Investigation into partial root zone drying in cotton cropping systems

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Abstract

Partial root zone drying (PRD) may have the potential to improve water use efficiency of cotton production in Australia. PRD was investigated in the field using drip irrigation, looking at the effect of irrigation treatments and planting configurations of the yield and development of cotton. The results indicate that there was no difference between treatments in leaf water potential, timing of stomatal closure, or vegetative and reproductive development. The lint yield of the skip planted PRD treatment (1.57 t/ha) was the same as the fully irrigated (1.61 t/ha), and the solid planted PRD (1.82 t/ha) yielded less than the fully irrigated (2.11 t/ha). From this preliminary experiment the benefits of PRD in the cotton system was not achieved. PRD did not affect cotton stomatal regulation or have a positive effect on the growth, development or yield. In addition, achieving PRD on clay soils with lateral water movement that are prevalent in the cotton growing regions is also difficult.

Keywords

Drip irrigation, planting configuration

Introduction

PRD has been investigated for irrigation of grape and other horticultural crops with claims of increased yield and water use efficiency. This experiment was established to investigate the possibility of using PRD in the Australian cotton system. To investigate the benefits of PRD on plant function and yield, this pilot experiment was established using drip irrigation and planting configurations to achieve the maximum possibility of successful implementation of this technique.

Methods

A preliminary field experiment was conducted at Narrabri (30.31?S 149.78?E) NSW Australia in the 2005-2006 cotton season. The Bollgard II[?] cotton variety Sicot 71BR was used. The experiment was planted on 11th October 2005, plots were 30m long by 5 rows wide. The experiment was grown in two row configurations on 1-metre beds: solid had one metre row spacing, while the skip had one row of cotton planted then one row blank (Figure 1). Irrigation was applied by surface drip tape with the tape laid in every furrow. Two irrigation treatments were imposed over the sowing configurations. The fully irrigated crop was watered using the tapes in both furrows at each irrigation (Figure 1 a and b), while the PRD only received irrigation from one furrow per irrigation (Figure 1 c and d). Drip irrigation was applied daily or every two days to maintain the fully irrigated crop near the field capacity. The drip irrigation system was capable of delivering 2 mm per hour. The fully irrigated and PRD treatments both had the same amount of water applied at each irrigation, to achieve this the PRD was irrigated for twice as long as the full irrigation.

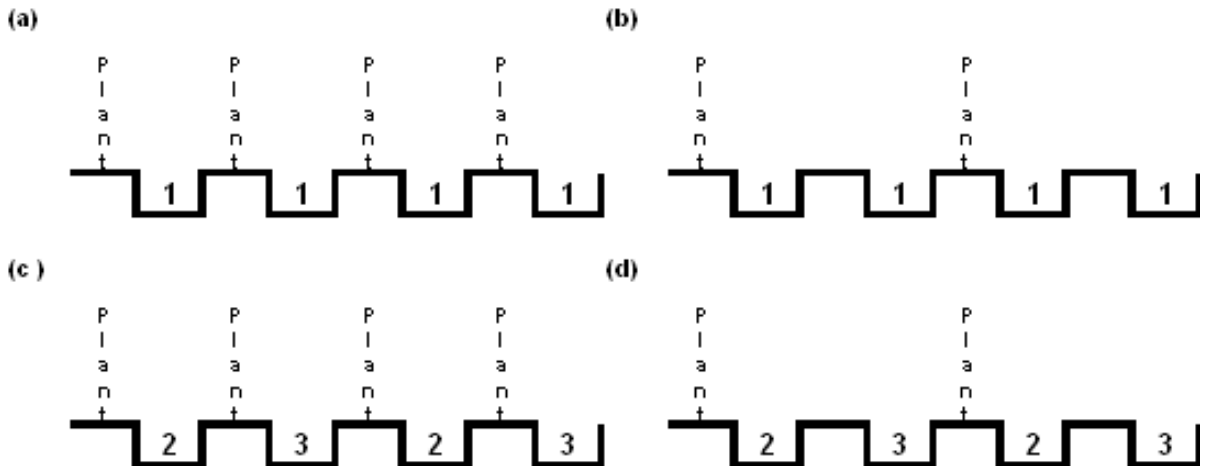

Figure 1. The four planting and irrigation configurations, solid planted (a and c) or skip planted (b and d) with water applied at every irrigation 1 (a and b), or water applied down only one furrow per irrigation 2 or 3 (c and d).

Results

The full irrigation treatments in both the solid and skip planted configurations had higher fruit numbers than the corresponding PRD treatments. There was no difference in average boll size between the full and PRD irrigation treatments. The PRD plants had a smaller total biomass than the full irrigation treatments (Table 1).

Table 1. Fruit number, boll weight and total dry weight as influenced by irrigation treatments and planting configurations.

Treatments	Fruit number (per m)	Average boll weight (g)	Total Dry Weight (g/m)
Solid planted full irrigation	123	5.4	659
Solid planted PRD	103	5.0	514
Skip planted full irrigation	226	3.8	850
Skip planted PRD	212	3.9	830

Yield of both PRD treatments was lower then the corresponding full irrigation plots (Table 2). Solid planting also had a higher yield than skip planted under both irrigation treatments.

Table 2. Influence of irrigation treatments and planting configurations on cotton lint yield (t/ha).

Treatments	Irrigation applied?	
Planting Configuration	Full	PRD

Solid	2.11	1.82
Skip	1.61	1.57

Discussion

PRD reduced the number of fruit (retained) on the plant in both planting configurations, and there was no increase in boll size to compensate for the loss of fruit numbers. The PRD plants were shorter than the full irrigation treatments in both planting configurations. Shorter plants with less number of fruits with resultant reduced yield indicates that although the same amount of water was applied to both irrigation treatments, the PRD crops were less water use efficient than the full irrigation treatments. In addition there was no difference in the timing of stomatal closure between the irrigation treatments in either of the planting configurations (data not shown).

It is anticipated that it would be difficult to achieve PRD on the cracking clay soils that are most common in the Australian cotton industry. This experiment used a drip irrigation system and skip planted cotton to achieve PRD that would not be a commercially acceptable and/or viable practice. However, under the deficit furrow irrigation system commonly used in the cotton industry the establishment of PRD on common vertosol soils is generally not practical.

Conclusion

This preliminary experiment showed no beneficial effect of PRD on cotton development or yield.

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