Early sowing and the interaction with row spacing and variety in first wheat crops under full stubble retention

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Key points

- Four wheat trials sown during mid-April 2014 and 2015 showed no difference in grain yield or quality as a result of being grown on 22.5cm, 30cm and 37.5cm row spacings, when averaged across four varieties (Bolac/Kiora, Lancer, Trojan and EGA Wedgetail).
- The 2016 trial sown during mid-April again showed no difference in yield between 22.5cm and 30cm row spacings, however yields were significantly less with the widest row spacing (37.5cm).
- Trial yields in 2016 were 1.5t/ha higher than 2014 and 2015 (3–4.25t/ha), with the higher yield potential likely to be a key factor in the poor performance of the widest row spacing (37.5cm).
- The Riverine Plains *Water Use Efficiency (WUE)* project (2009–13) showed that when crops were sown in the traditional sowing window, the 22.5cm spacing was more successful than the 30cm spacing, except in drier years with lower yield potential (2.5–3.0t/ha).
- In the three years (2014–16) of trialling row spacing on early-sown crops, crops grown on a 22.5cm row spacing produced more dry matter (DM) than crops grown on wider rows. However, the 2016 trial was the first to show a yield disadvantage to the widest row spacing (37.5cm) when sown early.
- As a result of lower yields, the 37.5cm row spacing gave significantly poorer water use efficiency (WUE) than 30cm row spacing, with a greater proportion of calculated water losses (soil evaporation, drainage or unused water).
- A barley row spacing trial, sown at the same time alongside the wheat, provided some useful comparative observations during 2016, with La Trobe barley producing higher DM and yields than wheat with a harvest index (HI) of approximately 50% compared with wheat at 40%.

Previous row spacing findings

Results from the Riverine Plains Inc *Water Use Efficiency (WUE)* project (2009–13) demonstrated that wheat grown on a narrow row spacing (22.5cm) was higher yielding than when sown in wider rows (30–37.5cm). Trials sown for the WUE project were established during the mid-May–early June sowing window, prompting research questions as to whether wider row spacing would be more successful if crops were sown earlier.

During the past two years results have shown no difference in grain yield or quality as a result of row spacing (from 22.5–37.5cm) when wheat crops were sown during mid-April, despite lower DM production with wider rows.

Method

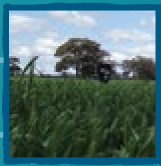
To complete a third and final year of research, two trials were established in 2016 under the Riverine Plains Inc stubble project: *Maintaining Profitable Farming Systems with Retained Stubble in the Riverine Plains Region (2013–18)*. The two trials were carried out in the same locations as in 2015, one in Barooga, New South Wales and the other in Yarrawonga, Victoria.

Four varieties, EGA Wedgetail (winter wheat), Trojan (mid-fast spring wheat), Lancer and Bolac (slow spring wheats) were sown at identical sowing rates per unit area at three row spacings: 22.5cm, 30cm and 37.5cm. The trials were sown on 14 April as split plot designs, with row spacing as the main plot and variety as the sub plot, replicated four times. All management, including starter fertiliser, was the same per unit area across the trials for the remainder of the season.

During 2016, a barley observation trial was added alongside the main wheat trial. While plot assessments were replicated, restrictions on the ability to spatially replicate these plots means these results are therefore presented as observation results.

Trial 1: Barooga, NSW

This trial suffered prolonged waterlogging over winter and had to be abandoned since large parts of the trial did not recover.



Trial 2: Yarrawonga, Victoria

Sowing date: 14 April 2016

Rotation: First wheat after canola

Variety: Kiora, Lancer, Trojan, EGA Wedgetail and La Trobe (barley)

Stubble: Canola unburnt

Rainfall:

GSR: 604mm (April – October)

Summer rainfall: 125mm

Soil mineral nitrogen: 50kg N/ha (0–60cm)

Results

i) Establishment and crop structure

Row spacing produced no difference in plant establishment but resulted in significant differences in tiller and head number when the widest rows (37.5cm) were compared with the 22.5cm and 30cm row spacings (Table 1 and Figure 1). The widest row spacing had significantly fewer tillers and heads per unit area than the narrower row spacings.

Lancer produced significantly fewer plants than Kiora and Trojan, and significantly fewer tillers and head numbers than the other three cultivars. The winter wheat EGA Wedgetail was slower to develop and produced significantly higher head numbers at harvest than the spring wheat varieties tested. The faster development of Trojan lead to the lowest head number per plant (2.58 heads/plant), a feature noted in the 2015 trials. In contrast, the head number per plant of the winter wheat EGA Wedgetail was 3.52 heads/plant.

TABLE 1 Plant counts 13 May 2016, three leaves unfolded (GS13), tiller counts 28 July 2016, targeted first node* (GS30–32) and head counts 5 December 2016, harvest (GS99)

Row spacing (cm)	Crop structure		
	Plants/m^2	Tillers/m^2	Heads/m^2
22.5	127^{a}	456^{a}	408^{a}
30	133^{a}	469^{a}	400^{ab}
37.5	128^{a}	416^{b}	342^{b}
Mean	**129**	**447**	**383**
LSD	23	34	60
Variety			
Wedgetail	129^{ab}	549^{a}	454^{a}
Kiora	132^{a}	435^{b}	385^{b}
Lancer	112^{b}	373^{c}	323^{c}
Trojan	144^{a}	431^{b}	372^{b}
LSD	18	47	48

*Actual growth stages at tiller assessment to account for varietal differences; Kiora GS32, Wedgetail GS30, Trojan GS32, Lancer GS32.

ii) Dry matter production and nitrogen uptake

The 22.5cm row spacing produced significantly more DM than the 37.5cm row spacing at flowering (GS59–65) and harvest (GS99) (Table 2). Wedgetail and Trojan produced more DM at harvest than Lancer.

The wider row spacing (37.5cm) did not have any effect on nitrogen uptake at the assessment targeting first node (GS31), however at the start of grain fill there was evidence of greater nitrogen uptake in the canopy of the narrowest row spacing (22.5cm). The reduced establishment and tillering with Lancer correlated with reduced nitrogen uptake compared with the other three cultivars when assessed throughout the season (Table 3).

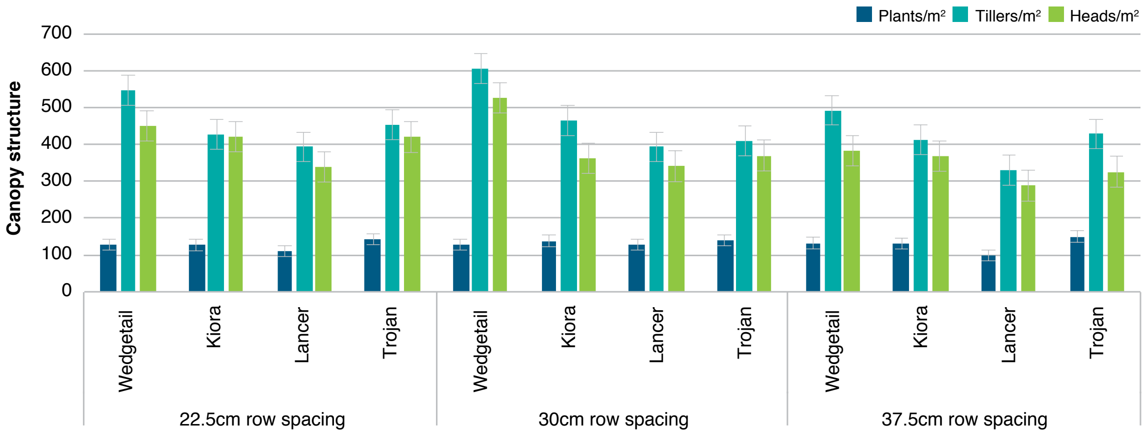


FIGURE 1 Plant counts 13 May 2016, three leaves unfolded (GS13), tiller counts 28 July 2016, targeted first node* (GS30–32) and head counts 5 December 2016, harvest (GS99)

*Actual growth stages at tiller assessment to account for varietal differences; Kiora GS31, Wedgetail GS30, Trojan GS32, Lancer GS31.
Error bars presented as a measure of LSD.

TABLE 2 Dry matter production 28 July 2016 (GS30-32)*; 25 October 2015, grain watery ripe^ (GS71–75) and 5 December 2016, harvest (GS99)

Row spacing (cm)	Dry matter (t/ha)		
	GS31	GS71	GS99
22.5	1.74^{a}	12.33^{a}	12.19^{a}
30	1.67^{a}	11.50^{a}	12.06^{ab}
37.5	1.52^{a}	10.31^{b}	11.21^{b}
Mean	**1.64**	**11.37**	**11.82**
LSD	0.29	1.15	0.90
Variety			
Wedgetail	1.66^{a}	10.94^{ab}	12.89^{a}
Kiora	1.78^{a}	11.96^{a}	11.78^{ab}
Lancer	1.36^{b}	10.33^{b}	10.16^{b}
Trojan	1.79^{a}	12.28^{a}	12.44^{a}
LSD	0.22	1.47	1.81

*Actual growth stages at first node assessment to account for varietal differences; Kiora GS31, Wedgetail GS30, Trojan GS32, Lancer GS31.
^Actual growth stages GS71 assessment Trojan GS75 Kiora GS73 Lancer GS73 Wedgetail GS71.

TABLE 3 Nitrogen uptake in dry matter 28 July 2016, (GS30–32)*; 25 October 2015, grain watery ripe^ (GS71–75) and 5 December 2016, harvest (GS99)

Row spacing (cm)	Nitrogen uptake in biomass (kg N/ha)		
	GS31	GS71	GS99
22.5	64^{a}	112^{a}	93^{a}
30	62^{a}	89^{ab}	101^{a}
37.5	54^{a}	81^{b}	107^{a}
Mean	**60**	**94**	**100**
LSD	10	20	19
Variety			
Wedgetail	60^{a}	108^{a}	113^{a}
Kiora	64^{a}	78^{c}	101^{a}
Lancer	56^{b}	91^{bc}	66^{b}
Trojan	62^{a}	99^{ab}	122^{a}
LSD	10	13	23

*Actual growth stages at tiller assessment to account for varietal differences; Kiora GS31, Wedgetail GS30, Trojan GS32, Lancer GS31.
^Actual growth stages GS71 assessment Trojan GS75 Kiora GS73 Lancer GS73 Wedgetail GS71.

iii) Grain yield and quality

The 22.5cm and 30cm row spacings had similar impacts on grain yield when averaged across the four varieties, however the lower DM observed with the widest row spacing (37.5cm) resulted in significantly less grain than the 30cm row spacing (Table 4). There were also no significant effects of row spacing on grain quality.

There were no significant varietal differences in yield, however Kiora had significantly lower protein than Trojan and EGA Wedgetail.

iv) Water use efficiency (WUE) calculations

The overall levels of WUE were generally low, since calculations showed that much of the water falling this spring was either lost or left unused (Table 5). Despite a softer finish, the overall harvest index (HI) was only 40% (40% of the final biomass was grain) compared with ideal, non-limited high-yielding longer-season scenarios of up to 50% in wheat.

There were significant differences in WUE when the 30cm row spacing was compared with the 37.5cm spacing; the 30cm offered superior WUE and showed a similar efficiency to the 22.5cm row spacing. There was no difference in WUE between the 22.5cm and 30cm spacings. By virtue of lower DM accumulation, the widest row spacing lost less water through the plant during the course of the season, but was calculated to have either lost or left unused more water than the narrower row spacing, which produced significantly more DM.

v) Results from three years of trials at Yarrawonga

The early-sown row spacing trial (mid-April) at Yarrawonga has now run for three years in different paddocks in the same rotation position after canola. In both 2014 and 2015 the narrow-row-spaced crops produced more DM, however 2016 was the only season where there were differences in grain yields (Figure 2). Higher yields in 2016 resulted in the widest row spacing (37.5cm) producing yields 0.34–0.43t/ha less than the 22.5cm and 30cm row spacing.

In previous work carried out by Riverine Plains Inc and FAR Australia, the influence of row spacing on grain yields has been shown to be affected by the overall yield potential of the season, with comparable yields across row spacings under lower-yielding scenarios. At a yield potential of 3.0–6.0t/ha there has been no difference in yield between 22.5cm and 30cm row spacings when wheat crops have been sown in mid-April. Wheat crops sown on a 37.5cm row spacing at the same time show no yield disadvantage provided grain yields are less than 3.5t/ha; this was observed with the harder finish in 2015. In a harder finish a higher HI helps to compensate, so relatively more grain is produced from the final DM. Under higher yield scenarios, the loss of final harvest DM at the widest row spacing cannot be compensated for with other factors such as HI.

Results in early-sown crops are different to results generated in later-sown crops (late May/early June) studied as part of the WUE project, where the 22.5cm spacing produced more DM than the 30cm spacing, and which led to more yield. In this study, the results demonstrate that the actual row spacing: either 22.5cm

TABLE 4 Yield, protein, test weight and screenings at harvest (GS99), 11 December 2016

Row spacing (cm)	Yield and quality			
	Yield (t/ha)	**Protein (%)**	**Test weight (kg/hL)**	**Screenings (%)**
22.5	5.60^{ab}	9.1^{a}	80.1^{a}	2.2^{a}
30	5.69^{a}	9.2^{a}	80.0^{a}	2.6^{a}
37.5	5.26^{b}	9.2^{a}	79.8^{a}	2.4^{a}
Mean	**5.52**	**9.2**	**80.0**	**2.4**
LSD	0.36	0.3	1.1	0.6
Variety				
Wedgetail	5.45^{a}	9.4^{a}	79.5^{a}	2.6^{a}
Kiora	5.80^{a}	8.5^{b}	80.2^{a}	2.6^{a}
Lancer	5.33^{a}	9.2^{ab}	80.0^{a}	2.4^{a}
Trojan	5.49^{a}	9.6^{a}	80.0^{a}	2.1^{a}
LSD	0.76	0.78	1.36	1.0

TABLE 5 Average biomass at harvest, yield (expressed at 0% moisture), harvest index (HI), calculated water use efficiency (WUE), calculated transpiration, calculated evaporation/drainage and transpiration efficiency (TE)

Row spacing (cm)	Biomass[1] (t/ha)	Yield[1] (t/ha)	HI[2] (%)	WUE[3] (kg/mm)	Transpiration[4] (mm)	Evaporation[5] (mm)	TE[6] (kg/mm)
22.5	12.19^{a}	5.04^{ab}	41.6^{a}	7.6^{ab}	206.4^{a}	456.6^{a}	22.9^{a}
30.0	12.06^{ab}	5.12^{a}	41.6^{a}	7.7^{a}	206.2^{a}	456.8^{a}	22.9^{a}
37.5	11.21^{b}	4.74^{b}	40.0^{a}	7.1^{b}	193.3^{a}	469.7^{a}	22.0^{a}
Mean	**11.82**	**4.97**	**41.1**	**7.5**	**202.0**	**461.0**	**22.6**
LSD	0.90	0.32	10.9	0.5	39.7	39.7	6.0

GSR (April – October) 604mm plus calculated soil water available on 1 April 2016 59mm — total 663mm

1. All harvest biomass and grain yield calculations are based DM content (i.e. 0% moisture, rather than grain at 12.5% moisture as in section iii of this report).
2. Harvest index (HI) is calculated by dividing the final harvest yield by the final harvest biomass.
3. Water use efficiency (WUE) is calculated by dividing grain yield by the available soil water (mm).
4. Transpiration through the plant was based on a maximum 55kg biomass/ha.mm transpired for wheat.
5. Soil evaporation, drainage, or unused water is calculated as the water that remains unaccounted after transpiration water has been subtracted from available soil water (stored in the fallow plus GSR).
6. Transpiration efficiency (TE) is calculated by dividing the final harvest yield per mm by the water transpired through the plant.

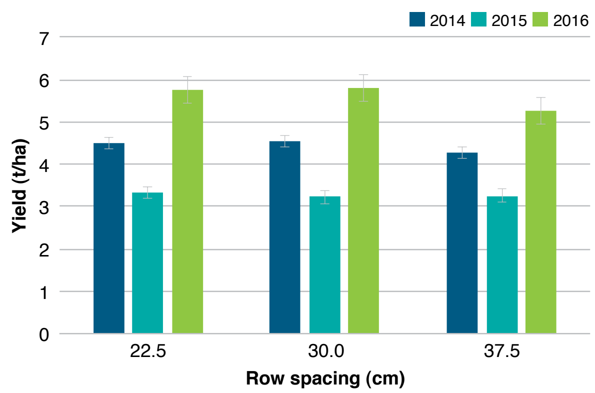


FIGURE 2 Influence of row spacing on grain yield in early-sown first wheat (average of four varieties) in 2014, 2015 and 2016, Yarrawonga, Victoria

Error bars presented as a measure of LSD.

or 30cm, is less important in determining wheat yield when crops are sown early (mid-April in this research project) compared with crops sown later.

vi) Barley observation trial

Adjacent to the wheat row spacing trial, La Trobe barley was sown on the same day and at the same row spacing as the wheat trial. Various measurements were taken throughout the season, similar to the wheat row spacing trial. As these plots were replicated, but not spatially randomised, the figures have not been statistically analysed.

In all plots, 100% of the crop was brackled by harvest, with a severity of 5 (scale 1–5 where 5 is completely brackled).

Note: Brackling occurs when crop stems break or bend part way up the stem, letting the head hang down — this is different to lodging where the stem bends or breaks at the base, or the roots lose anchorage. Brackling in barley is often associated with head loss at harvest, while wheat rarely, if ever, brackles.

Row spacing had no effect on brackling severity at harvest. There appeared to be few differences in crop structure measurements with tiller numbers per plant exceeding wheat with 620–690 tillers/m² from 115–130 plants/m² (Figure 3).

As was the case in wheat, the narrower row spacing in barley produced more DM per unit area than the wider rows, with similar harvest DM accumulation to the wheat (Figure 4).

A comparison of the mean yield of the wheat (average of four cultivars) and barley row spacing trial (La Trobe) revealed that barley, for the same early sowing (14 April), was higher yielding than wheat (Figure 5). While trials are not statistically comparable, the scale of the yield increase of barley would suggest merit in further investigating early-sown barley after canola (depending on potential profitability and farming system fit) (Table 6). The harvest indices for barley show it was more efficient than wheat at turning final harvest biomass (measured on 5 December) into grain.

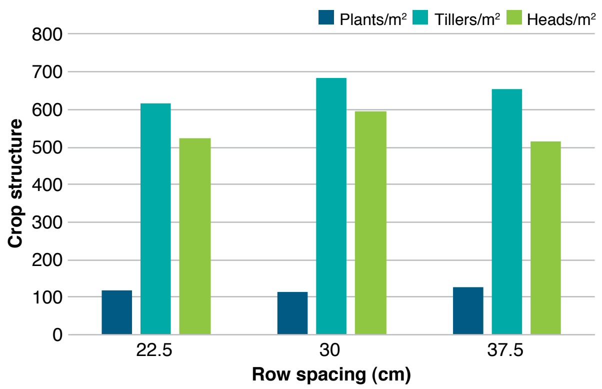


FIGURE 3 Plant counts 13 May 2016 for La Trobe barley, three leaves unfolded (GS13); tiller counts 17 August 2016; flag leaf visible (GS37) and head counts 5 December 2016, harvest (GS99)

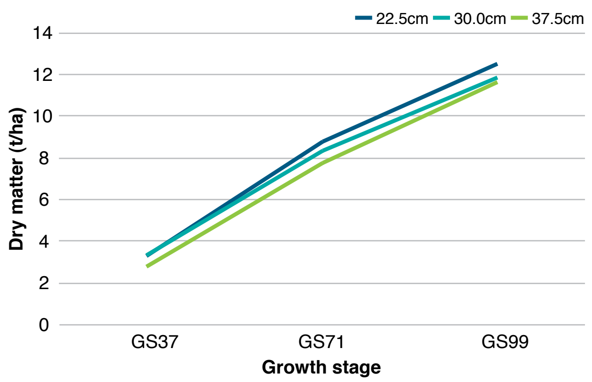


FIGURE 4 Dry matter production for the barley observation trial, 28 July 2016, third node (GS33); 25 October 2016, late milk stage (GS77) and 5 December 2016, harvest (GS99)

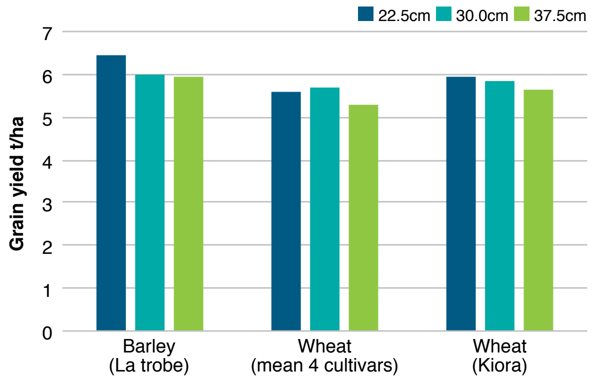


FIGURE 5 Comparative yield of barley, wheat (mean of four cultivars) and wheat (Kiora) at 11 December 2016, harvest (GS99)

TABLE 6 Yield, protein, test weight and screenings of La Trobe barley at 11 December 2016, harvest (GS99)

Row spacing (cm)	Yield and quality			
	Yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
22.5	6.46	10.2	65.0	10.3
30.0	5.99	9.9	64.3	11.5
37.5	5.95	10.0	64.3	13.9

No means or LSD values are presented as this was designed as a demonstration trial, without randomisation of treatments.

Implications for commercial practice

Wheat crops sown early in the Riverine Plains region during mid-April (emerging 20–30 April) have shown no difference in grain yield between a 22.5cm and 30cm row spacing over three years of research. However, as sowing dates move later (mid-May–June) the advantage of the narrower 22.5cm row spacing becomes more apparent (see the Riverine Plains *Between the Rows* publication).

Row spacings wider than 30cm were successful with wheat, provided crop yield potential did not exceed 4t/ha and crops were sown in mid-April. For later sowing and for regions or seasons with higher yield potential, a row spacing of 37.5cm significantly reduced DM production and resultant grain yield.

Acknowledgements

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