## Improving water use efficiency

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 highest recorded water use efficiency (WUE) was observed at Spalding where 26.6 kg of wheat was produced per hectare for every mm of growing season rainfall.
- Growing season rainfall was below average meaning that stored summer soil moisture was very valuable in 2011.
- The WUE at Hart has been 14 kg/mm/ha or 70% calculated since 2001.

**Why do the trial?**

Impressive gains in improving crop and systems water use efficiency (WUE) have been captured by Australian farmers over the past 30 years and some farmers are achieving close to their environmentally attainable yields in most seasons.

This trial will investigate the reasons for these differences in WUE by continuing with trials established at 4 sites in 2008 on different soil types and rainfall zones in selected grower paddocks. The sites established are:

- Hart, 400mm annual rainfall, sandy clay loam
- Condowie, 350mm, sandy loam
- Spalding, 450mm, red brown earth
- Saddleworth, 500mm, black cracking clay

**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 and 4 crops.

The 4 crops include Gladius wheat, Fleet barley and Kaspa peas grown in rotation to ensure weed free plots are available for wheat in each successive season.
All trials were sown with 50mm chisel points and press wheels on 225mm (9") row spacing.

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.

Drained upper limit and crop lower limit (wheat) were measured at each site in 2008 to calculate plant available water capacity (PAWC).

WUE was calculated for the cereal crops at each site using the French & Schultz formula. Given the wet summer of 2010 and 2011 the growing season rainfall was calculated as:

- 1/3 rainfall above 20mm for December to February
- ½ rainfall above 20mm for March
- the total rainfall between April and October

The values used are based on previous measurements of summer fallow use efficiency.

Wheat Yield potential = (GSR-110mm)*20 kg/mm/ha

Barley Yield potential = (GSR-90mm)*15 kg/mm/ha

**Results**

Growing season rainfall (GSR calculated from April to October) in 2011 was well below average (Table 1) with Condowie having the highest GSR decile (4.5). Given the wet finish to 2010 and frequent summer rains an allowance of stored summer rainfall was added to the traditional GSR (Table 1) (referenced as GSR+S). Using this method the GSR+S ranged between 262mm (Condowie and Hart) to 335mm (Saddleworth). Condowie was the only site to have more GSR+S compared to its long term GSR average.

Using this method 40 to 50mm of stored summer moisture was included in the GSR total. Measurements of moisture prior to sowing indicate that another 20mm was actually present and may explain why the Spalding site has a very high water use efficiency (WUE)(Table 3). The crop was able to access more water than what the GSR+S formula has allowed for. This might be due to the cool conditions in 2011 reducing the evaporation of moisture or larger rainfall events increasing the efficiency of water storage. This stored moisture was very important in 2011 and it could be realistically expected to have contributed 0.5 to 1.0 t/ha in extra grain yield.

*Table 1. Soil type and growing season rainfall (GSR) as the average, April to October and its decile and the GSR including an allowance for stored summer rainfall (GSR+S) for the four WUE sites in 2011*.

| Site | Soil type | Average GSR | 2011 Apr - Oct GSR (mm) | 2011 GSR decile | 2011 GSR with summer rain |
|---|---|---|---|---|---|
| Condowie | sandy loam | 252 | 232 | 4.5 | 262 |
| Hart | sandy, clay loam | 305 | 219 | 2.0 | 262 |
| Spalding | red brown earth | 322 | 234 | 2.5 | 292 |
| Saddleworth | black cracking clay | 374 | 296 | 2.0 | 335 |

The wheat WUE ranged from 12.6 kg/mm/ha at Hart to 26.6 kg/mm/ha at Spalding (Table 3) producing grain yields of 2.74 t/ha and 4.84 t/ha respectively. This ranking of sites was also the same in 2010.

Wheat grain yields ranged from 1.91 t/ha (Condowie) to 5.38 t/ha (Saddleworth) and barley grain yields ranged from 1.77 t/ha (Condowie) to 5.02 t/ha (Spalding) (Table 2). Protein levels were good for wheat and barley and screenings were all below 2.5% at all WUE sites in 2011.

*Table 2. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%<2.0 mm for wheat and %<2.2mm for barley) at the four WUE sites in 2011*.

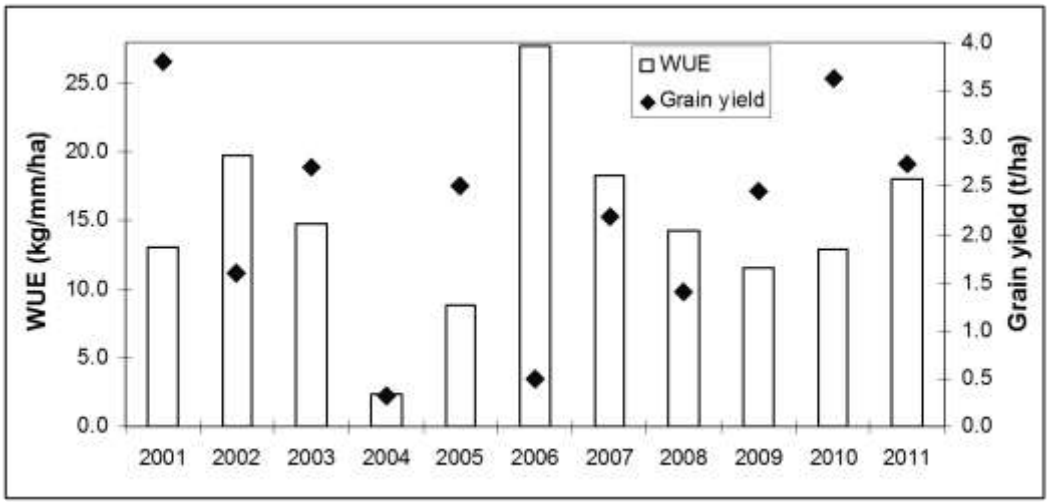
| Site | Crop | Grain Yield (t/ha) | Protein (%) | Test weight (kg/hL) | Screenings (%) |
|---|---|---|---|---|---|
| Condowie | Wheat | 1.91 | 12.6 | 73.2 | 2.1 |
| | Barley | 1.77 | 12.0 | 63.5 | 1.9 |
| Hart | Wheat | 2.74 | 12.5 | 70.4 | 1.7 |
| | Barley | 3.48 | 11.7 | 64.3 | 1.3 |
| Spalding | Wheat | 4.84 | 12.9 | 78.3 | 1.1 |
| | Barley | 5.02 | 12.0 | 66.2 | 0.9 |
| Saddleworth | Wheat | 5.38 | 11.0 | 80.8 | 0.9 |
| | Barley | 4.71 | 12.3 | 67.0 | 1.7 |

*Table 3. Soil type, average and total rainfall and wheat and barley water use efficiency (WUE) for the four WUE sites in 2011*.

| Site | Soil type | Average total rainfall (mm) | 2011 total rainfall | Wheat WUE (kg/ha/mm) | Barley WUE (kg/ha/mm) |
|---|---|---|---|---|---|
| Condowie | sandy loam | 349 | 415 | 18.0 | 20.2 |
| Hart | sandy, clay loam | 400 | 387 | 12.6 | 10.3 |
| Spalding | red brown earth | 434 | 419 | 26.6 | 24.9 |
| Saddleworth | black cracking clay | 497 | 450 | 23.9 | 19.2 |

The calculated WUE at Hart over the past 11 years has ranged between 2.4 kg/mm/ha (2004) to 27.8 kg/mm/ha (2006). The efficiency of crop water use depends on many factors and so it is expected that this figure will vary from year to year. Over the reported period the Hart field site has averaged about 14 kg/mm/ha or 70% WUE. This knowledge of expected efficiency can be particularly important when using seasonal rainfall to calculate likely yield expectations.

*Figure 1. Wheat grain yield and water use efficiency using April to October growing season rainfall and 20 kg/mm/ha potential grain yield between 2001 and 2011 at the Hart field site.*

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