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

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Key points

- Two wheat trials sown during mid-April 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, Lancer, Trojan and Wedgetail).
- Although crops grown on a 22.5cm row spacing produced more dry matter (DM), this did not correspond to increased yield.
- The results were identical to that seen with wheat sown in mid-April 2014.
- There were no differences in yields of the four wheat varieties, although Bolac produced higher screenings than the other three varieties in both trials.
- There was no difference in overall water use efficiency (WUE) between narrow and wide row spacing, although calculated water losses (soil evaporation, drainage or unused water) were greater with the wide spacing than the narrow spacing.

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 equivalent crops sown in wider rows (30–37.5cm). Trials sown for the *WUE* project were established on crops sown in the mid May – early June sowing window, prompting research questions as to whether wider row spacings would be more successful if crops were sown earlier.

During 2014, first-year results showed no difference in grain yield or quality as a result of row spacing from 22.5–37.5cm, when crops were sown in mid-April, despite lower DM production with wider rows.

Method

To confirm the 2014 results, two trials were established in 2015 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 conducted in the same locations as 2014: one in Barooga, New South Wales and the other in Yarrawonga, Victoria.

Four varieties, 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 15 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 across the trials for the remainder of the season.

Trial 1: Barooga, NSW

Sowing date: 15 April 2015
Rotation: First wheat after canola
Varieties: Bolac, Lancer, Trojan and Wedgetail
Stubble: Canola, unburnt
Rainfall:
GSR: 201mm (April – October)
Summer rainfall: 107mm
Soil mineral nitrogen: 58kg N/ha (0–60cm)

Results

i) Establishment and crop structure

The narrow row spacing (22.5cm) produced significantly more tillers per unit area compared with wider rows (Table 1). This difference carried through to head numbers, with between 35–55 more heads with the narrow row spacing.

Averaged across the three row spacings, Wedgetail and Bolac produced significantly more heads than Lancer and Trojan, with Trojan producing significantly fewer heads than all the other varieties. There were no significant interactions between row spacing and variety, with all four varieties responding to increasing row width in the same way in regards to their crop structure (Figure 1).

TABLE 1 Plant counts 6 May 2015, two leaves unfolded (GS12), tiller counts 9 July 2015, targeted first node* (GS30–31) and head counts 18 November 2015, harvest (GS99)

Row spacing (cm)	Canopy structure (m^{2})		
	Plants	Tillers*	Heads
22.5	110^{b}	356^{a}	331^{a}
30	127^{a}	306^{b}	297^{b}
37.5	112^{ab}	274^{b}	275^{b}
Mean	**116**	**312**	**301**
LSD	16	32	32
Variety			
Wedgetail	113^{a}	386^{a}	338^{a}
Bolac	113^{a}	328^{b}	320^{ab}
Lancer	116^{a}	271^{c}	293^{b}
Trojan	123^{a}	264^{c}	254^{c}
LSD	18	37	36

Figures followed by different letters are regarded as statistically significant.

* Actual growth stages at tiller assessment to account for varietal differences; Bolac GS31, Wedgetail GS30, Trojan GS31, Lancer GS31.

TABLE 2 Dry matter 9 July 2015, first node* (GS30–31), 23 September 2015, targeted start of flowering^ (GS59–65) and 18 November 2015, harvest (GS99)

Row spacing (cm)	Dry matter (t/ha)		
	GS30–31	GS59–61	GS99
22.5	1.31^{a}	9.07^{a}	10.27^{a}
30	1.35^{a}	8.42^{ab}	9.23^{b}
37.5	1.29^{a}	8.01^{b}	8.46^{b}
Mean	**1.32**	**8.50**	**9.32**
LSD	0.19	0.75	0.99
Variety			
Wedgetail	1.34^{ab}	7.20^{c}	9.35^{a}
Bolac	1.27^{b}	8.84^{ab}	8.94^{a}
Lancer	1.14^{b}	8.50^{b}	9.32^{a}
Trojan	1.52^{a}	9.46^{a}	9.66^{a}
LSD	0.22	0.87	1.15

Figures followed by different letters are regarded as statistically significant.

* Actual growth stages at tiller assessment to account for varietal differences: Bolac GS31, Wedgetail GS30, Trojan GS31, Lancer GS31.

^ Actual growth stages at GS61 assessment to account for varietal differences: Trojan GS65, Bolac GS61, Lancer GS61, Wedgetail GS59.

ii) Dry matter production and nitrogen uptake

The increased tiller numbers with the narrow row spacing did not result in an increase in DM production at first node (GS31). However the narrow row spacing produced significantly more DM at flowering (GS59–65) and harvest (GS99) compared with the wider row spacings (Table 2). At the wider row spacings of 30cm and 37.5cm there were no significant differences in DM production but there was a trend for the 30cm row spacing to produce more DM than the 37.5cm spacing.

Trojan initially produced more DM than the other varieties at first node (GS31) and flowering (GS59–65), however by harvest (GS99) this difference was not significant.

Nitrogen uptake was increased with the narrow row spacing at flowering (GS61) and harvest (GS99) compared with crops grown in wider rows (Table 3). While Trojan had a higher uptake of nitrogen compared with Lancer at first node (GS31), by the start of flowering (GS61) there were no differences between varieties.

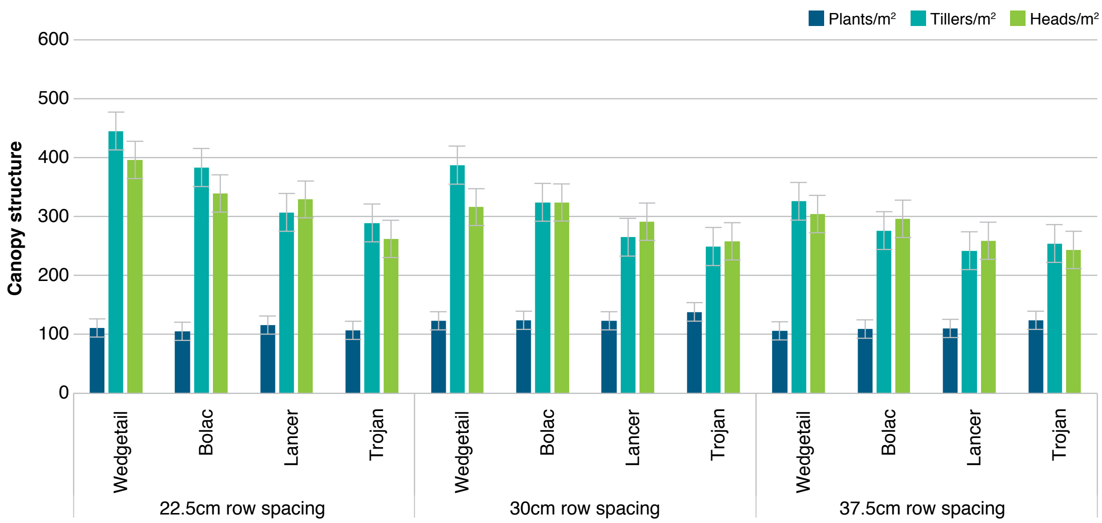

FIGURE 1 Canopy structure across all row spacing and variety treatments. Plant counts 6 May 2015, two leaves unfolded (GS12), tiller counts 9 July 2015, targeted first node (GS31*) and head counts 18 November 2015, harvest (GS99)

*Actual growth stages at tiller assessment to account for varietal differences: Bolac GS31, Wedgetail GS30, Trojan GS31, Lancer GS31.

Error bars are a measure of LSD

TABLE 3 Nitrogen uptake in dry matter 9 July 2015, first node* (GS31), 23 September 2015, targeted start of flowering^ (GS61) and 18 November 2015, harvest (GS99)

Row spacing (cm)	Nitrogen uptake in dry matter (kg N/ha)		
	GS30–31	GS59–61	GS99
22.5	46[a]	112[a]	102[a]
30	46[a]	100[ab]	77[b]
37.5	43[a]	93[b]	78[b]
Mean	**45**	**102**	**86**
LSD	6	13	18
Variety			
Wedgetail	46[ab]	98[a]	87[a]
Bolac	44[ab]	100[a]	82[a]
Lancer	41[b]	102[a]	87[a]
Trojan	49[a]	108[a]	83[a]
LSD	6	16	18

Figures followed by different letters are regarded as statistically significant.

* Actual growth stages at tiller assessment to account for varietal differences: Bolac GS31, Wedgetail GS30, Trojan GS31, Lancer GS31.

^ Actual growth stages at GS61 assessment to account for varietal differences: Trojan GS65, Bolac GS61, Lancer GS61, Wedgetail GS59.

TABLE 4 Yield, protein, test weight and screenings at 27 November 2015, harvest (GS99)

Row spacing (cm)	Yield and quality			
	Yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
22.5	4.17[a]	9.8[a]	77.2[a]	7.1[a]
30	4.20[a]	9.6[a]	77.8[a]	6.7[a]
37.5	4.23[a]	9.9[a]	77.4[a]	7.1[a]
Mean	**4.20**	**9.8**	**77.5**	**7.0**
LSD	0.50	0.5	0.9	1.2
Variety				
Wedgetail	3.91[a]	9.6[b]	76.7[b]	5.3[b]
Bolac	4.18[a]	9.7[b]	76.0[b]	11.9[a]
Lancer	4.28[a]	10.3[a]	79.0[a]	5.1[b]
Trojan	4.44[a]	9.5[b]	78.2[a]	5.7[b]
LSD	0.57	0.6	1.0	1.4

Figures followed by different letters are regarded as statistically significant.

iii) Grain yield and quality

There were no differences in grain yield or grain quality due to the different row spacings (Figure 2 and Table 4).

Although there were no significant differences in grain yield, the trends in yield followed DM production at flowering (GS59–61). Trojan had the highest DM at this stage and yielded 4.44t/ha, while Wedgetail had the lowest DM, yielding 3.91t/ha. The protein level recorded with Trojan suggested that nitrogen fertiliser applied may have been suboptimal. Lancer had significantly higher protein than the other varieties, while Bolac had the highest screenings.

iv) Water use efficiency calculations

While there were no differences in WUE due to row spacings, as the grain yield from the widest row spacing (37.5cm) was derived from significantly less DM, the harvest index (HI) of the wider-row-spaced crops was significantly higher (Table 5). The calculated transpiration of crops grown on wide row spacings was also less than the narrow rows, resulting in a greater transpiration efficiency (TE) in wide rows.

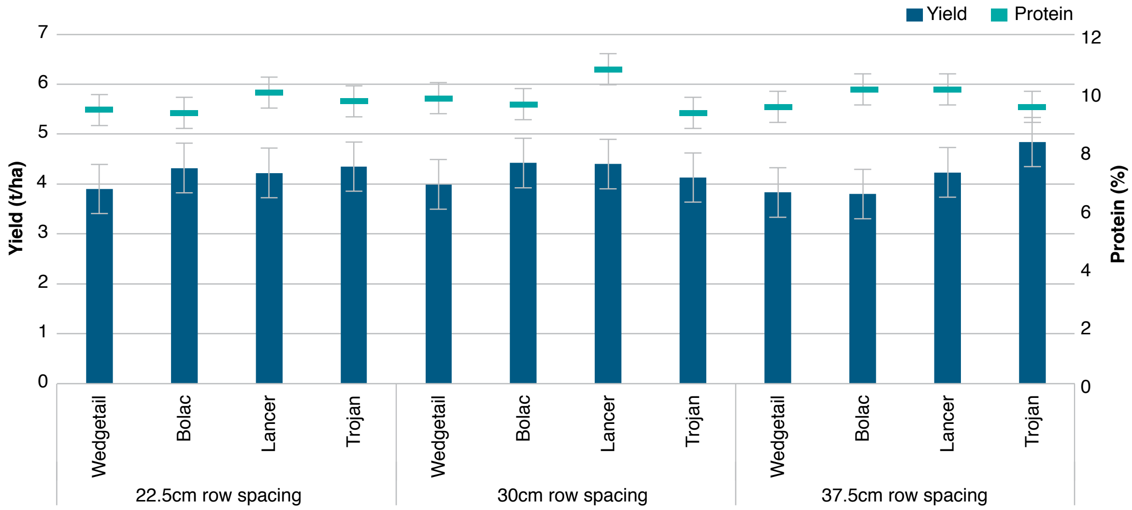

FIGURE 2 Yield and protein at 27 November 2015, harvest (GS99)
Error bars are a measure of LSD

TABLE 5 Average biomass at harvest, yield (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	10.27	3.65	36.1	15.3	186.7	51.4	19.8
30.0	9.23	3.67	40.3	15.4	167.8	70.4	22.1
37.5	8.46	3.70	44.6	15.5	153.8	84.4	24.5
Mean	**9.32**	**3.68**	**40.3**	**15.4**	**169.4**	**68.7**	**22.2**
LSD	0.99	0.43	5.9	1.8	18.1	18.1	3.2

GSR (April–October) 201mm plus calculated soil water available on 1 April (37.4mm) — total 238mm

1. All harvest biomass and grain yield calculations are based on 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. water transpired through the plant.

v) Results from two years of trials at Barooga

This early-sown trial (mid-April) has now run for two years in the same rotation position, but different paddocks. While the narrow-row-spaced crops had higher DM production across both years there has been no differences in grain yield due to row spacing (Figure 3).

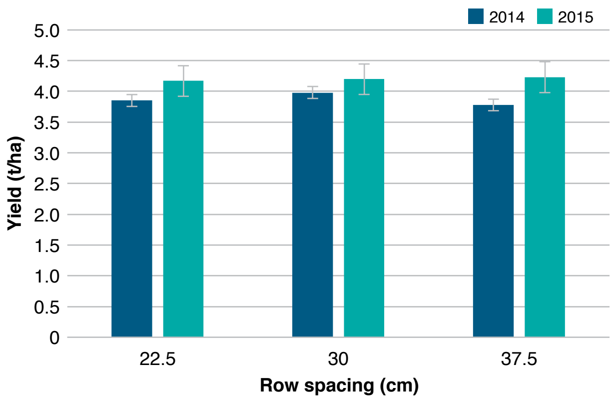

FIGURE 3 Influence of row spacing on grain yield in early-sown first wheat (average of four varieties) across 2014 and 2015 at Barooga, NSW

Trial 2: Yarrawonga, Victoria

Sowing date: 15 April 2015

Rotation: First wheat after canola

Variety: Bolac, Lancer, Trojan and Wedgetail

Stubble: Canola unburnt

Rainfall:

GSR: 266mm (April–October)

Summer rainfall: 120mm

Soil mineral nitrogen: 74kg N/ha (0–60cm)

Results

i) Establishment and crop structure

Row spacing produced the same patterns of tiller response as seen in Trial 1 at Barooga, NSW with wider rows resulting in lower tiller and head numbers despite similar plant populations of 158–171 plants/m^2 (Figure 4 and Table 6).

Trojan produced significantly fewer head numbers than Wedgetail and Bolac, despite having a slightly higher plant population. In both the Barooga and Yarrawonga row spacing trials Trojan showed reduced tillering characteristics relative to the other varieties investigated.

TABLE 6 Plant counts 7 May 2015, two leaves unfolded (GS12), tiller counts 8 July 2015, targeted first node (GS30–32*) and head counts 16 November 2015, harvest (GS99)

Row spacing (cm)	Crop structure (m^2)		
	Plants	Tillers*	Head
22.5	171^{a}	348^{a}	413^{a}
30	158^{a}	304^{b}	363^{b}
37.5	162^{a}	282^{c}	364^{b}
Mean	**164**	**311**	**380**
LSD	14	22	32
Variety			
Wedgetail	155^{b}	341^{a}	382^{b}
Bolac	165^{ab}	336^{a}	446^{a}
Lancer	156^{b}	277^{b}	357^{bc}
Trojan	178^{a}	292^{b}	337^{c}
LSD	16	25	37

Figures followed by different letters are regarded as statistically significant.

*Actual growth stages at tiller assessment to account for varietal differences: Bolac GS31, Wedgetail GS30, Trojan GS32, Lancer GS31.

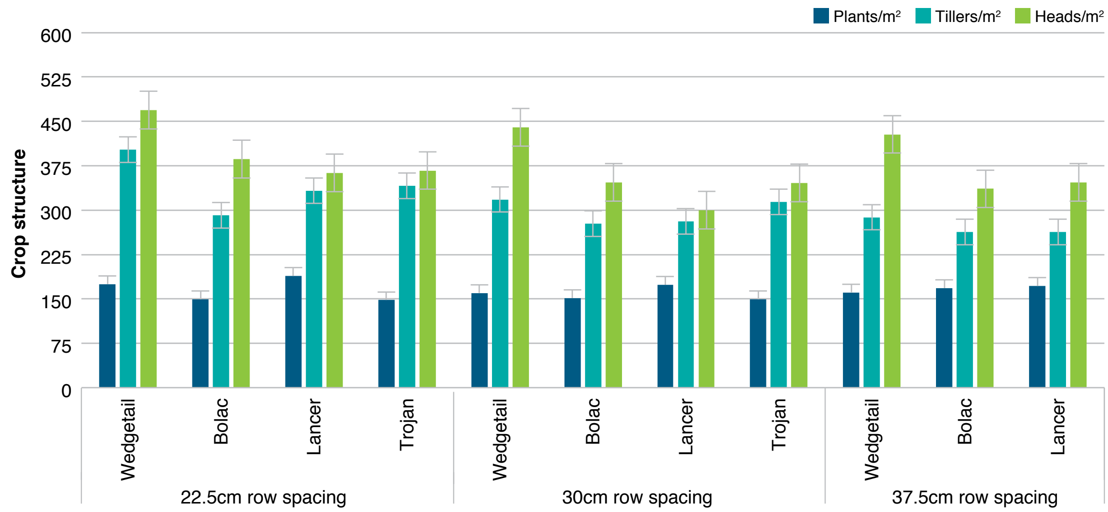

FIGURE 4 Plant counts 7 May 2015, two leaves unfolded (GS12), tiller counts 8 July 2015, targeted first node (GS31*) and head counts 16 November 2015, harvest (GS99)

*Actual growth stages at tiller assessment to account for varietal differences; Bolac GS31, Wedgetail GS30, Trojan GS32, Lancer GS31.

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 was greater than both the 30cm and 37.5cm row-spaced crops at harvest (GS99) (Table 7).

Bolac and Trojan consistently produced higher DM throughout the season. At the pre-harvest assessments the increased DM may be due to Bolac and Trojan being slightly more advanced in growth stage.

Row spacing did not have any effect on nitrogen uptake. Bolac and Trojan had greater nitrogen uptake at first node (GS31), however by start of flowering (GS61) all varieties had similar values (Table 8).

iii) Grain yield and quality

Row spacing had no effect on grain yield when averaged across the four varieties, despite significant differences in DM at harvest (Figure 5 and Table 9). There were also no significant effects on grain quality. Screening levels were high (about 20%) across all row-spacing treatments.

TABLE 7 Dry matter production 8 July 2015, first node* (GS31), 23 September 2015, targeted start of flowering^ (GS61) and 16 November 2015, harvest (GS99)

Row spacing (cm)	Dry matter (t/ha)		
	GS30–32	GS59–65	GS99
22.5	1.49[a]	9.47[a]	9.49[a]
30	1.49[a]	9.12[ab]	8.49[b]
37.5	1.47[a]	8.67[b]	8.42[b]
Mean	**1.48**	**9.09**	**8.80**
LSD	0.19	0.65	0.50
Variety			
Wedgetail	1.37[b]	8.40[b]	8.08[b]
Bolac	1.65[a]	9.88[a]	9.32[a]
Lancer	1.24[b]	8.20[b]	8.59[b]
Trojan	1.68[a]	9.85[a]	9.21[a]
LSD	0.217	0.747	0.582

Figures followed by different letters are regarded as statistically significant.

* Actual growth stages at tiller assessment to account for varietal differences: Bolac GS31, Wedgetail GS30, Trojan GS32, Lancer GS31.

^ Actual growth stages at GS61 assessment to account for varietal differences: Trojan GS65, Bolac, GS59 Lancer GS61, Wedgetail GS55.

TABLE 8 Nitrogen uptake in biomass 8 July 2015, first node* (GS31), 23 September 2015, targeted start of flowering^ (GS61) and 16 November 2015, harvest (GS99)

Row spacing (cm)	Nitrogen uptake in biomass (kg N/ha)		
	GS30–32	GS59–65	GS99
22.5	56[a]	114[a]	91[a]
30	54[a]	113[a]	87[a]
37.5	55[a]	114[a]	82[a]
Mean	**55**	**114**	**87**
LSD	7	14	36
Variety			
Wedgetail	51[b]	118[a]	75[a]
Bolac	61[a]	119[a]	87[a]
Lancer	50[b]	106[a]	95[a]
Trojan	59[a]	111[a]	89[a]
LSD	8	16	22

Figures followed by different letters are regarded as statistically significant.

* Actual growth stages at tiller assessment to account for varietal differences: Bolac GS31, Wedgetail GS30, Trojan GS32, Lancer GS31.

^ Actual growth stages at GS61 assessment to account for varietal differences: Trojan GS65, Bolac GS59, Lancer GS61, Wedgetail GS55.

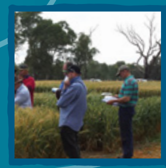

TABLE 9 Yield, protein, test weight and screenings at 24 November 2015 harvest (GS99)

Row spacing (cm)	Yield and quality			
	Yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
22.5	3.33[a]	13.0[a]	75.7[a]	19.3[a]
30	3.22[a]	13.3[a]	75.7[a]	19.2[a]
37.5	3.25[a]	13.7[a]	75.4[a]	20.5[a]
Mean	**3.27**	**13.3**	**75.6**	**19.7**
LSD	0.31	1.1	1.6	9.1
Variety				
Wedgetail	3.23[a]	13.8[a]	74.3[b]	17.7[b]
Bolac	3.32[a]	13.3[a]	74.3[b]	30.9[a]
Lancer	3.28[a]	13.5[a]	78.0[a]	10.5[b]
Trojan	3.25[a]	12.7[a]	75.8[b]	19.5[b]
LSD	0.36	1.3	1.9	10.5

Figures followed by different letters are regarded as statistically significant.

There were no varietal differences in yield or protein, however Bolac had significantly higher screenings (30%) than the other varieties.

The sharp end to the season at this site may have prevented the higher harvest DM in the narrow-row-spaced crop from finishing during the grain fill period, which is supported by lower harvest index (Table 10).

iv) Water use efficiency calculations

There were no significant differences in WUE although there was a trend for wide rows to be more efficient than narrow row spacing in terms of water passing through the plant (transpiration efficiency — TE). However more water was calculated to have been lost or left unused in wider rows as the overall WUE was similar at the three row spacing (Table 10).

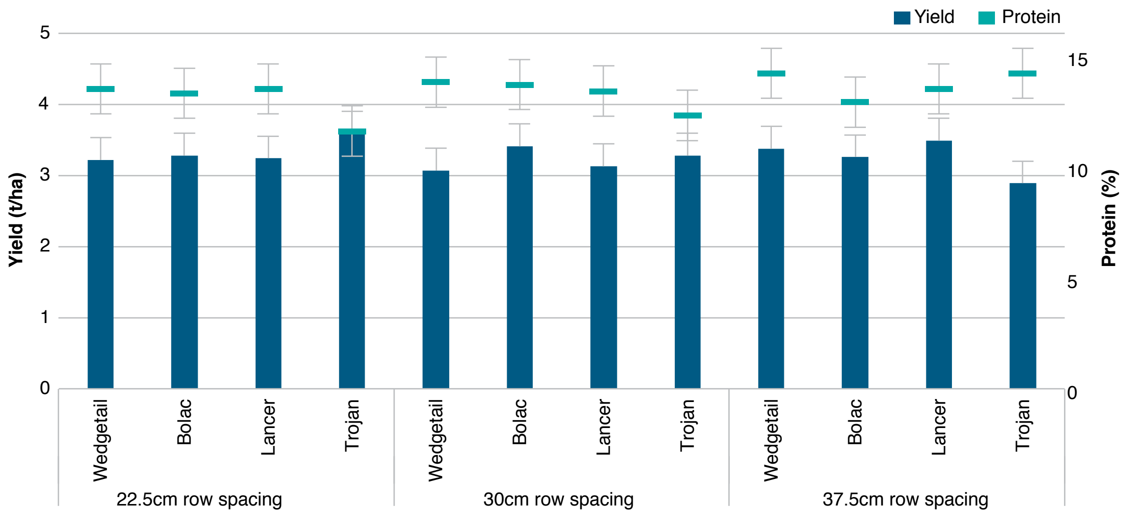

FIGURE 5 Influence of row spacing and cultivar on yield and protein
Error bars are a measure of LSD

TABLE 10 Average biomass at harvest, yield (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	9.49	2.92	30.8	9.5	172.5	135.3	17.0
30.0	8.49	2.82	33.2	9.2	154.4	153.5	18.3
37.5	8.42	2.85	34.2	9.3	153.1	154.8	18.8
Mean	**8.80**	**2.86**	**32.8**	**9.3**	**160.0**	**147.9**	**18.0**
LSD	0.50	0.27	3.0	0.9	9.1	9.1	1.6

GSR (April–October) 266mm plus calculated soil water available on April 1 42mm — total 308mm

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. water transpired through the plant.

v) Results from two years of trials at Yarrawonga

The early-sown row spacing trial (mid-April) at Yarrawonga has now run for two years in the same rotation position after canola, in different paddocks. In both 2014 and 2015 the narrow-row-spaced crops produced more DM, however there have been no differences in grain yield in either year (Figure 6). This result is the same as that seen at the Barooga, NSW trial.

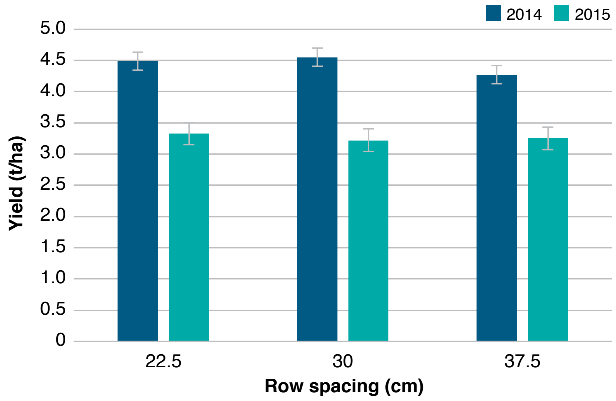

FIGURE 6 Influence of row spacing on grain yield in early-sown first wheat (average of four varieties) in 2014 and 2015, Yarrawonga, Victoria

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 narrow row spacing produced more DM, which led to more yield. This indicates that row spacing is less important in determining wheat yield when crops are sown early, compared with crops sown later.

Acknowledgements

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