Polymers – a paradigm shift in thinking

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Take Home Messages

This trial is a joint project between the Birchip Cropping Group (BCG), the Cooperative Research Centre (CRC) for Polymers and Integrated Packaging.

Due to seasonal conditions there were no yield or quality results obtained from this trial in 2006.

Background

Crops grown under polymers (plastic), is not a new concept. European horticulture industries have been using the technique for some time. However, polymers have never been used commercially under Australian broad-acre conditions.

The system involves covering crops, immediately after sowing, with a thin, clear UV-degradable polyethylene film (with the edges buried in the soil between crop rows to seal it). Initial trials in northern Australia comparing corn, maize, potatoes and other crops have shown a yield increase of 30-100% when grown under the polymer film.

The BCG has been investigating for several years the use of X-tend or 'polymers' to improve crop growth in the Wimmera Mallee environment. A new trial was started in 2006 at the Birchip main site.

The main object of wrapping the crop is to retain and recycle moisture that would otherwise be unavailable to the plant because of transpiration and evaporation. The polymer also lifts soil temperatures at sowing and creates a warm, moist micro-environment for germination and early plant growth. There is also a suggestion of better plant water use efficiency under polymers.

Polymers may also play a role in allowing farmers to grow higher value crops in environments normally not conducive to their growth. Summer crops in these environments may also be a possibility.

A key challenge will be to make the system affordable and workable. At six microns thickness, the film costs $250 per hectare however researchers are developing a thinner film that would reduce costs over time.

Aim

To monitor the growth of wheat and lentils grown under polymer film compared to natural conditions. The trial was also an investigation into the effect of time of removal of polymer film on yields. Weed emergence under the polymers compared to natural conditions was also observed.

Methods

Replicates:	4
Plot size:	12m x 1m
Crop & Variety:	Wheat (Yitpi) and Lentils (Nugget)
Sowing Date:	20th July 2007.
Sowing Density:	175pl/m2 wheat, 55kg/ha Lentils
Treatments:	- Wheat and Lentils
	- Four different timings of polymer removal- 3.5 weeks, 7 weeks, 10 weeks and 12 weeks after sowing plus control (natural environment)
Fertiliser:	50kg/ha Supreme 10Z

A full weather station was installed to monitor the environment around and beneath the film during the trial. Factors being measured included: wind speed and direction, air temperature and humidity, incident UV and solar radiation, rainfall, and soil temperature and moisture, with soil temperature and moisture, as well as air temperature and humidity being monitored under the film.

Results

Unfortunately, while this trial was eventually laid out as planned (later than anticipated due to the delay in the winter rain), no final yield results could be obtained due to drought. However, some interesting observations were made in the early stages.

To start with, there was the usual increased growth in the early stages for the plants under the film, in comparison with the controls: the control cereal plots were only at 2-3 leaf stage on the 11/8/2006 and the cereal under the plastic has started to tiller (2 tillers in most cases). It was noted that the lentils had a yellow tinge to them, and brownish marks over the leaves, with some leaves looking like they have burnt off (particularly for those plants that were touching the plastic).

As an aside: Some Yitpi wheat was sown dry on the 25th May and covered with the polymer. Some interesting observations were made of this demonstration. One striking aspect was that these plants that were sown on the 25th May in bone-dry conditions actually germinated under the film. The wheat sown without plastic did not germinate. The film appears to have the ability to pull moisture up from deep reserves and concentrate it in the top soil layer. A soil moisture profile was taken, and it was found that the soil moisture profile was identical to natural conditions below about 10 cm – above that, the moisture level was significantly higher under the film (Figure 1). Another aspect of note was that the plants grew lushly under the film (until it got too hot) but were killed when the film was removed, being too soft for the conditions. And it was striking that plants grew well on the outside edge of the film (Figure 2). This was not due to run-off, but appeared to be related to the ability of the film to pull up sub-surface moisture. When the film was removed, the plants died, while those next to the plastic continued to thrive despite the lack of rain.

The full climate data was collected for this trial. The temperature increase (both in soil and air) under the film was significant (Figures 3 & 4). Likewise, the soil moisture was higher (Figure 1). It was also noted that during rainfall, the water clearly permeated under the film (Figure 1). The soil moisture probe was place at 7 cm depth in the centre of the plot.

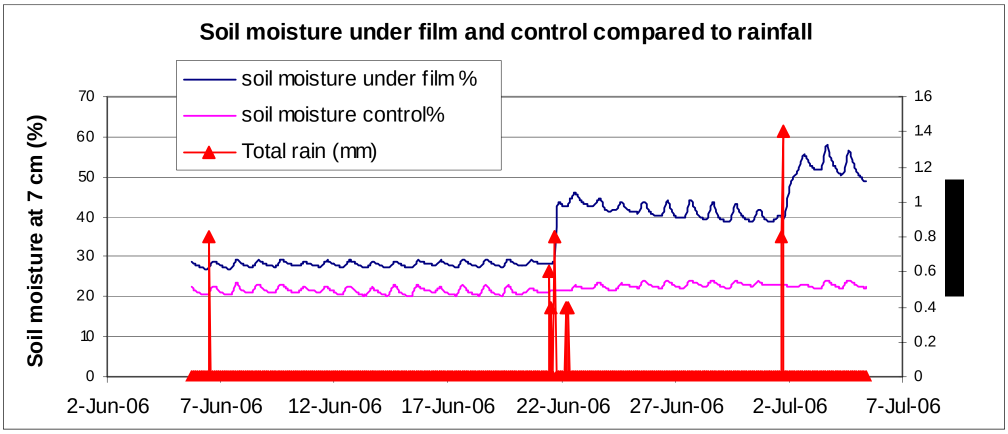

Figure 1: Soil moisture under the film from the early sown demonstration

Figure 2: Wheat growth at edge of film in Birchip

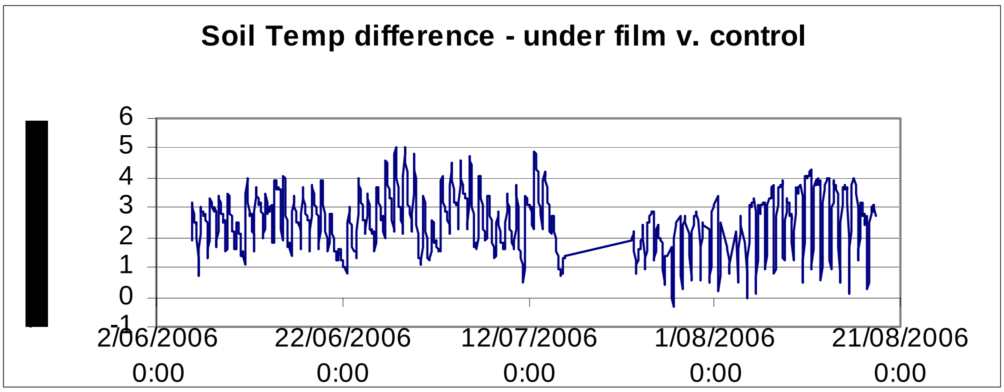

Figure 3: Effect of film on soil temperatures in Birchip

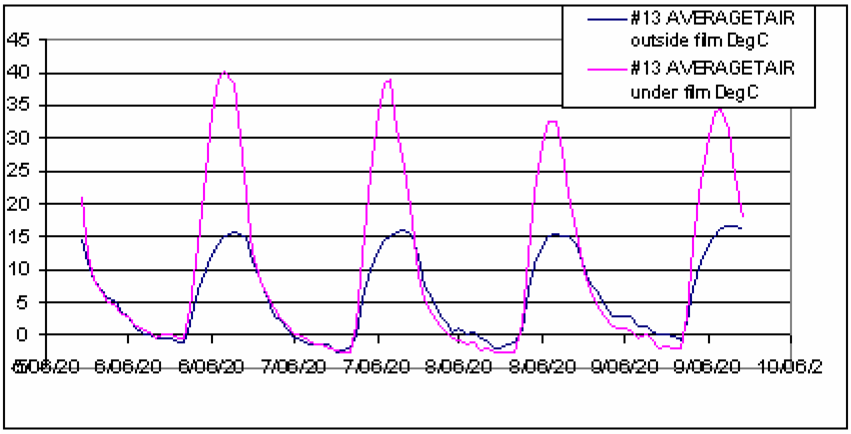

Figure 4. Air temperature collected 6-10th June under the plastic and outside the plastic

In June, air temperature under the plastic was up around 40°C whereas air temperature outside the plastic peaked at 15°C.

One other result of interest was the very early germination of summer weed species: an indication that the film may allow for the planting of summer crops this far south and/or be effective for soil solarization.

Commercial Practice

A system is being developed to sow the crop and cover it with film at the same time, to save machinery operations, however a key challenge will be to control the rate at which the film degrades under UV light so that time and expense is not required to remove it manually. Ideally, it would degrade sufficiently before rising spring temperatures made it too hot under the film for the crop to survive. Unlike maize crops, with which the X-tend system has been trialed overseas, cereal crops won't be able to break through the film on their own. The film must also degrade sufficiently where it is in contact with the soil.

BCG are also trialing an addition experiment with polymers over summer called 'Summer Solarization' where by clear and black plastic are being laid on fallow ground with the intention that the plastic will dramatically increase the temperature and humidity in the top layer of soil and in the air under the films, so much so that summer weeds as well as possible winter weed seed stock will emerge and be killed (cooked) under the plastic.