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

Nick Poole and Michael Straight
FAR Australia in conjunction with Riverine Plains Inc

Key points

- Two trials with first wheat sown during mid-April 2014 showed no difference in grain yield or quality as a result of being grown on 22.5cm or 30cm row spacings.
- Crops grown on a 37.5cm row spacing were 5–6% lower yielding than crops on the 30cm spacing.
- Although these are single-year results, they indicate the yield advantages of a narrow spacing (22.5cm) over 30cm, measured with later-sown wheat crops, may not be apparent when wheat crops are sown early (during mid-April).
- Trends suggesting higher dry matter (DM) production with a narrow row spacing, which were observed with later-sown crops, were still apparent in these earlier-sown crops, however this did not translate to higher grain yields.

Previous row spacing findings

Results from the Riverine Plains Inc *Water Use Efficiency (WUE)* project demonstrated that wheat grown on a narrow row spacing of 22.5cm was higher yielding than crops grown on wider rows (30–37.5cm). This difference in yield was correlated to lower dry matter (DM) production on wider rows, partly due to late canopy closure, with less sunlight interception compared with crops sown on narrower rows, which generate full ground cover earlier in the season.

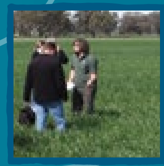
All of the previous WUE project trials (2009–13) were sown in the mid May–early June sowing window, prompting the question; "would wider rows be more successful if wheat crops were sown earlier?" Earlier sowing would result in earlier canopy closure for all row spacings, which may influence the relative differences in DM production and final grain yield.

Method

To answer the question of the influence of early sowing on wheat row spacing, two trials were set up under the Riverine Plains Inc stubble project: *Maintaining profitable farming systems with retained stubble in the Riverine Plains region* (2013–18). The two trials, one in Barooga, NSW and the other in Yarrawonga, Victoria, were sown 16 April 2014 and 17 April 2014; this is four to six weeks earlier than the previous WUE project trials.

Four varieties, Wedgetail (winter wheat), Eaglehawk, Lancer and Bolac (longer-season spring wheats) were sown at identical sowing rates per unit area at three row spacings: 22.5cm, 30cm and 37.5cm. The trial was established as a split plot design with row spacing as the main plot and variety as the sub plot, and replicated four times. Monoammonium phosphate (MAP) was applied at 70kg/ha at sowing with all subsequent management being the same across the trials in line with the host farmer's paddock management.





Trial 1: Barooga, NSW

Sowing date: 16 April 2014
Rotation: First wheat after canola
Varieties: Bolac, Eaglehawk, Lancer and Wedgetail
Stubble: Canola, unburnt
Rainfall:
GSR: 348mm (April–October)
Summer rainfall: 84mm
Soil mineral nitrogen: 73kg N/ha (0–60cm)

Results

i) Establishment and crop structure

The widest row spacing (37.5cm) had significantly lower plant establishment and tiller numbers in comparison to the 22.5cm and 30cm row spacings (Table 1). At harvest there was no significant difference in head numbers.

There were significant differences in establishment, tiller numbers and final head counts as a result of varietal selection, with Bolac and Wedgetail producing significantly more heads than Lancer and Eaglehawk (Table 1). The advantage in the number of heads produced can be related to higher plant populations established and tiller numbers.

TABLE 1 Plant counts 13 May 2014, three leaves unfolded (GS13), tiller counts 28 July 2014, targeted first node* (GS31–32) and head counts 18 November 2014, harvest (GS99)

Row spacing (cm)	Crop structure (m²)		
	Plants	Tillers*	Heads
22.5	130^{a}	421^{a}	349^{a}
30	130^{a}	410^{a}	325^{a}
37.5	117^{b}	351^{b}	324^{a}
Mean	**126**	**394**	**333**
LSD	12	33	32
Variety			
Bolac	138^{a}	411^{b}	376^{a}
Eaglehawk	118^{b}	338^{c}	284^{b}
Lancer	106^{c}	343^{c}	313^{b}
Wedgetail	142^{a}	485^{a}	358^{a}
LSD	12	46	39

* Actual growth stages at tillering assessment to account for varietal development differences; Wedgetail GS31, Eaglehawk, Lancer and Bolac GS32.

ii) Dry matter production and nitrogen uptake

There was a trend for narrower row spacing to produce a greater amount of DM than wider rows, however only at first node (GS31) was the difference statistically significant (Table 2). At GS31, the 37.5cm row spacing produced significantly less DM than the 30cm spacing. The lower harvest head numbers recorded with Lancer and Eaglehawk were reflected in lower final harvest DM weights compared with Wedgetail and Bolac (Table 2). However, differences in DM production at GS31 did not translate to significant differences in nitrogen uptake at that time (Table 3).

TABLE 2 Dry matter 28 July 2014, first node* (GS31), 30 September, targeted start of flowering* (GS61–65) and 18 November 2014, harvest (GS99)

Row spacing (cm)	Dry matter (t/ha)		
	GS31	(GS61–65)*	GS99
22.5	2.9^{ab}	9.1^{a}	10.3^{a}
30.0	3.1^{a}	8.6^{a}	9.7^{ab}
37.5	2.7^{b}	8.4^{a}	9.6^{b}
Mean	**2.9**	**8.7**	**9.9**
LSD	0.3	1.1	0.6
Variety			
Bolac	3.2^{ab}	9.3^{a}	10.2^{ab}
Eaglehawk	2.5^{b}	8.2^{b}	9.1^{c}
Lancer	2.7^{ab}	8.6^{ab}	9.5^{bc}
Wedgetail	3.2^{a}	8.7^{ab}	10.6^{a}
LSD	0.6	0.9	0.9

* Actual growth stages GS61 assessment Eaglehawk GS61, Lancer and Bolac GS65, Wedgetail GS63

TABLE 3 Nitrogen uptake in biomass 28 July 2014, first node (GS31), 30 September 2014, start of flowering (GS61) and 18 November 2014, harvest (GS99)

Row spacing (cm)	Nitrogen uptake in biomass (kg N/ha)		
	GS31	GS61	GS99
22.5	60^{a}	92^{a}	101^{a}
30.0	68^{a}	89^{a}	84^{a}
37.5	62^{a}	91^{a}	90^{a}
Mean	**63**	**91**	**92**
LSD	9	18	25
Variety			
Bolac	60^{a}	89^{b}	95^{ab}
Eaglehawk	66^{a}	85^{b}	81^{b}
Lancer	57^{a}	82^{b}	86^{ab}
Wedgetail	71^{a}	107^{a}	105^{a}
LSD	14	13	24

TABLE 4 Yield, protein, screenings and test weight at harvest (GS99), 27 November 2014

Row spacing (cm)	Yield and quality			
	Yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)
22.5	3.85[ab]	11.8[a]	2.8[a]	77.5[a]
30.0	3.98[a]	11.9[a]	2.7[a]	78.9[a]
37.5	3.78[b]	11.8[a]	2.6[a]	79.2[a]
Mean	**3.87**	**11.9**	**2.7**	**78.5**
LSD	0.19	0.7	0.2	1.8
Variety				
Bolac	4.14[a]	11.2[b]	3.4[a]	79.9[a]
Eaglehawk	3.27[b]	12.4[a]	3.2[a]	78.5[a]
Lancer	4.02[a]	12.0[a]	2.2[b]	80.2[a]
Wedgetail	4.05[a]	11.9[a]	2.0[b]	75.5[b]
LSD	0.17	0.6	0.4	2.0

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	10.32	3.37	33.0	9.8	187.7	156.8	18.1
30.0	9.71	3.49	36.4	10.1	176.6	167.9	20.0
37.5	9.60	3.31	34.6	9.6	174.5	170.0	19.0
Mean	**9.88**	**3.39**	**34.7**	**9.8**	**179.6**	**164.9**	**19.1**
LSD	0.64	0.17	2.8	0.5	11.6	11.6	1.5

GSR (April–October) 315.1mm plus calculated soil water available on 1 April (29.4mm) — total 344.5mm

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 for 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.

iii) Grain yield and quality

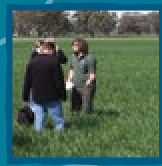
The optimum row spacing in terms of grain yield was 30cm, which was significantly higher yielding than crops sown on the 37.5cm spacing. There was no significant difference in yield between the 22.5cm and 30cm spacings. There were also no significant effects of row spacing on grain quality parameters of protein, screenings and test weight (Table 4).

In terms of variety performance, Eaglehawk yielded significantly less than the other varieties. Bolac had the lowest protein levels, and Wedgetail had the lowest test weight.

iv) Water use efficiency calculations

There were no significant differences in WUE due to row spacing (Table 5). Significantly higher DM production with crops grown on the narrow row spacing (22.5cm) did not translate to higher yields compared with those on the wider row spacings, resulting in a lower harvest index (HI). Although crops grown on the wider row spacings appeared to result in more efficient grain production per millimetre of water transpired through the plant (TE), this effect was negated by calculations indicating greater water losses though soil evaporation or unused water in crops on the wider rows.





Trial 2: Yarrawonga, Victoria

Sowing date: 17 April 2014
Rotation: First wheat after canola
Variety: Bolac, Eaglehawk, Lancer and Wedgetail
Stubble: Canola unburnt
Rainfall:
GSR: 372.8mm (April–October)
Summer rainfall: 113.6mm
Soil mineral nitrogen: 48kg N/ha (0–60cm)

Results

i) Establishment and crop structure

There were small but significant differences in crop establishment at different row spacings, with established plant populations varying from 101–113 plants/m^2 (Table 6). The narrow row spacing (22.5cm) produced significantly more tillers per unit area than wider row spacings. Trends in variety crop structure were similar to Trial 1 at Barooga, NSW, with Bolac and Wedgetail producing significantly higher plant populations, tillers and heads than Lancer and Eaglehawk (Table 6).

ii) Dry matter production and nitrogen uptake

The 22.5cm row spacing produced significantly more DM at the flowering and harvest assessments than crops sown on the 30cm and 37.5cm spacings (Table 7). Comparison of varieties revealed significantly less harvest DM with Lancer than the three other varieties. There was an indication that the significantly higher DM production measured with the narrow row spacing was associated with higher nitrogen uptake, although it was only significant at mid-flowering (Table 8). There were no differences in nitrogen uptake between varieties.

TABLE 6 Plant counts 13 May 2014, three leaves unfolded (GS13), tiller counts 26 August 2014, third node–flag leaf emergence (GS33–GS39) and head counts 25 November 2014, harvest (GS99)

	Crop structure (m^2)		
Row spacing (cm)	**Plants**	**Tillers***	**Heads**
22.5	101^{b}	359^{a}	359^{a}
30.0	113^{a}	319^{b}	321^{a}
37.5	106^{b}	288^{c}	318^{a}
Mean	**107**	**322**	**333**
LSD	5	19	24
Variety			
Bolac	110^{a}	337^{b}	352^{a}
Eaglehawk	95^{b}	299^{c}	306^{b}
Lancer	107^{ab}	281^{c}	301^{b}
Wedgetail	115^{a}	370^{a}	373^{a}
LSD	15	26	32

* Actual growth stages at the tillering assessment were; Bolac, Lancer GS39, Wedgetail, Eaglehawk GS33.

TABLE 7 Dry matter 4 August 2014, first node* (GS31–32), 2 October 2014, mid-flowering* (GS65–69) and 25 November 2014, harvest (GS99)

	Dry matter (t/ha)		
Row spacing (cm)	**GS31–32***	**GS65–69***	**GS99**
22.5	3.1^{a}	10.0^{a}	11.6^{a}
30.0	3.1^{a}	9.2^{b}	10.3^{b}
37.5	3.0^{a}	8.5^{b}	10.1^{b}
Mean	**3.1**	**9.2**	**10.7**
LSD	0.4	0.9	0.8
Variety			
Bolac	3.5^{a}	9.9^{a}	10.7^{ab}
Eaglehawk	2.8^{b}	9.1^{ab}	11.0^{a}
Lancer	2.9^{b}	8.7^{b}	10.1^{b}
Wedgetail	3.2^{ab}	9.3^{ab}	10.9^{a}
LSD	0.4	1.1	0.7

* Actual growth stages at GS31 assessment were; Bolac GS32, Wedgetail GS31, Eaglehawk GS32, Lancer GS32. Actual growth stages at GS65 assessment; Bolac GS69, Wedgetail GS65, Eaglehawk GS65, Lancer GS69.

TABLE 8 Nitrogen uptake in biomass 4 August 2014, first node–third node (GS31–GS33), 2 October 2014, mid-flowering (GS65) and 25 November 2014, harvest (GS99)

	Nitrogen uptake in biomass (kg N/ha)		
Row spacing (cm)	**GS31**	**GS65**	**GS99**
22.5	90^{a}	141^{a}	121^{a}
30.0	91^{a}	110^{b}	100^{b}
37.5	86^{a}	114^{b}	106^{ab}
Mean	**89**	**122**	**109**
LSD	10	24	18
Variety			
Bolac	98^{a}	122^{ab}	101^{a}
Eaglehawk	86^{b}	119^{b}	112^{a}
Lancer	81^{b}	113^{b}	105^{a}
Wedgetail	90^{ab}	134^{a}	119^{a}
LSD	12	15	22

iii) Grain yield and quality

Row spacing had no significant effect on grain yield, although the trends are identical to Trial 1 at Barooga, NSW with crops grown on the 30cm row spacing producing the optimum yield and crops sown on the 37.5cm spacing producing a lower yield than both the 22.5cm and 30cm spacings (Table 9). There were no effects of row spacing on grain quality measurements of protein, screenings and test weight. At this trial site Wedgetail and Lancer were significantly higher yielding than Bolac and Eaglehawk.

iv) Water use efficiency calculations

When comparing WUE, the significantly higher biomass produced on the narrow row spacing (22.5cm) led to significantly more water being used by the crop (calculated transpiration use) than on the wider row spacings (Table 10). The higher DM of crops grown on the narrow row spacing did not translate into higher grain yields, resulting in significantly lower harvest index (HI) and lower transpiration efficiency (TE). Despite the advantages of the wider row spacings in terms of HI and calculated TE there were no significant differences in calculated WUE due to row spacing since wider rows were calculated to have lost significantly more water through soil evaporation (and or other unused water).

TABLE 9 Yield, protein, screenings and test weight at harvest (GS99), 27 November 2014

	Yield and quality			
Row spacing (cm)	Yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)
22.5	4.49[a]	12.1[a]	6.81[a]	74.6[a]
30.0	4.55[a]	12.2[a]	6.96[a]	75.9[a]
37.5	4.27[a]	12.4[a]	7.09[a]	75.9[a]
Mean	**4.44**	**12.2**	**0.07**	**75.5**
LSD	0.29	0.3	0.02	2.4
Variety				
Bolac	4.01[b]	12.4[a]	11.46[a]	72.6[c]
Eaglehawk	4.22[b]	12.1[a]	10.79[a]	76.4[b]
Lancer	4.73[a]	12.4[a]	2.61[b]	79.5[a]
Wedgetail	4.79[a]	12.2[a]	2.96[b]	73.3[c]
LSD	0.28	0.3	0.02	2.3

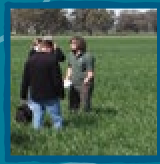
TABLE 10 Average biomass at harvest, yield (0% moisture), harvest index (HI), calculated water use efficiency (WUE), calculated transpiration, calculated evaporation/drainage and transpiration efficiency (TE)

Row spacing (cm)	Biomass[1] (kg/ha)	Yield[1] (t/ha)	HI[2] (%)	WUE[3] (kg/mm)	Transpiration[4] (mm)	Evaporation[5] (mm)	TE[6] (kg/mm)
22.5	11.64	3.93	34.2	10.9	211.7	148.1	18.8
30.0	10.28	3.98	38.9	11.1	186.9	172.8	21.4
37.5	10.14	3.73	37.0	10.4	184.3	175.5	20.4
Mean	**10.69**	**3.88**	**36.7**	**10.8**	**194.3**	**165.5**	**20.2**
LSD	0.536	0.50	0.7	0.7	4.6	4.6	0.0

GSR (April–October) 320.1mm plus calculated soil water available on 1 April (39.7mm) — total 359.8mm

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.





Commercial application

As these are only one-year results, exercise caution when interpreting these findings on farm. However since both trial sites gave similar yield results the indications are that when sowing wheat in the early window of mid-April the yield advantage of crops grown on a narrow (22.5cm) row spacing over a wide (30cm) row spacing has not been observed. These results are contrary to previous findings in the WUE project, whereby wheat crops were sown later in the main season window of mid-May to early June.

Acknowledgments

The trial was carried out as part of the Riverine Plains Inc GRDC-funded project *Maintaining profitable farming systems with retained stubble in the Riverine Plains region*.

Thanks go to the farmer co-operators, J and S Bruce Barooga, NSW and Telewonga Pty Ltd, Yarrawonga, Victoria.

CONTACT

Nick Poole
FAR Australia
E: poolen@far.org.nz