Water extraction of high retention cotton crops

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Abstract

Cotton is an indeterminate crop with fruit load controlling the extent of vegetative and root development. The advent of Bt transgenic crops capable of high early fruit retention has raised the question whether those crops need irrigating earlier and more frequently because of differences in root development. To measure differences in water extraction, as a measure of root development, between the high and low retention crops an experiment was established with three levels of fruit retention in a Bt transgenic variety: high (no manual fruit removal), medium (fruit removal from the bottom 5 fruiting branches) and low (all fruit removed from the plant). Manual fruit removal was undertaken between each irrigation in the medium and low retention treatments. In addition a water stress treatment in which the first two irrigations were missed was imposed across all fruit removal treatments. The depth of water extraction was monitored using neutron probes in both the plant row and associated furrow.

The fruit removal treatments had visible differences in the above ground vegetative growth of cotton; however, there was no difference in water extraction between the high and medium fruit removal treatments at either mid-flowering or the last effective flower (cutout). The low fruit retention treatment was not different to the other treatments at mid-flowering, but had extracted slightly more water by cutout. There was no interaction between the extended water stress and the fruit removal treatments, although all treatments with fruit removal extracted water deeper in the profile.

Keywords

Water stress, Fruit removal, root development

Introduction

The introduction of transgenic cotton allows for higher levels of early season of fruit retention. This early season fruit retention has the potential to affect development of the indeterminate cotton plant and modify plant structure possibly changing plant water requirements and uptake through effects on vegetative and root growth. The rationale for this is that crops with high fruit retention put more resources into fruit and less into vegetative growth; hence they may have a smaller root system less able to explore the soil for water. To address this question we established an experiment to examine the effect of three levels of fruit retention on soil water extraction patterns as a measure of root development.

Methods

The field experiment was conducted at Narrabri (30.31?S 149.78?E) Australia in the 2004-2005 season. The experiment used the Bollgard II variety Sicot 71BR. The experiment was grown with three level of fruit retention; high (no fruit removed) medium (fruit removed from the bottom 5 fruiting branches) and nil (all fruit removed from the plants). Two irrigation treatments were used, normal irrigation and stressed, where the first two irrigations were missed. A split plot design with irrigation as main plots with five replicates was used. The experiment was planted on 11 October 2004 and plots were 7m long by 3 rows wide with additional buffering to prevent lateral water movement. Two neutron probe tubes were installed per plot, in the middle row 2m from the end of the fruiting plot. The first probe tube was installed in the top of the hill and the second in the furrow. Statistical analyses were conducted using Genstat? software.

Results

At mid flowering and cutout (determined by medium fruit retention treatment) there was no difference in water extraction between the high and medium fruit retention. The nil retention treatment appeared to extract water to a slightly greater depth than the other treatments, however, this difference was not significant. The water stress treatments (data not presented) gave similar results between fruit removal treatments with no significant difference in moisture extraction, the only difference being a greater depth of extraction in all fruit retention treatments.

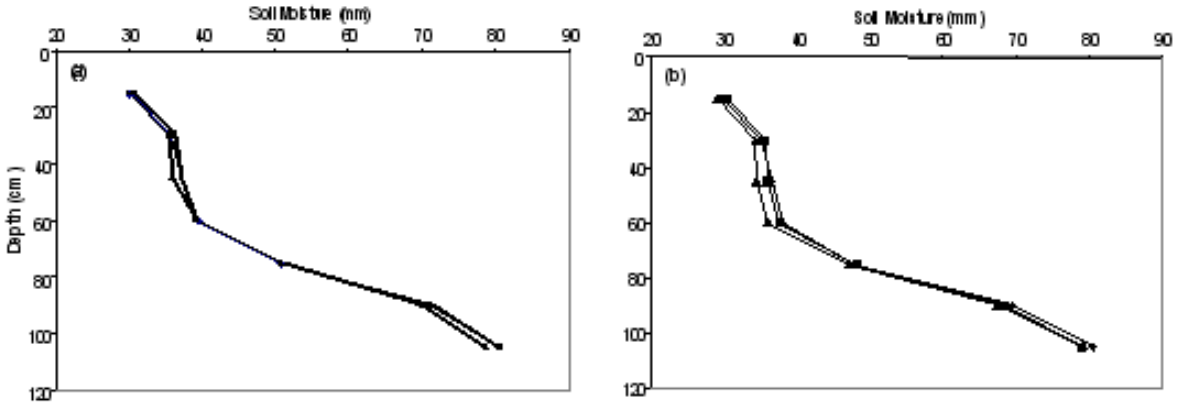

Figure 1. Water extraction at (a) mid flowering and (b) cutout for the fruit removal treatments High (♦), Medium (■) and Nil (▲) under full irrigation.

Under full irrigation total dry matter biomass was greatest in the high retention crop with 883 g m^{-2} compared to 863 g m^{-2} for the medium and 745 g m^{-2} in the nil.

Discussion

At either mid flowering or cutout, the level of fruit retention had no difference on the depth of water extraction of the cotton crops. The addition of water stress before and during flowering caused the plants to extract water from further down the profile but there was no interaction with the fruit removal treatments. This indicates that water use of the plants was not dictated by the level of crop fruit retention.

The difference in dry matter production shows that although the nil retention plants were taller (data not shown), total dry matter production was highest in the high retention treatments. This higher biomass may have lead to greater water use by the high retention crops post cutout.

Further research on post cutout water use of different fruit retention levels is required.

Conclusion

High fruit retention cotton crops did not extract water differently from crops that had medium or nil fruit retention.

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