Evaporative effects on cotton water stress

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Summary

Climatic factors such as vapor pressure (the capacity of the air to hold water at a given temperature, which is used to calculate relative humidity) influence crop growth, including how much moisture from the plant is needed for transpiration, Transpiration is important to regulate leaf temperature which influences photosynthesis and crop growth. This study showed that changes in vapor pressure affected the level of stress a plant regardless of the level of soil moisture highlighting the need for irrigation scheduling to reflect both factors. Quantifying these effects is also important where future climate change predictions suggest lower humidity and higher temperature which will increase the evaporative demand on crops.

Introduction

Denmead and Shaw (1962) showed that the impact of a given water deficit on plant function is greater when the evaporative demand is high. This may create problems when pre-determined deficits are used for irrigation scheduling as they may not reliably match the plant's water requirements. Conceivably under high levels of soil moisture with high evaporative demand, plants could still experience stress which will impact on growth and ultimately yield. This maybe especially important, as predictions of future climate change suggest more frequent days of higher temperatures as well as lower humidity (CSIRO, 2007). To investigate the effects of vapour pressure on the degree of plant stress we have conducted studies that varied soil moisture using an irrigation scheduling experiment. These experiments were conducted over two seasons which provided a range of evaporative demands between the seasons,

Material and Methods

Measurements of midday leaf water potential (an indicator of plant stress that represents the force the plant is using to extract water from the soil) were taken during flowering in the 2006/07 and 2007/08 seasons in the furrow deficit irrigation experiment of Steve Yeates. Four irrigation treatments were applied with average soil moisture deficits of 37, 61, 81 and 125 mm. The varieties used were Sicot 71BR in 2006/2007 and Sicot 70BRF in 2007/2008. Soil moisture was measured using a neutron probe on the same day as the leaf water potential readings were taken, and climatic data was obtained from the Silo patch point data set for Narrabri (Bureau of Meteorology).

Results and Discussion

The combination of the four irrigation treatments and a large difference in climatic conditions between the two growing seasons produced a wide range of leaf water potential data. The average atmospheric vapour pressure during flowering was 20.8 hPa in 2006/2007 compared to 18.2 hPa in 2007/2008. This indicates a hotter drier atmosphere experienced during the season in 2006/2007.

These differences in vapour pressure significantly affected the leaf water potential of the crop. Generally, when crops experienced high vapour pressure (greater than 20 hPa) during flowering in both seasons crops were more stressed compared when they experience low vapour pressure (lower than 20 hPa) during flowering (Figure 1). The results also showed that only when soil moisture levels were near to field capacity there was little affect of vapour pressure.

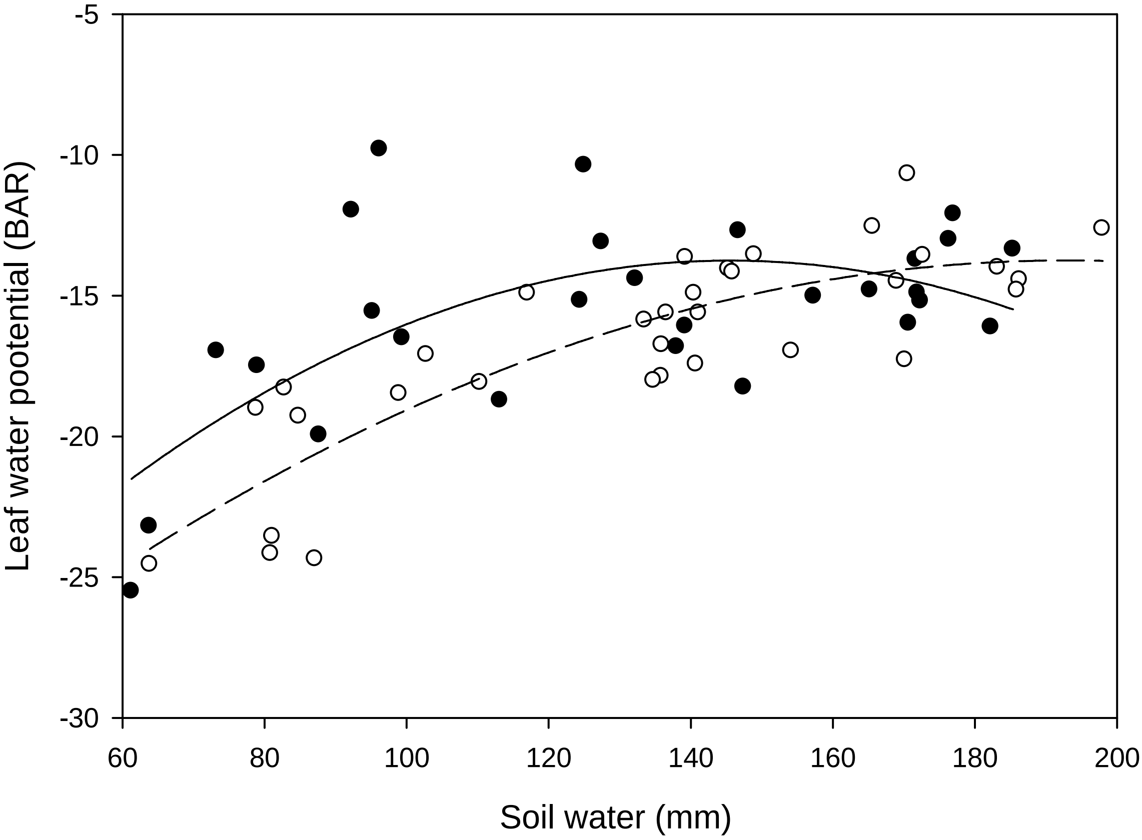

Figure 1. Effect of vapour pressure on leaf water potential, high vapour pressure (○,dashed line) and low vapour pressure (●, solid line).

The responses found here have important implications for irrigation management as differences in evaporative demand, including those associated with climate change, may necessitate changes in irrigation scheduling. Irrigation frequency may need to increase and soil moisture deficits reduced to maintain plant growth and yield under adverse climatic conditions.

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References

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