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Irrigation scheduling for cotton under drip

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A large scale drip irrigation experiment was established at Warren to find a useful way to schedule irrigations. We found both yield and profit were maximised by drip irrigating cotton with the same amount of water we estimated the crop to have used on the previous day.

Determining how much water a drip irrigated cotton crop requires can be a tricky business. The systems are designed to deliver the water to the crop with a high degree of application efficiency. This can be wasted if the amount of water applied is not what the crop requires.

Experience has shown it is easy to either over or under irrigate with drip. There is a high degree of uncertainty among users of drip irrigation about the appropriate tools, techniques and strategies for scheduling drip irrigation.

Generally this is because the amounts of water applied daily are only very small and the effects of applying too little (water stress) or too much (excessive growth and/or deep drainage) take some time before they become visible. And by this time it is usually too late!

To try to determine a reliable way to schedule irrigations for drip irrigation with some accuracy an experiment was run over two seasons at 'Bellevue', Warren. Crop water use was calculated using daily evapotranspiration data from a weather station and a crop factor (Figure 1).

The crop was irrigated at four different levels. Each treatment was irrigated each day with a portion of the estimated crop water use from the previous day as follows:

- 100 per cent of crop water use;
- 75 per cent of crop water use;
- 50 per cent of crop water use; or,
- 125 per cent of crop water use.

For example; if the evapotranspiration from the previous day was five mm and the crop factor 0.8 then the 100 per cent treatment would receive four mm, and the 75 per cent, 50 per cent and 125 per cent treatments would receive three, two and five mm respectively.

Neutron probe access tubes were installed 10 cm from an emitter and read weekly to assess, and if necessary, adjust the crop factor. If the neutron probe data showed the 100 per cent treatment to be getting wetter, then the crop

FIGURE 1: Crop factor used for the experiment

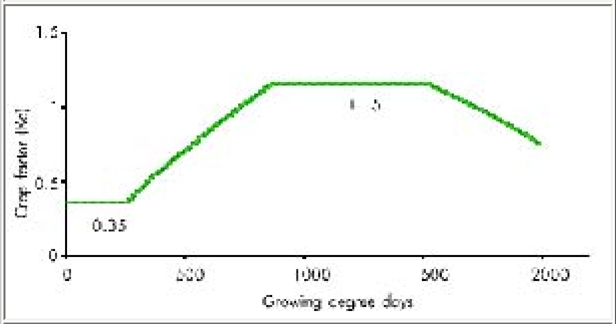


FIGURE 2: Soil water content and rainfall in the 1999–00 season

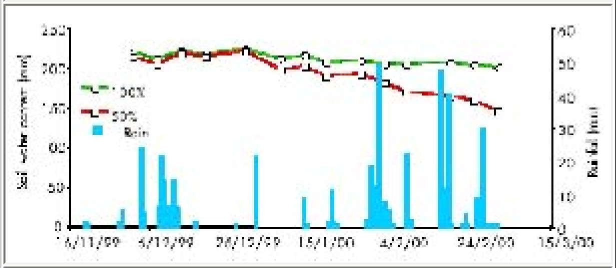


FIGURE 3: Soil water content and rainfall in the 2000–01 season

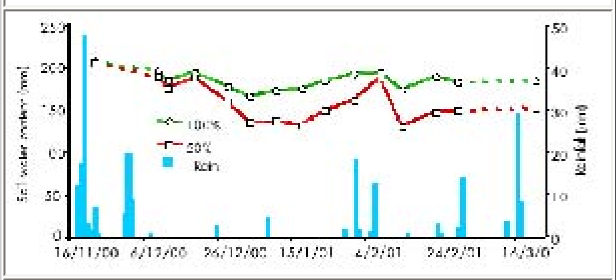
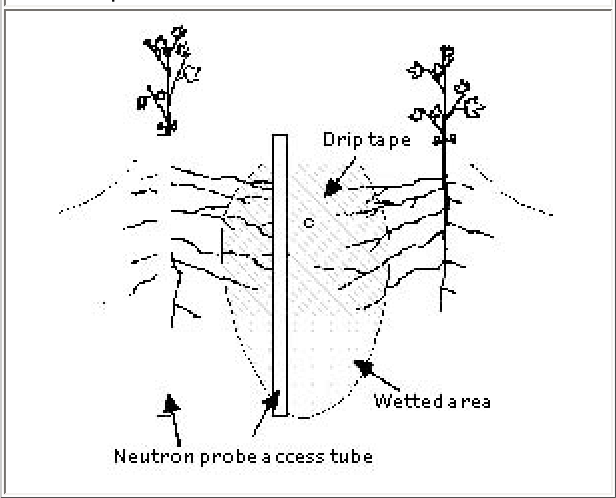


FIGURE 4: Relative location of drip tape, cotton plants, wetted area after 12 mm irrigation and neutron probe access tubes



factor was reduced by an amount proportional to the increase in soil water content. Similarly if the 100 per cent treatment became drier the amount of water applied was increased the following week.

Yield and Water Use

In both seasons we found that the crop in the 100 per cent treatment was the highest yielding, gave the best returns and made the most efficient use of the water applied (Table 1).

We concluded that if water is limiting, then it is better to err on the side of under-irrigating, whereas if water is abundant then it is better to err on the side of over-irrigating. But it is important to note that there was a yield penalty if 25 per cent more water was applied than the crop required.

Soil Water Content

In the 1999–00 season, the soil water content in the 100 per cent treatment remained relatively constant over the season (Figure 2) so we did not need to adjust the crop factor. This indicated the model accurately predicted crop water use. The water content in the 50 per cent treatment declined over the period of the season indicating that it was not receiving enough water to satisfy its needs.

The 2000–01 season was a warmer season and the accuracy of the model was well tested. The soil water content of the 100 per cent treatment declined during late December and early January (Figure 3). It was determined that the amount that we were under irrigating the 100 per cent treatment was about 0.5 mm per day. The crop factor was then adjusted up by 0.1 (from about 0.85 to 0.95) to provide this extra water.

The spike in the 50 per cent treatment on the February 8, 2001 corresponds with rain in early February of about 30 mm and the sharp decline occurred afterward because no water was applied for two days after the rain. During this time, water from the rainfall was used up very fast as there was little reserve left in the parts of the soil not wet by the irrigation, which we were also monitoring (Figure 4).

From December 23–30 1999, 60 mm of rain fell and no irrigation was applied for five days. But the subsequent decline in the stored soil water of the 50 per cent treatment was not as fast as it was in February 2001, as the plants were able to draw upon water stored prior to the rain outside the area wet by irrigation. This showed us that it was also important to monitor what was happening in the profile away from where the drippers were wetting.

Conclusions

The saving in water was not enough to pay for the reduction in yield. It was most profitable to irrigate with the aim of achieving maximum yield rather than saving water.

TABLE 1: Partial budget for each treatment (irrigation water assumed to be $30 per megalitre)

Treatment	Average yield (bales/ha)	Average water use (Ml/ha)	Gross return @450/bale	Variable costs ($/ha)	Net return ($/Ml)	Net return ($/ha)
50%	6.8	3.7	3060	2215	845	229
75%	7.5	4.6	3375	2242	1133	249
100%	8.1	5.3	3645	2266	1379	261
125%	7.9	6.2	3555	2294	1261	203

While scheduling drip irrigated cotton using evapotranspiration data works it is important to monitor the soil water content. To grow a good cotton crop we needed to apply enough water to keep the crop growing vigorously. The key is not to get caught applying not quite enough each day.

It is important to watch what happens to the soil water content after rain to know when to start irrigating again. We found that for this purpose it is best to watch what is happening in the soil outside the drip irrigation wetted area

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