Managing crop growth and water use

This trial is funded by the GRDC and conducted in collaboration with Chris Lawson and Victor Sadras, SARDI, and Glenn McDonald from the University of Adelaide.

Key findings

- Wheat dry matter production and total crop nitrogen was significantly lower in wider row spacing treatments.
- For the all the crops grain yield was significantly lower in the wider row spacing treatments.
- Treatments imposed to manipulate crop growth were unable to save more soil moisture for grain fill.

Why do the trial?

Throughout southern Australia many trials have recently focussed on improving the retention of summer rainfall and have clearly shown that effective and early summer weed control can increase the retention of stored soil moisture. Previous research conducted at the Hart field site in 2009 and 2010 showed that soil cover i.e stubble, provided limited additional benefit.

The research also showed that additional stored moisture was more likely to be used early in the season to increase crop growth, rather than contributing towards grain fill.

The above average rainfall and cool summer conditions of 2010 and 2011 built up a significant amount of stored soil moisture (40 to 60mm in many areas). This trial aimed to manage the crop canopy and conserve the stored soil moisture so that it might be saved for grain-fill, rather than being used to create early crop growth.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	All treatments received 10 kg/ha phosphorus
Seeding date	20th May 2011	**Varieties**	Gladius wheat @ 100 kg/ha Hyperno durum @ 100 kg/ha Buloke barley @ 100 kg/ha

The trial was a randomised block design with 9 treatments and 3 replicates (Table 1). The seeding equipment used was a knife-point press wheel system on 22.5cm (9”) row spacings. The wider row treatments were 45cm (18”) row spacings and for the straw treatments 6 t/ha was spread evenly over the plots immediately after sowing. This straw layer provided about 95% soil cover.

Table 1. Treatments and nitrogen fertiliser rates and timings for managing crop growth and water use at Hart in 2011.

Treatment	Nitrogen fertiliser (kg N/ha) timing			
	Sowing	2nd August (GS31)	5th September (GS39)	Total
Conventional crop	32	42	0	74
Reduced seed rate (50 kg/ha)	32	42	0	74
Slashed at GS30	32	42	0	74
Wide row (450mm)	9	42	23	74
Wide row (450mm) + 6 t/ha straw	9	42	23	74
Growth regulant at GS30	32	42	0	74
Delayed nitrogen	9	42	23	74
6 t/ha straw	32	42	0	74
High rate delayed nitrogen	9	42	74	125

42 kg N/ha was applied to all treatments at 1st node (GS31) and at full flag leaf emergence (GS39) nitrogen was added to the wider row spacing and delayed nitrogen treatments.

1 L/ha of chlormequat plant growth regulator was applied at the beginning of stem elongation (GS30) and the slashing plots were cut down to 10cm of height on the same day.

Dry matter cuts (2m of crop row) were conducted at flowering and unreplicated leaf samples were also collected. Gravimetric soil samples were collected on the 27th September, coinciding with flowering for the wheat and durum.

Plant counts and head counts were conducted during the season and all plots were assessed for grain yield, protein, wheat screenings with a 2.0 mm screen and barley screenings with a 2.2 mm screen and retention with a 2.5mm screen.

Pre-sowing plant available soil moisture was 70mm and soil nitrogen to 60cm was 82 kg N/ha

Results

Crop establishment was significantly lower for the wider row spacing treatments for all the crops, averaging 52 plants per square metre, compared to 132 for the other treatments (Table 1). The 6 t/ha layer of straw significantly reduced the barley crop emergence, down to 76 plants per square metre.

However, by early grain fill there was no difference in the number of heads per square metre in the barley (Table 1). Both the wheat and durum plots had lower head numbers in the wider row spacing and reduced seed rate treatments. While for the durum, delaying nitrogen application or slashing at stem elongation also reduced the number of heads produced.

Table 1. Crop establishment measured as plants per square metre and resultant heads per square metre for canopy management treatments at Hart in 2011.

Treatment	Plants per square metre			Heads per square metre		
	Wheat	Durum	Barley	Wheat	Durum	Barley
Conventional crop	131	151	110	295	286	572
Reduced seed rate (half 50 kg/ha)	87	99	56	296	236	578
Slashed at GS30	159	159	112	310	239	603
Wide row (450mm)	59	54	49	233	182	434
Wide row (450mm) + 6 t/ha straw	51	63	36	246	201	439
Growth regulant at GS30	130	148	104	354	298	501
Delayed nitrogen	130	156	102	302	253	453
6 t/ha straw	114	146	76	375	234	541
High rate delayed nitrogen	141	153	96	341	276	519
LSD (0.05)	21	29	23	64	71	ns

Wheat dry matter production and total crop nitrogen content was significantly lower for the wider row spacing treatments (Table 2). Plant and head numbers per square metre were also lower for these treatments. However, at flowering in the barley there was no difference in dry matter production or crop nitrogen content. There was no significant difference between the treatments in wheat or barley for total crop nitrogen concentration (not displayed).

Although the measurement of leaf boron concentration was not replicated (Table 2) it clearly shows for the wider rows and the addition of straw treatments producing lower boron concentrations, for wheat and barley. This was visually evident, resulting in greener canopies for these treatments. In the barley the wider row treatment with a layer of straw produced the lowest leaf boron concentration.

Table 2. Crop growth measured as dry matter production (t/ha), total crop nitrogen content (kg N/ha) and leaf boron concentration (ppm) at flowering for wheat and barley and canopy management treatments at Hart in 2011.

Treatment	Wheat			Barley		
	Dry matter (t/ha)	Nitrogen (kg N/ha)	Boron (ppm)	Dry matter (t/ha)	Nitrogen (kg N/ha)	Boron (ppm)
Conventional crop	7.7	91.9	32	10.4	159.4	59
Reduced seed rate (half 50 kg/ha)	7.8	109.3	27	11.1	151.3	67
Wide row (450mm)	6.0	82.9	23	10.5	141.4	61
Wide row (450mm) + 6 t/ha straw	5.7	82.0	18	10.3	164.9	38
Growth regulant at GS30	8.0	117.0	29	11.7	176.9	71
6 t/ha straw	8.8	120.1	22	8.6	147.2	63
LSD (0.05)	1.8	28.2	1 rep only	ns	ns	1 rep only

For all the crops grain yield was significantly lower in the wider row spacing treatments (3.14 t/ha) compared to the other treatments (3.49 t/ha) (Table 3). In the barley there was no significant difference between the remaining treatments, but for the wheat and durum the reduced seed rate and slashing treatments also significantly reduced grain yield. For all the crops applying a growth regulant at stem elongation, delaying nitrogen, applying 6 t/ha straw on 22.5cm row spacings or growing a conventional crop all produced statistically similar grain yields.

Grain protein in the durum and barley was significantly higher where grain yields were low, straw had been added to 22.5cm row spacings or the higher rate of nitrogen was applied. There was no significant difference between the treatments for the wheat protein. There was no significant difference between crops or treatments for screenings, retention or test weights (not displayed).

Table 3. Grain yield (t/ha) and protein (%) for wheat, durum and barley and canopy management treatments at Hart in 2011.

Treatment	Grain yield (t/ha)			Protein (%)		
	Wheat	Durum	Barley	Wheat	Durum	Barley
Conventional crop	3.66	3.18	3.87	11.0	11.3	10.3
Reduced seed rate (half 50 kg/ha)	3.32	2.94	3.66	11.7	11.9	11.0
Slashed at GS30	3.14	2.94	3.54	11.7	11.6	10.7
Wide row (450mm)	3.28	2.83	3.40	11.4	12.1	11.4
Wide row (450mm) + 6 t/ha straw	3.14	2.92	3.29	12.0	12.3	11.9
Growth regulant at GS30	3.89	3.26	3.75	11.1	11.3	11.4
Delayed nitrogen	3.64	3.35	3.77	11.4	10.6	11.0
6 t/ha straw	3.79	3.19	3.45	10.7	11.8	11.3
High rate delayed nitrogen	4.13	3.28	3.52	11.7	11.7	11.4
LSD (0.05)	0.53	0.22	0.37	ns	0.68	0.52

The wider rows and wider rows with 6 t/ha straw treatments produced significantly higher grain weight (51.5 mg) for the barley (Table 4). Grain weight was not significantly different between any of the treatments in the wheat (37.1 mg) and durum (35.8 mg).

For all the crops the number of grains produced per square metre was significantly lower in the wider row spacing and reduced seed rate treatments (Table 4). These treatments averaged 7840 grains per square metre while the other treatments averaged 8980 grains per square metre, 15% more. In the wheat slashing at stem elongation also significantly reduced grain number.

Table 4. Grain weight (mg/grain) and grains per square metre produced for all crops and treatments at Hart in 2011.

Treatment	Grain weight (mg/grain)			Grains per square metre		
	Wheat	Durum	Barley	Wheat	Durum	Barley
Conventional crop	38.0	35.1	46.1	9657	9062	8396
Reduced seed rate (half 50 kg/ha)	37.4	34.7	47.1	8847	8486	7780
Slashed at GS30	35.1	34.3	43.7	8934	8948	8119
Wide row (450mm)	36.8	35.7	48.3	8417	7928	6646
Wide row (450mm) + 6 t/ha straw	38.6	36.7	51.5	8144	7964	6355
Growth regulant at GS30	37.5	35.9	44.6	10395	9094	8405
Delayed nitrogen	37.1	36.7	46.7	9905	9152	8076
6 t/ha straw	38.5	35.8	46.1	9840	8895	7889
High rate delayed nitrogen	34.7	37.4	45.1	11069	8782	6984
LSD (0.05)	ns	ns	2.4	1304	540	592

In the barley soil moisture measurements at flowering showed only very small differences between the treatments (Table 5). The total moisture content down to 90cm ranged from 108.5 mm (reduced seed rate) to 123.9 mm (6 t/ha straw) across the treatments, a difference of only 15mm. This difference was significant in the 50-70cm and 70-90cm soil layers. The two treatments with 6 t/ha straw had significantly higher soil moisture at both depths.

In the wheat there was less than 10mm difference between the treatments for the 90cm total core, which was not significant.

Table 5. Total soil moisture for increments down to 90cm and total moisture content at anthesis in barley for canopy management treatments at Hart in 2011.

Treatment	Total soil moisture (mm)				
	0-20cm	20-50cm	50-70cm	70-90cm	Total
Conventional crop	21.2	32.8	25.4	32.6	112.0
Reduced seed rate (half 50 kg/ha)	19.1	30.0	25.2	34.2	108.5
Wide row (450mm)	20.2	34.6	29.0	32.2	116.0
Wide row (450mm) + 6 t/ha straw	20.8	32.9	28.6	35.8	118.1
6 t/ha straw	19.7	34.9	33.7	35.6	123.9
LSD (0.05)	ns	ns	2.8	3.1	

The wet 2011 summer provided an opportunity to reduce early crop growth and aim to conserve moisture for grain fill. None of the treatments used to manipulate the crop canopy positively influenced crop growth or grain yield. This was supported by little difference in soil moisture remaining at flowering.

The dry and warm period in August and September meant that crops with a lower number of grains set per square metre had a limited grain yield potential. Although the treatments with straw visually stayed greener for longer and had lower levels of boron, they were unable to produce extra grain yield. Possibly they produced too few grains per square metre, weren't encouraged to develop a deep enough root system or all the treatments were limited by the high boron subsoil.

This is particularly relevant given that the addition of a straw layer produced significant grain yield increases at other sites in 2011.

Effect of straw keeping crop greener

Allergic to bees??

Canopy management; wide v conventional

WUE – Condowie site

WUE – Saddleworth site