Improving water use efficiency – reducing soil evaporation

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

- The addition of a straw layer acted to reduce evaporation and significantly increased grain yields and water use efficiency in 2010 and 2011 at 3 field sites.
- Soil evaporation also decreased with increasing light interception from larger crop canopies.

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 increases stored soil moisture. Soil cover i.e stubble, throughout the summer period was shown to provide limited additional benefit.

This trial aimed to use a thick layer of cereal straw maintained within the growing season to focus on reducing the amount of moisture lost to soil evaporation. The trials were conducted on the previously established sites used in the previous improving water use efficiency article.

How was it done?

Plot size 8m x 10m

Seeding date
Hart 30th May 2011
Condowie 21st May
Spalding 19th May
Saddleworth 16th June

Fertiliser

Hart	DAP@50 kg/ha+2% Zn
Condowie	DAP@40 kg/ha+2% Zn
Spalding	32:10 (DAP/Urea) @ 150 kg/ha
Saddleworth	DAP@90 kg/ha+2% Zn

Post emergent nitrogen

Hart	UAN @ 70 L/ha 29th July 2011
Saddleworth	Urea @ 100 kg/ha 2nd August 2011

Each trial was a randomised complete block design with 3 replicates using Gladius wheat at Hart, Condowie and Saddleworth and Pugsley wheat at Spalding.

The trials were sown with 50mm chisel points and press wheels on 225mm (9”) row spacing.

6 tonnes/ha of oaten straw was spread evenly over the plots immediately after sowing. This straw layer provided about 95% soil cover.

50 kg N/ha was spread on the 23rd July. Dry matter cuts were taken at flowering.
Measurements of gravimetric soil water content and light interception were taken to calculate soil evaporation through the growing season.

All cereal grain 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.

Results

In 2010, the addition of straw increased wheat grain yields by 5, 7 and 14% at Spalding, Saddleworth and Condowie respectively. In 2011 these values were 8, 19, 26 and 11% at Spalding, Saddleworth, Condowie and Hart respectively. Condowie produced the largest increase in grain yield from 1.91 t/ha to 2.40 t/ha, while Spalding had the lowest increase (Figure 1). The ranking of these sites was consistent between 2010 and 2011. The addition of extra nitrogen increased grain yield significantly at Condowie and Hart.

Figure 1. The influence of straw or straw and extra nitrogen on wheat grain yields at Hart, Condowie, Saddleworth and Spalding in 2011. (LSD's (0.05) for grain yield were 0.16, 0.32, 0.93 and 0.43 for Condowie, Hart, Saddleworth and Spalding, respectively).

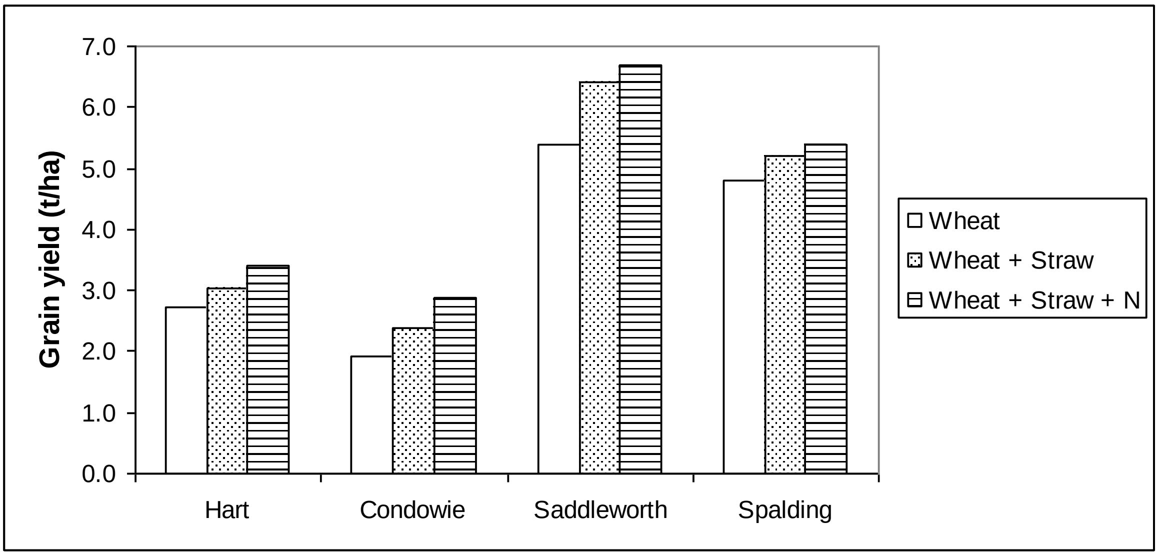
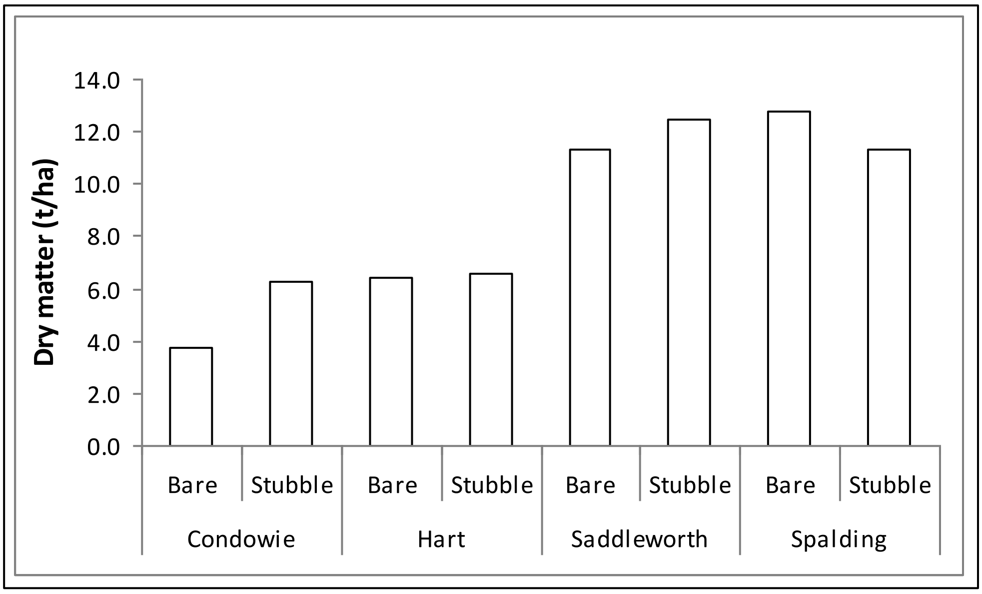


Table 1. Wheat grain quality measurements for straw and nitrogen treatments applied at Condowie, Hart, Saddleworth and Spalding in 2011.

Site	Treatment	Grain yield (t/ha)	Protein (%)	Test wt (kg/hL)	Screenings (%)	WUE
	Wheat	1.91	12.6	73.2	2.1	12.6
Condowie	Wheat + Straw	2.40	12.6	74.0	2.1	15.8
	Wheat + Straw + N	2.87	13.2	72.7	2.4	18.9
LSD (0.05)		0.16	0.5	2.3	ns	na
	Wheat	2.74	12.5	70.4	1.7	18.0
Hart	Wheat + Straw	3.05	12.7	71.0	2.0	20.1
	Wheat + Straw + N	3.41	13.5	70.9	2.5	22.4
LSD (0.05)		0.32	0.6	1.9	0.4	na
	Wheat	5.38	11.0	80.8	0.9	26.6
Saddleworth	Wheat + Straw	6.35	11.5	76.9	1.3	35.2
	Wheat + Straw + N	6.69	12.1	75.8	1.6	36.8
LSD (0.05)		0.93	1.0	1.9	0.6	na
	Wheat	4.84	12.9	78.3	1.1	23.9
Spalding	Wheat + Straw	5.20	12.0	77.8	1.1	23.1
	Wheat + Straw + N	5.43	13.2	77.8	2.0	24.0
LSD (0.05)		0.43	ns	1.3	ns	na

Generally the application of extra nitrogen had a smaller effect on grain yield compared to the addition of straw, but it significantly increased grain protein at Condowie and Hart by an average of 0.7% (Table 1).

Figure 2. The biomass production (kg/ha) at anthesis at each site for wheat with and without 6t/ha straw in 2011.



The addition of straw immediately after seeding reduced the plant emergence of these treatments by about 20%. However, apart from Spalding the other sites produced greater biomass where straw had been added (Figure 2). This increase was greatest at Condowie and Saddleworth, which is also similar to the greatest increases in grain yield.

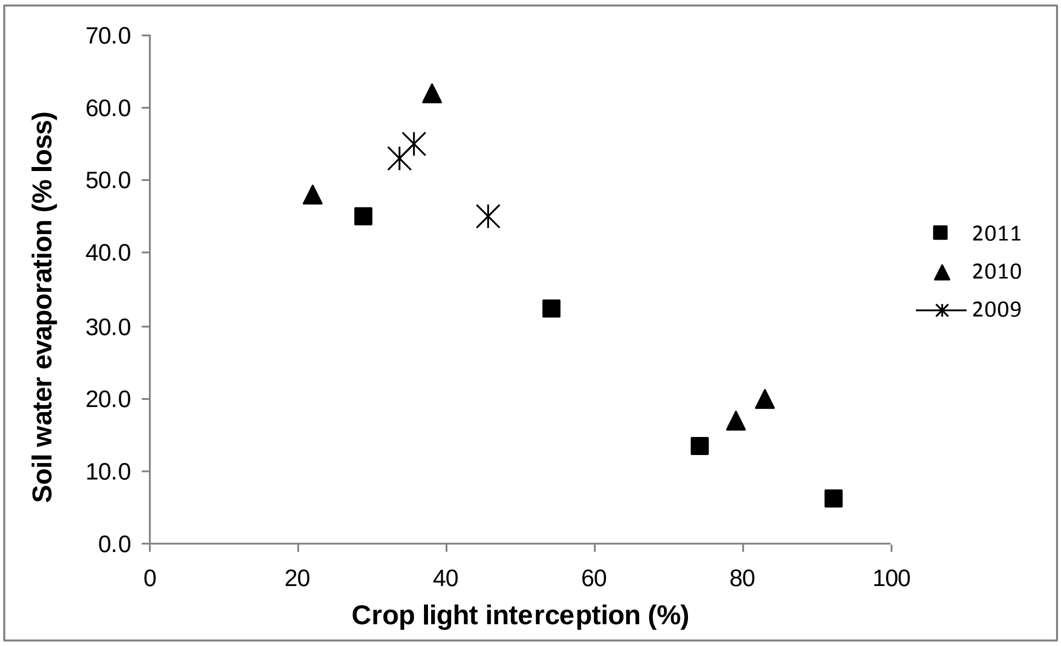


Figure 3. The percentage of total crop available water evaporated from the soil and the amount of light intercepted by the crop canopy during stem elongation at three sites in 2009 and 2010, and four sites in 2011.

Logically, reducing the amount of sunlight hitting a soil surface, for instance by adding a layer of straw, will decrease the amount of moisture lost from soil evaporation. Figure 3 shows how the developing crop canopy at each of the sites was also able to reduce soil evaporation. As more light was intercepted by the crop canopies the proportion of water lost through soil evaporation decreased, thus leaving more water available for crop transpiration or growth.

Generating this sort of soil cover would be unrealistic in most paddocks and so future research will look at the benefits of standing stubble.

Acknowledgements
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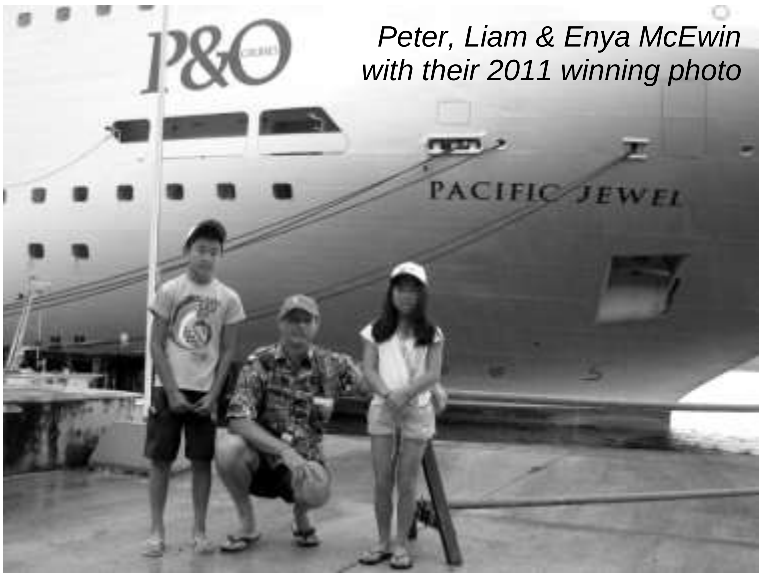

Peter, Liam & Enya McEwin with their 2011 winning photo

Hart board member Damien Sommerville in Ireland


Hart trials manager Peter Hooper at the Taj Mahal