AN EVALUATION OF DRIP IRRIGATION FOR COTTON

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Drip irrigation has been of interest in regions where water is scarce or expensive (e.g. Israel and Arizona). In Australia the water supply is very variable, while the cost of water, though cheap by some standards, could become more expensive in the future. Claims by distributors and agents of improved efficiency of irrigation and heavier yields of cotton due to drip irrigation in 1981-82 and 1983-84 had not been validated for Australian conditions. This created the need for an objective assessment of drip irrigation for cotton. This project compares two types of drip irrigation and standard furrow irrigation in a randomized and replicated experiment. A comparison over several seasons is essential for accurate economic assessment of drip irrigation, as the outlay on mains and drip lines needs t be paid for by extra yield . The aims of the project are to compare the water use, waterlogging, fertilizer recovery and yield of each irrigation method. These comparisons will quantify and help explain the differences in performance of crops growing in the respective systems. Results from this experiment will improve furrow irrigation technology by highlighting irrigation management, waterlogging and nutritional problems.

The project now has three years of results and is expected to be continued for at least one more season in its present form.

Climate

The following table shows the main features of the climate in the three seasons of the experiment. The most outstanding features are that 1983/84 was wet and cool; while the other two seasons have been drier than average. The consequences of these aspects of the climate on crop performance will be highlighted in each section.

	Rainfall mm	Day degrees base 12	Radiation Langleys/day
1983/84	570	1523	525
1984/85	204	1794	579
1985/86	235	1706	531
26 year mean	324	1754	561

All values relate to the period October 1 to March 31.

Crop establishment

We intended to pre-irrigate the furrow irrigation treatment and water up the drip irrigation treatments as would be standard practice for each. Rain assisted establishment in two of the seasons. Crop establishment was therefore identical for each method of irrigation in those seasons.

Surface drip irrigation has produced problems with plant establishment, particularly when the soil profile was dry. It was necessary in this experiment (1984/85), and sometimes commercially, to man-handle the drip pipes and place them on top of the row. This procedure is labour intensive. Under surface drip irrigation, seedbed preparation and moisture conservation become more critical, and wide, flat beds should be considered to improve subbing during watering-up.

Fertiliser application

Drip irrigation allows precise metering of fertiliser to cotton. At this site the only nutrient deficiency is nitrogen. No response has been obtained to phosphorus and zinc at the site. Nitrogen as anhydrous ammonia was applied to the furrow irrigation treatments as a band beneath each hill before sowing. In the drip irrigation treatments, nitrogen was applied in the irrigation water as urea or urea/ammonium nitrate solution (Easy-N). An identical total amount of N was applied to each treatment. The timing of the N application varied with each drip treatment as follows:

	Percentage of total N applied; mean of 3 seasons	
Stage	Surface drip irrigation	Buried drip irrigation
Before or at sowing	nil	20
November	6	10
December	40	27
January	52	41
February	2	2

These different patterns of N application created different peaks of N uptake. The general pattern of N uptake was a peak at 70-80 days from sowing (early flowering), with a second peak 160 days from sowing. The rate of N uptake at the first peak was affected by the proportion of fertiliser applied early: furrow irrigation had the most uptake and surface drip had the least. The rate of N uptake at the second peak was greater for drip irrigation and corresponded to the fertiliser applied in January. This late N uptake did not contribute to crop yield and can delay defoliation and harvest. The reduction in N uptake around day 100 had two main causes:

a) A heavy boll load restricts the N uptake by a crop.

b) In 1983/84, there was heavy cloud and cool weather at this time.

The conclusion from these N studies is that N application should cease early in crop growth. (Refer to the other articles on N application at this Conference).

Irrigation

A detailed summary of water applications to each treatment was as follows:

Treatment	Season	Water applied mm	Soil use mm	Rain mm	Total mm	Water use efficiency kg lint/mm
Surface drip	1983/84	122	88	448	658	2.54
	1984/85	497	49	123	669	2.92
	1985/86	616	23	114	753	2.39
	mean					2.62
Buried drip	1983/84	149	83	448	680	2.45
	1984/85	524	49	123	696	2.69
	1985/86	585	0	114	699	2.91
	mean					2.68
Furrow	1983/84	115	89	448	652	2.48
	1984/85	598	76	123	797	2.18
	1985/86	662	72	114	848	2.13
	mean					2.26

The rain column is effective rain; i.e. not counting runoff in heavy falls and falls less than 10 mm.

Total water use for each treatment was generally close to 7 Ml per ha. This water was applied more efficiently to the buried drip irrigation treatment, since evaporation from the soil surface was avoided. Additionally, waterlogging after irrigation was reduced with drip irrigation and these factors account for its 17% higher water use efficiency when compared to furrow irrigation.

Yield and quality

Yield was measured by mechanically harvesting the full length of the field. The results were as follows:

	Total lint yield kg/ha			
Irrigation treatment	1983/84	1984/85	1985/86	Mean
	DP61	DP90	DP90	
Surface drip	1670	1956	1796	1807
Buried drip	1668	1870	2031	1856
Furrow	1620	1739	1807	1722
Mean	1653	1855	1878	1795

The sustained wet and cloudy weather in 1983/84 removed any effect of method of irrigation on crop yield. In the two dry seasons since then, drip irrigation has yielded up to 1 bale per hectare more than furrow irrigation. The relatively poor yield of surface drip irrigation in 1985/86 could be directly attributed to the N application schedule outlined earlier.

Where yield increases have been obtained with drip irrigation, it has been via increases in boll numbers. Boll size was generally smaller in drip irrigation treatments.

There were no effects of drip irrigation on fibre quality. The late N uptake from drip irrigation (Fig 1) could cause reductions in grade in some seasons, but not in the seasons of experiment so far.

Variety

Deltapine 61 was the only variety in the experiment in 1983/84. In the following two seasons, Deltapine 90, Siokra and Sicot 3 were included.

The general yield superiority of DP90 and Siokra over the old standard DP61 was evident in both seasons. In the 1985/86 season where larger and lusher plants were produced, Siokra showed better adaptability to drip irrigation Part of this superiority could be attributed to bacterial blight resistance in Siokra.

Disease

The incidence of bacterial blight infection on bolls of DP90 was assessed in the 1985/86 season by Dr S.J. Allen. The results were as follows:

Treatment	Percent of bolls infected
Surface drip	27.0
Buried drip	28.0
Furrow	17.5

There was less bacterial blight in the furrow irrigation treatments than under drip irrigation. The ranking of blight infection was directly proportional to plant size: larger plants of DP90 had more blight.

Conclusions

We conclude that the drip system is very expensive and probably not economic for cotton on established country. This conclusion is particularly true while cotton prices remain low. Drip irrigation may be economic on country not yet developed for cotton and unsuitable for furrow irrigation, such as steeper land, soil of variable texture, sandy soils, etc.

The imported practice, of continuing to apply N to drip irrigated cotton through January and February, appears to be inefficient and wasteful. The evidence from this experiment on clay soil is that N application should cease before boll filling.