		

(See page 11 Table 1 for example)

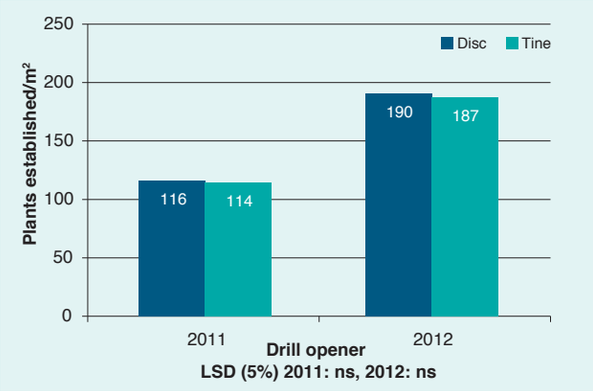

FIGURE 2 Influence of drill opener on plant establishment in second wheat following the break during 2012 and 2011 established on the same site and assessed at the three-leaves-unfolded stage (GS13)*

* Mean of three row spacings

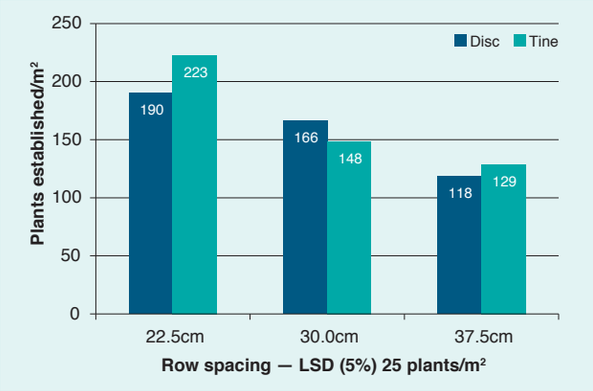

FIGURE 3 Influence of row spacing and drill opener method on plant establishment, at one-leaf-unfolded stage (GS11)

Dry matter production

i) Row spacing

Dry matter (DM) production throughout the growing season was significantly higher at the 22.5cm row spacing than at the 37.5cm spacing. Between the wider row spacings (30cm and 37.5cm), there was no significant difference in DM production at any of the assessment timings. The flowering (GS61) plus 15 day assessment (on 19 October) was the only assessment where the 22.5cm spacing did not produce significantly higher DM than the 30cm row spacing (see Figure 4).

This trend was similar to that observed in the second wheat grown on this site previously. In these previous trials, the 22.5cm row spacing produced significantly more DM throughout the growing season than the widest row spacing (37.5cm). The quantity of DM produced by the 30cm spacing was intermediate between the 22.5cm and 37.5cm results (statistical significance varying between trials).

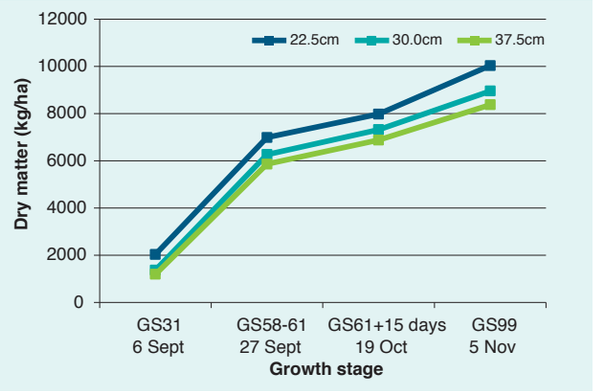

FIGURE 4 Influence of row spacing on dry matter production* in second wheat

* Mean of both drill openers (6 September – 5 November 2012)

ii) Drill opener

During 2012, the disc opener produced significantly (p=0.02) more DM/ha at the first node (GS31) assessment (194kg DM/ha) in early September and again at the harvest assessment (771kg DM/ha), than the tine drill opener (see Figure 5).

The 2011 second wheat trial (time replicate two) showed no influence of drill opener on DM production.

The 2012 trial showed a significant interaction between row spacing and drill opener in DM assessed at crop maturity (GS99) (see Figure 6). This interaction, which was evident in both 2011 and 2012, indicated that moving row spacing from 22.5cm to 30cm significantly reduced DM production with the tine opener, but not the with disc opener. It is unclear why this is the case but it does correlate with the plant establishment results, which were lower with tine opener at the 30cm row spacing.

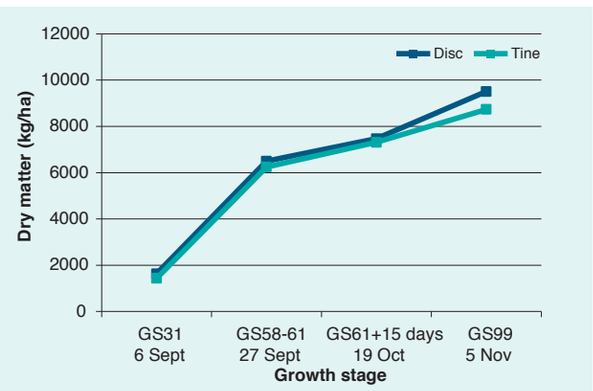

FIGURE 5 Influence of drill opener on dry matter production*

* Mean of three row spacings (6 September – 5 November 2012)

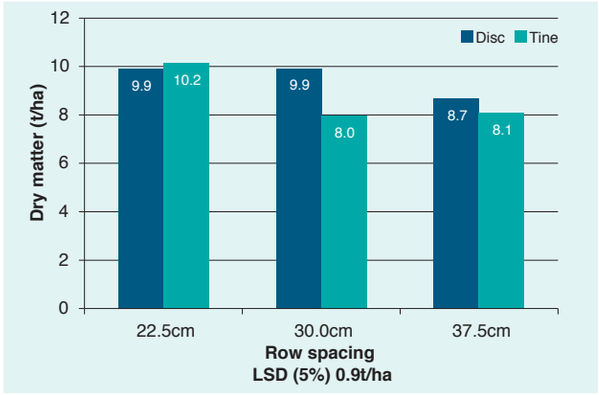

FIGURE 6 Influence of row spacing and drill opener on dry matter production at harvest

Crop structure

At the 22.5cm row spacing there were significantly more plants, tillers and heads/m^2 produced than with the crop established using the 30cm row spacing. In turn, the 30cm row spacing had significantly more plants, tillers and heads/m^2 than the 37.5cm row spacing (see Figure 7).

Interestingly, while there was no significant difference in plant establishment results between the disc and tine opener at establishment, the disc opener produced significantly more tillers and heads/m^2 at harvest than the tine opener (data not shown).

Tiller mortality was greatest at the narrow row spacing (26%), with proportionally fewer tillers forming a head compared with the wider row spacings. Tiller mortality rates were similar to those observed in the 2012 first wheat trial at Coreen. In terms of tiller production per established plant, the differences due to row spacing were relatively small (1.93–2.08 tillers/plant).

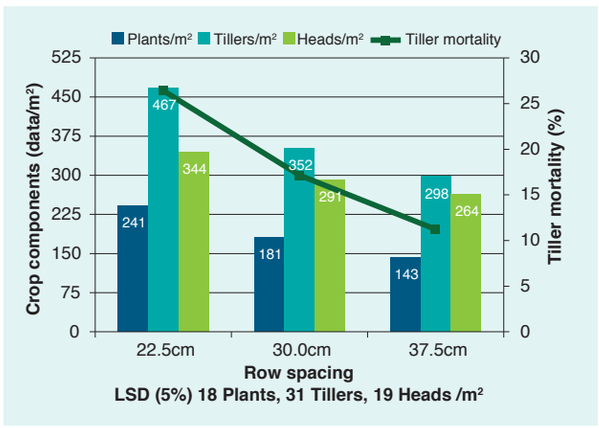

FIGURE 7 Influence of row spacing on crop structure in second wheat*

* Mean of both drill openers

Yield

i) Yield

The 2012 trial had an average yield of 4.08t/ha, which was 0.23t/ha higher than the second wheat crop grown on the site during 2011 (time replicate two). The 2012 trial produced the same result as the 2011 trial, whereby the 22.5cm row spacing significantly out yielded the 37.5cm row spacing. During 2012, the advantage of the 22.5cm spacing was 0.49t/ha (mean of both drill openers) more than the 37.5cm spacing, compared to a yield advantage of 0.39t/ha more than the 37.5cm spacing in 2011.

The principal difference between the 2011 and 2012 results was that the 30cm row spacing was also significantly inferior to the 22.5cm row spacing during 2012 (see Figure 8).

During 2012 there was no yield difference generated in the trial as a result of the drill opener. This was despite the differences in DM production in favour of the disc and the significant difference in ear numbers between the openers observed this season. The same result was also observed in 2011 (see Figure 9).

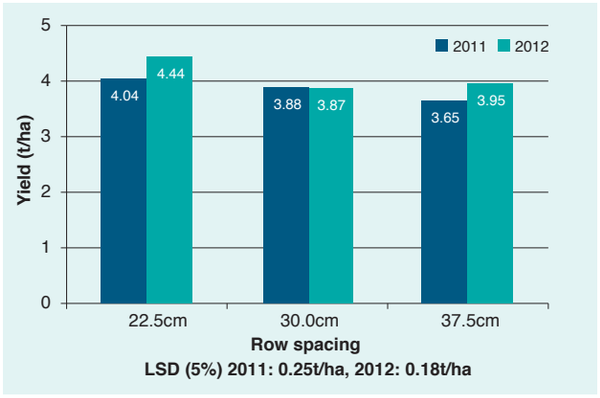

FIGURE 8 Influence of row spacing on yield in second wheat – 2011 and 2012*

* Mean of both drill openers

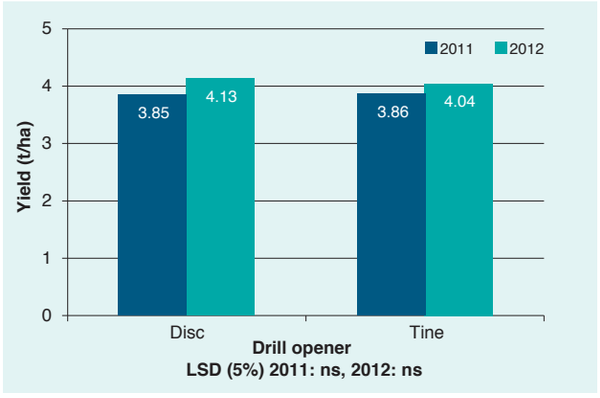

FIGURE 9 Influence of drill opener on yield*

* Mean of three row spacings

There was a significant interaction (p = 0.042) between row spacing and drill opener on the yields observed in the trial (see Figure 10). This indicates that yields from the disc opener were less affected by wider row spacings than the equivalent tine treatments. The disc opener at the widest row spacing yielded significantly more than the tine opener.

Interestingly, green leaf retention data collected at flowering GS65+15 days (19 October) showed the greatest level of greenness retention (on the top three leaves of the canopy) was in the disc-established plots at the 37.5cm row spacing (data not shown). There was a significant interaction between row spacing and disc opener on green leaf retention but only when measured on the last emerged leaf before the flag (Flag-1).

ii) Grain protein content

The crop established at the narrow row spacing (22.5cm) generated the lowest protein content of 9.8%. This was significantly (p=0.02) less than the widest row spacing (37.5cm) at 10.3%. The intermediate row spacing (30cm) had a protein content between the two extremes and was not significantly different to either the widest or the narrowest row spacing.

iii) Nitrogen off-take

Crops established at the 22.5cm row spacing removed significantly more nitrogen in the straw and grain than the widest (37.5cm) row spacing (see Figure 11). Between 16% and 21% of the nitrogen removed at harvest was in the straw and head residue, with the remainder in the grain. There was no significant difference in nitrogen removal between the crops established with narrow and intermediate row spacings or the intermediate and widest row spacings.

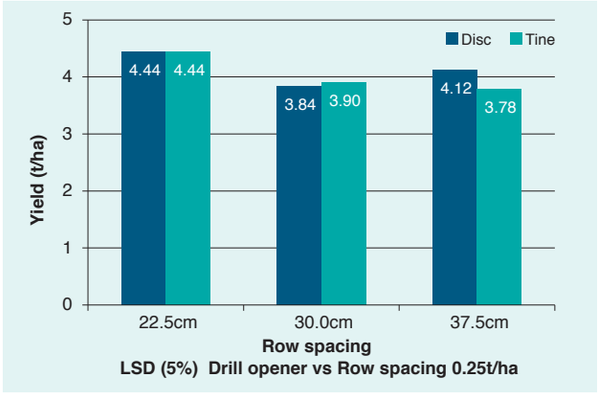

FIGURE 10 Influence of row spacing and drill opener on second wheat yield

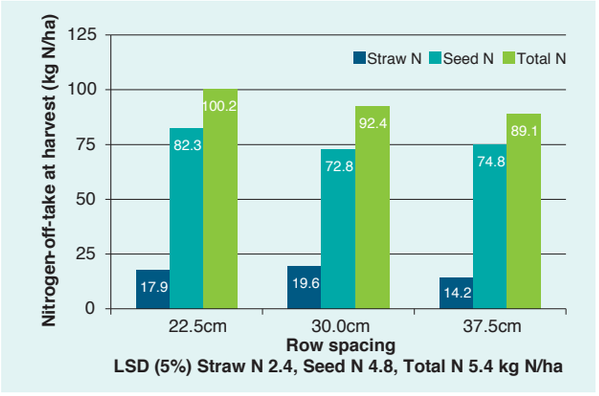

FIGURE 11 Influence of row spacing and drill opener on nitrogen off-take at harvest in second wheat*

* Mean of both drill openers

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	10030	4441	44.3	12.7	182	167	24.4
30	8953	3867	43.2	11.1	163	187	23.8
37.5	8372	3952	47.2	11.3	152	198	26.0

[1] Based on 232mm of GSR (April – October) + 35% fallow efficiency (118mm) for January – March rainfall (total GSR + stored = 350mm) 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 openers

Observations and comments

Estimating WUE from DM production at harvest showed that the narrow row spacing (22.5cm) had better overall WUE than the other spacings. The narrow spacing had the lowest level of unproductive water (water lost through evaporation, drainage and/or water left unused at harvest). However, the transpiration efficiency (grain produced per millmetre of water going through the plant) was lower with the narrow and middle spacings because less of the biomass produced was converted to grain compared with the widest (37.5cm) rows (i.e. the narrow and intermediate rows had a lower harvest index than the widest rows). The advantage of wider rows in lower harvest index and higher transpiration efficiency were however outweighed by greater use of the available soil water with the narrow rows (see Table 2).

Sponsors

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