Yield and water use improvements of South Australian wheat varieties from 1957-2007

Funded by the GRDC Water Use Efficiency Initiative. Conducted by Chris Lawson and Victor Sadras, SARDI

Key findings

- An increase of wheat grain yields released between 1957 and 2007 was found.
- Yields have increased because of improved harvest index, more biomass at flowering, and increased grain number.
- Nitrogen is critical in allowing each variety to reach its potential through increasing growth rate between stem elongation (GS31) and flowering.
- WUE has improved over the 1957-2007 timescale through increased yields, not greater extraction of water.

Why do the trial?

In 2010 the initial 'Historical Trial' was conducted over three sites. The work showed a steady increase in yields over the variety time scale. In 2011 the trial was repeated at Hart and Roseworthy, with the addition of high and low nitrogen treatments. Both trials monitored water use with a capacitance probe installed in each plot. The purpose of this trial is to update the water use efficiency benchmark of 20 kg/ha/mm derived from French and Schultz. The benchmark should be updated to account for the advances made in wheat breading over the past 50 years.

How was it done?

Plot size 1.4m X 10m

Fertiliser **High Nitrogen**:

- 90 kg DAP at sowing
- 160 kg/ha urea on 29th July
- 50 kg/ha urea on 7th September

Low Nitrogen:

- 90 kg DAP at sowing

Seeding date Hart: 30th May
Roseworthy: 7th June

13 varieties released between 1957 and 2007 were used. They were; Heron (1958), Gamenya (1960), Halberd (1969), Condor (1973), Warigal (1978), Spear (1984), Machete (1985), Janz (1989), Frame (1994), Krichauff (1997), Yitpi (1999), Wyalkatchem (2001), and Gladius (2007).

Results

In the 2010 season we found the annual rate of yield improvement was 25 kg/ha. In the 2011 trails this rate of improvement dropped to 15 kg/ha. We expect the rate to fluctuate year on year depending on the environmental yield, the 2010 season average yield for the trial was 4.2 t/ha at Hart, while in 2011 it was 3 t/ha, hence the reduced rate of improvement.

Improved harvest index is one of the reasons for the increase in yield over time (Figure 1). In varieties released after the 1980s grain number increased, this observation was consistent over both 2010 and 2011 seasons. In 2010 we found that increased yield was correlated to greater biomass at flowering, this was also the case in 2011, although there was no significant difference among the varieties.

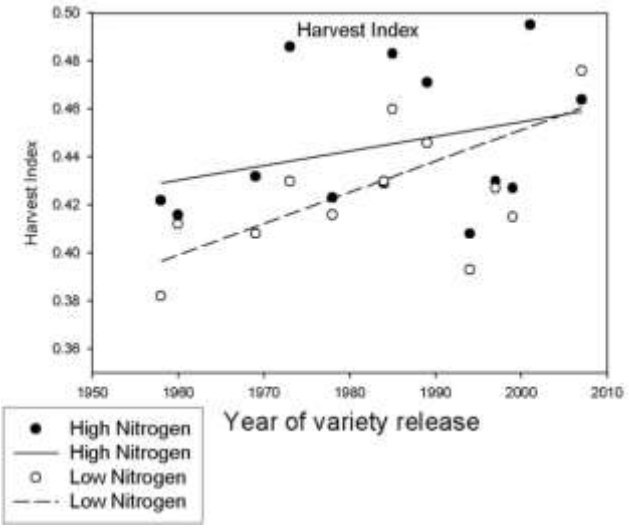

Figure 1: Harvest index for all varieties and nitrogen treatments. Linear regression shows trends for nitrogen treatments.

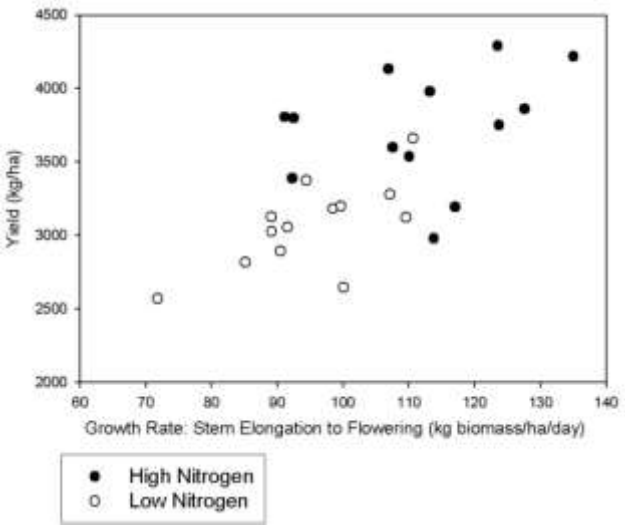

Figure 2: Relationship between grain yield and growth rate between stem elongation and anthesis for high and low nitrogen treatments.

The addition of nitrogen increased growth rate between stem elongation and flowering. This increased growth rate had a strong correlation with final yield (Figure 2). This has implications for farm management as it shows having adequate nitrogen is critical to capture yield potential.

Wheat varieties have increased yield under the same water uptake, hence water use efficiency has improved. The total water use from each variety did not differ, which was consistent in both 2010 and 2011. The major advances in breeding have come through improved plant physiology rather than improved water uptake. These advances mean a WUE benchmark closer 25 kg/ha/mm should be used.