Thin oxodegradable film and profile soil water under cotton

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Abstract
Previous studies utilising oxodegradable thin film have shown that seedbed soil temperatures were elevated between 2-4 ^{o}C, and seedbed moisture was conserved under the film compared with bare soil. The issue of film restricting cotton emergence has been resolved by using slit film at planting. It is speculated that thin film may conserve profile soil water for longer than under bare soil, thus conferring some benefit in the early growth of cotton possibly due to better root growth.

This preliminary work followed changes in profile water with and without film at two irrigated (Narrabri and Carrathool) and a dryland (Willow Tree) site. Multi-depth-soil-moisture-sensors installed in the plant line monitored changes in soil water at 10, 30, 50, 70 and 90 cm with the data being logged at three hourly intervals.

Preliminary results indicate that profile water varied both under the film and bare control and over time at all sites, with the profile under the thin film being drier at one irrigated (Narrabri) and wetter at the dryland (Willow Tree) site and wetter at the second irrigated site (Carrathool). There was no difference in plant height, node numbers and open bolls at the end of the season between treatments at all sites. It is yet to be determined if differences in profile water will translate into greater lint yield at picking.

Key Words
Plastic film, Mulch, Irrigated cotton, Dryland cotton

Introduction

Thin plastic film has been used as a mulch to increase soil temperature, conserve soil water and to improve crop establishment for crops such as maize (Li et al. 2014), vegetables (Qin et al. 2014) and cotton (Dai and Dong, 2014).

If the film is impermeable to water, evaporation from soil is reduced which will alter evapotranspiration (ET). There can be an advantage in rainfed situations by conserving available water and improved crop water use efficiency (WUE), which can reduce seasonal variability associated with rainfall (Bu et al. 2013). Under irrigation there is potential to reduce water use and increase WUE (Yaghi et al. 2013), which will be attractive as the price of water increases or security of access to and supply of water decreases.

Little work has been undertaken to assess the benefit of thin film in conserving soil profile water over time. This preliminary research was undertaken to test the hypothesis that thin oxodegradable film could conserve soil profile water under a cotton crop during the growing season.

Materials and Methods

Field experiments were conducted at Narrabri and Carrathool under irrigation and at Willow Tree under rainfed conditions. All experiments compared slotted thin film covered areas with uncovered areas as the control. Two films were used at Narrabri (F1, oxodegradable & F2, certified biodegradable), one at Carrathool (F1) laid in 6 alternate rows and across 24 rows at Narrabri and Carrathool, respectively while the experiment at Willow Tree was a demonstration site with no replication. Fields were planted on 29 September 2014, 22 September 2014, and 4 October 2014 at Narrabri, Carrathool and Willow Tree, respectively with the thin film being placed mechanically on the same day at Narrabri and Carrathool and five days after planting by hand at Willow Tree. Plots were the three rows (1m spacing) by 180 m and 500 m at Narrabri and Carrathool, respectively, and only two rows by 10 m at Willow Tree. Cultivar Sicot 74 BRF was planted on ridges at Narrabri and Carrathool with Sicot 71 BRF being planted on flat ground at Willow Tree.

Multi depth soil moisture sensors (Odyssey, Dataflow Systems) were installed at each site on the same day as the film was laid with the exception being Willow Tree. Sensors were placed in access tubes in oversized augured holes at Narrabri and Carrathool and pushed to depth at Willow Tree. The oversized holes were filled with a soil-water slurry before the access tubes were inserted. This necessitated that the data for the first 7 DAP (Days after planting) being ignored as the soil re-equilibrated. Profile moisture was logged at 10, 30, 50, 70, and 90 cm depths every three hours during the growing season at each site. The sensors were not calibrated for each site, however they were all set-up with the same parameters to ensure that relative differences between treatments would be maintained. Soil water monitoring was unable to be replicated at all sites due to equipment restrictions. The fields were managed by the individual growers at each site.

Results and Discussion

For the Narrabri site the bare control treatment started wetter and continued to be so throughout the season compared to the film treatments (Fig. 1), which contrasts the observations from previous studies (Li et al. 2014, Qin et al. 2014, Dai and Dong, 2014). This was unexpected and most likely due to starting profile water varying across the experimental site. To determine whether the films at this site were effective in conserving profile water the data were made relative to the starting profile water under each treatment (starting soil water subtracted from subsequent readings); this adjusted all treatments to the same starting value (Fig. 2). Although there was variation in profile water during the season the soil profile tended to be wetter from 42-65 DAP under the films (Fig. 2) with treatments being similar until 93 DAP when film 1 began to breakdown and the profile started to dry down. After 109 DAP the soil profile under film 2 was wetter until monitoring ceased, while both film 2 and the bare treatment dried to similar points between irrigations (Fig. 2). Film 2 did not degrade as rapidly as film 1. Irrigations occurred on 1, 24, 66, 83, 106, 116, 128 and 138 days DAP.

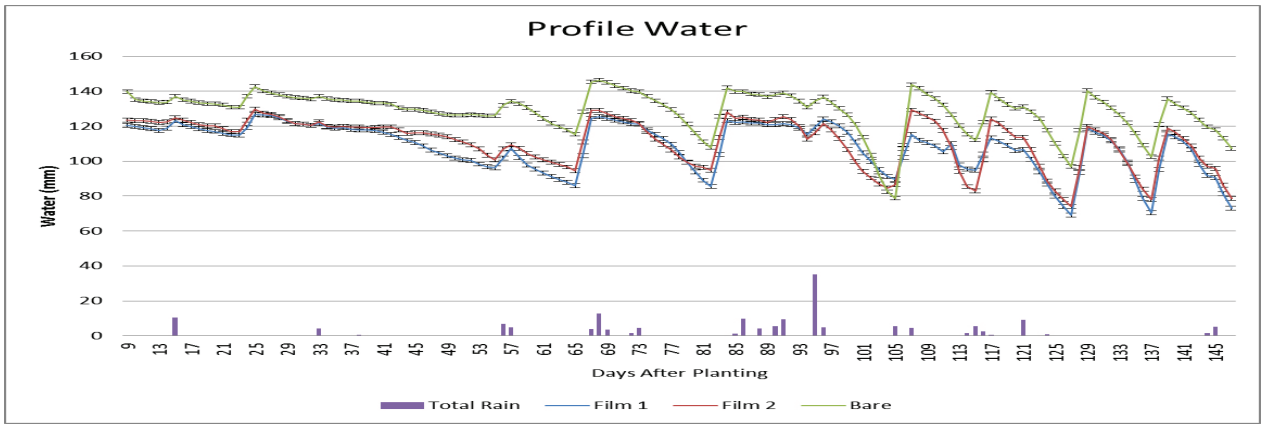

Figure 1. Soil profile water under film and bare treatments at the Narrabri irrigated site 2014-2015 (bars are +/- standard error of daily data)

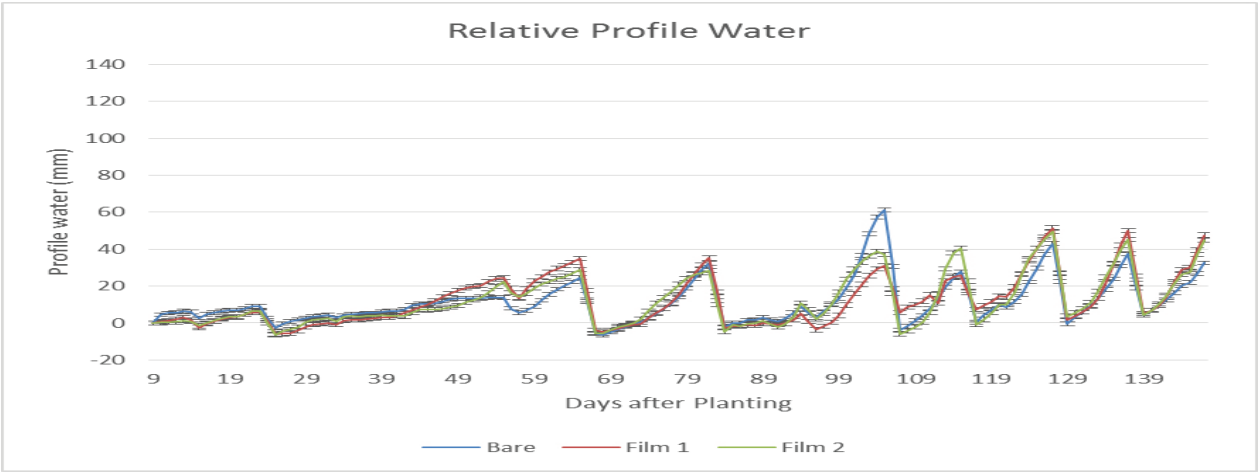

Figure 2. Relative change in soil profile water under film and bare treatments at the Narrabri irrigated site 2014-2015 (bars are +/- standard error of daily data)

At the Carrathool site, the thin film maintained the soil profile wetter though the season compared to the bare treatment (Fig. 3). The bare treatment was wetter after the first irrigation as it took longer for irrigation water to move from the furrows to the plant line under the film. Both treatments came together after subsequent irrigations with the film maintaining a wetter soil profile between irrigations (Fig. 3).

For the rainfed site at Willow Tree, the thin film maintained higher soil profile water compared to the bare treatment over the period of monitoring (Fig. 4). Peaks in soil moisture coincide with rainfall events during the season (data not shown) indicating that the rainfall was effective in replenishing profile water under the film and the bare treatment with the film protecting profile water.

The results indicate that the profile was wetter under the film at the point when monitoring ceased at Carrathool and Willow Tree, while the profile was wetter under film 2 and drier under film 1 at Narrabri due to film 1 breaking down earlier than film 2. In the rainfed system the profile dried down to a greater extent under the bare treatment compared to the film which suggests that water extraction patterns may be different under the two treatments.

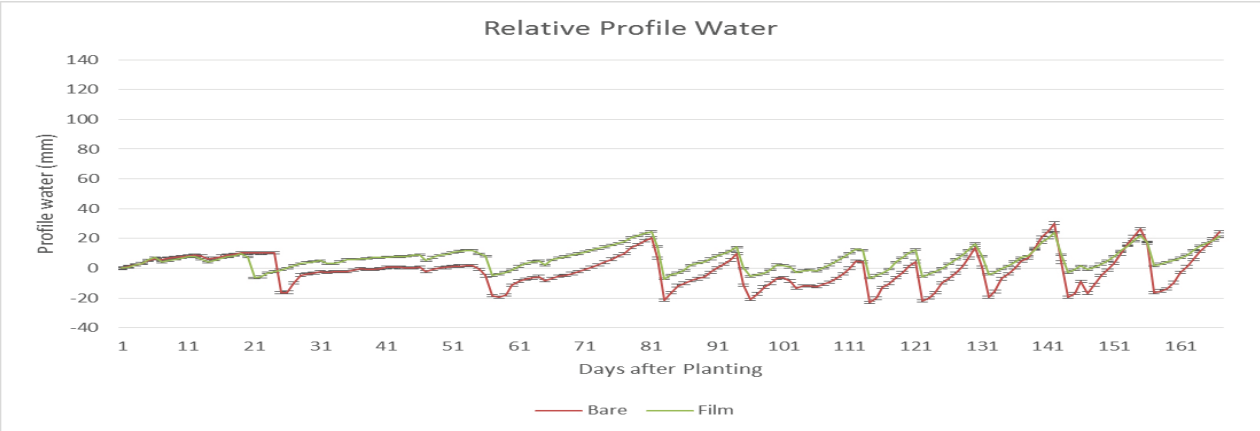

Figure 3. Relative change in profile water under film and bare treatments at the Carrathool irrigated site 2014-2015 (bars are +/- standard error daily data)

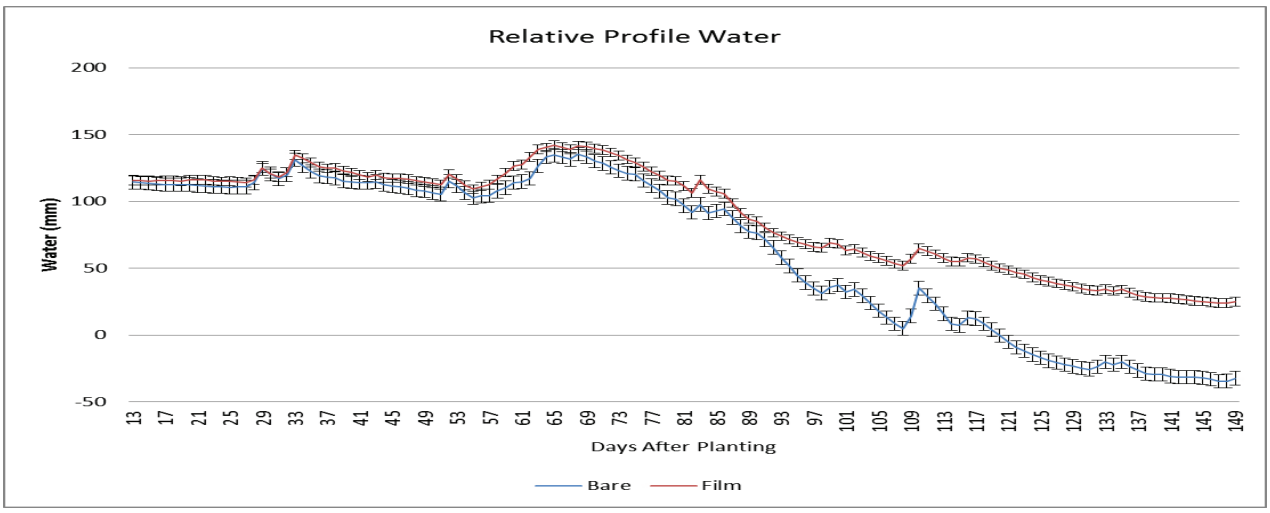

Figure 4. Relative change in profile water under film and bare treatments at the Willow Tree dryland site 2014-2015 (bars are +/- standard error of daily data)

Conclusions

Thin oxodegradable thin film shows potential to conserve soil profile water during the season under both irrigation and rainfed cotton systems. There were differences between irrigated and rainfed and between bare and film, which reflect environmental conditions at each site. There is a need to repeat the experiments over several seasons to be able to quantify the effect in the long-term. This will require further resources for replicated monitoring of profile water.

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