

Effect of conservation cropping on crop growth, yield and quality

John Kirkegaard, John Angus and Geoff Howe, CSIRO Plant Industry
Email: John.Kirkegaard@csiro.au

Key messages

- Both stubble retention and direct-drilling consistently reduced early crop vigour despite improved soil conditions and good establishment. Diseases and inhibitory microbes appear to be the main problem.
- Stubble retention and direct drilling reduced yield when rainfall was average or above, but had no effect when rainfall was below average. There was little effect on grain protein.
- Early sowing, deep soil disturbance, dry springs and low stubble loads overcame the reduction in seedling vigour.

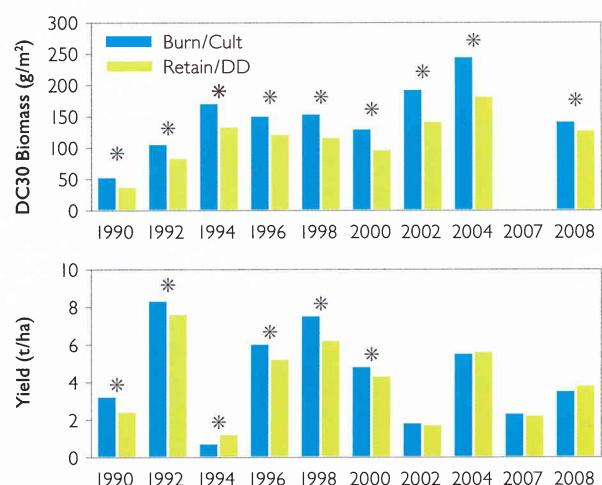
Background

Performance of stubble-retained, direct-drilled crops was often disappointing despite the reported benefits of conservation cropping to soil fertility. In the 1980s most growers reduced heavy stubble loads with a late burn and 1 or 2 pre-sowing cultivations to establish crops. They were keen to take the next step to full conservation cropping to save time, fuel and labour; provided yields and profit were maintained. The Harden long-term experiment investigated crop performance and soil fertility under different tillage systems for 20 years. Scientists examined many aspects of the system in collaboration with local growers to understand and alleviate constraints to productivity within conservation cropping systems.

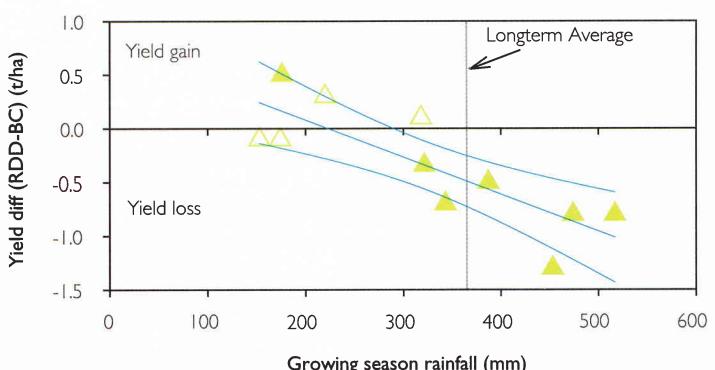
Seedling vigour, crop growth and yield

Stubble retention and direct drilling consistently led to slow early growth of wheat compared to crops grown after late stubble burning and one pre-sowing cultivation. The mean reduction was 20% (Fig. 1). Growth was reduced despite similar plant populations, adequate water and nutrition and did not diminish during the 20 years. Disease and Inhibitory microbes (pg 8) were primarily responsible for slow growth, despite the break-crop/wheat sequence. The effects of stubble and cultivation on seedling vigour were separate and additive.

From 1990 to 2000, the reduction in early wheat growth translated to lower yield, except during the 1994 drought, when conservation cropping significantly improved yield due to carry-over water from 1993 (Fig. 1). Data compiled across all seasons reveals a clear impact of seasonal rainfall on crop response to conservation cropping (Fig. 2). In dry seasons (<250 mm GSR) there is either no significant difference between Burn/Cultivate (BC) and Retain/Direct Drill (RDD) or a small yield improvement,



> Figure 1 Effect of tillage and stubble management on wheat growth (DC30) and yield (* indicates significant differences P=0.05).



> Figure 2. Yield response in wheat crops to conservation cropping in relation to growing season rainfall. Open symbols are years with no significant response. Yields were reduced by conservation cropping in average or above average rainfall seasons. Dotted line shows long-term average rainfall at Harden. The other lines show the fitted regression ($r^2=0.7$) and 95% confidence interval.

while in average or above-average seasons there is a yield reduction due to conservation cropping. This observation is consistent with (1) increasing incidence and impact of disease and possibly N leaching and tie-up leading to reduced early growth in wetter seasons and (2) the early growth reductions persisting to reduce yield in wetter seasons, but not persisting in drier seasons. Overcoming these underlying constraints to productivity became a focus for research at the site so yield penalties could be avoided in wet years and greater benefits of water conservation could be realised in dry seasons.

Overcoming the constraints

Separate experiments showed strategies to avoid the early growth and yield penalties of conservation cropping: (1) sowing with deep tines to cultivate below the seed (see picture below) improved the vigour and yield of direct-drilled crops in 1992 and 2002 (2) early sowing reduced the yield penalty of conservation cropping in 1996. Further improvement may be possible by overcoming stubble-borne disease using fungicidal seed dressings and growing cultivars with good resistance to yellow leaf spot. The wheat cultivar used in the experiment, Janz, was frequently infected from stubble that persisted through the break crop year in the stubble retained treatments. Further improvement could follow with varieties more tolerant to leaf diseases and better able to resist the inhibitory organisms associated with conservation cropping (pg 8). Inter-row sowing with precise guidance systems may provide further opportunities to reduce the impact of stubble and soil-borne diseases.

- > Deep narrow tines to cultivate below the seed were tested in 1992 and widely adopted in the region with local modifications.



Practical implications

The experiment explained the problems of slow early growth and generally reduced yield during the early adoption of conservation cropping in high-rainfall cropping regions. Subsequent research showed that the yield penalty could be at least partly overcome by early sowing and deep narrow points. Further improvements may be possible, based on research investigating varietal selection for conservation cropping and improved control of *Rhizoctonia*.

Growers in the region are keen to adopt conservation cropping because of the environmental benefits, improved timeliness and savings in labour, fuel and machinery use. The results of the experiment provide information needed in balancing these benefits with the reduced yields. Increasingly growers are adopting conservation cropping as the yield penalty is overcome.

Further reading

- Kirkegaard, J.A., Angus, J.F., Gardner, P.A. and Müller, W. (1994) Reduced growth and yield of wheat with conservation cropping. I. Field studies in the first year of the cropping phase. *Australian Journal of Agricultural Research* 45, 511-28.
- Kirkegaard, J.A., (1995) A review of trends in wheat yield response to conservation cropping in Australia. *Australian Journal of Experimental Agriculture* 35, 835-48.
- Kirkegaard, J.A., Howe, G.N., Simpfendorfer, S., Angus, J.F., Gardner, P.A. and Hutchinson, P. (2001). Poor wheat yield response to conservation cropping: causes and consequences during 10 years of the Harden tillage trial. Proc.. 10th Australian Agronomy Conference. www.regional.org.au/au/asa/2001/4/c/kirkegaard.htm