Canopy temperature for optimal furrow irrigation scheduling

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Most (90%) Australian cotton farms are furrow irrigated with irrigation schedule based on target soil moisture deficit and farmer's intuition. To optimise this practice a modified protocol (BIOTIC) based on canopy temperature (a plant water status indicator) was applied in Australian system.

The old vs new: a comparison

Experiments were conducted with cotton (*Gossypium hirsutum* L.) in two Australian cotton regions (Namoi and Emerald) to

i. test the feasibility of scheduling irrigation in furrow systems by canopy temperature (Tc)

ii. compare crop performance under irrigation scheduled by Tc with traditional scheduling approach based on targeted soil moisture deficit and farmer's intuition.

Canopy temperature irrigation was based on modifications to the Temperature-Time Threshold (or BIOTIC) proposed by Wanjura and co. (Wanjura et al., 1995; Mahan et al., 2005). It represented a target accumulation of stress time above the optimum temperature for a crop's physiological function in a given environment.

Plant response to different irrigation schedules

Irrigation scheduled by Tc matched traditional schedules used by high yielding and experienced farmers in the two valleys. Mean modified Temperature-Time Threshold of 45.1h (Namoi) and 41.9h (Emerald) between irrigation events from reproductive development to maturity resulted in mean leaf water potential (LWP) of -1.7 and -1.8MPa respectively, which was only higher than those of control plants (-1.6MPa) in Emerald.

Plant response to either Tc or traditional irrigation schedule in each region, including fruit distribution (Fig. 1) biomass (Fig. 2) and yield (Table 1) were not different ($P>0.05$).

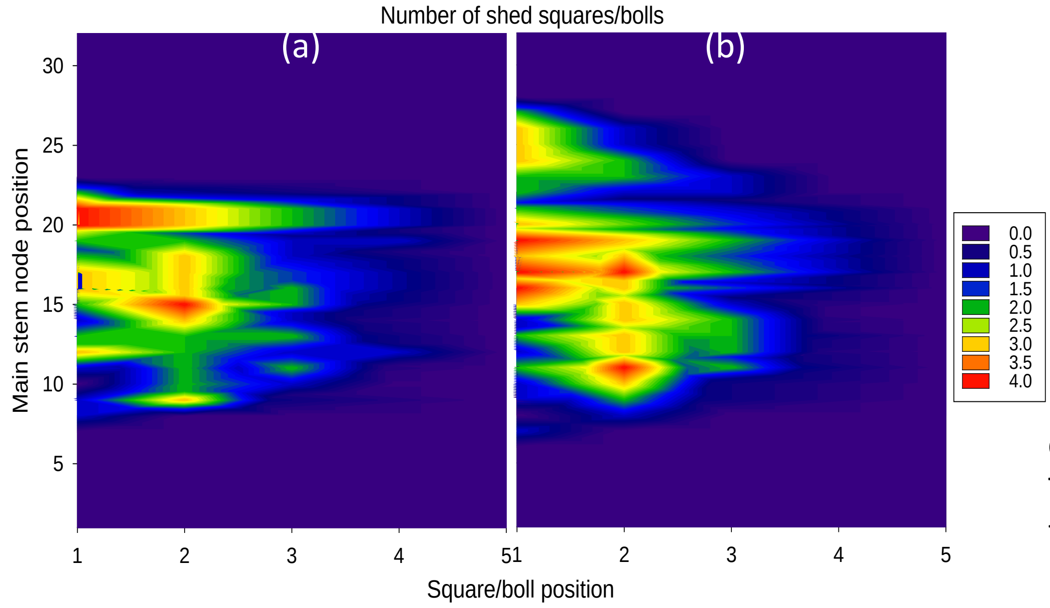

Figure 1 Vertical and horizontal distribution of mean shed squares/bolls of four representative plants irrigated by canopy temperature (a) or traditional farmer's approach (b) in the Namoi valley

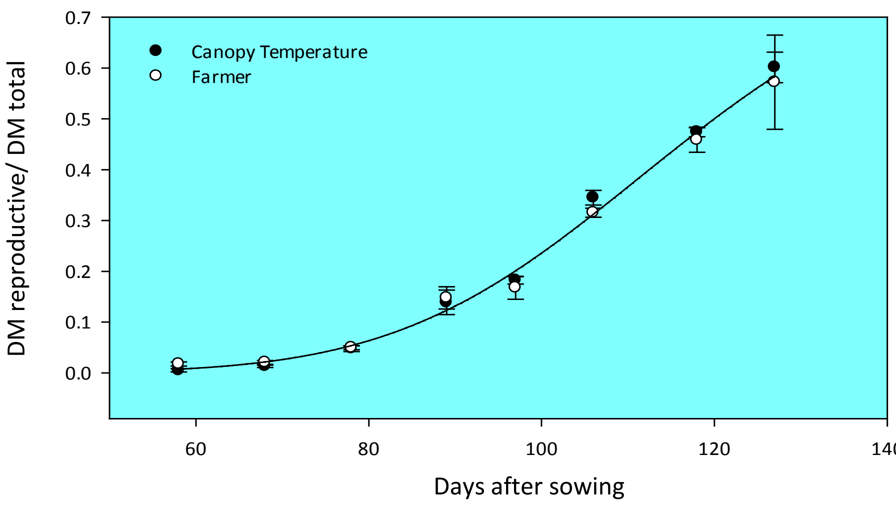

Figure 2: Ratio of reproductive to total dry matter for canopy temperature and farmer's (traditional) irrigation schedule . Bars are s.e.m. R^2 = 0.993±0.018; $P<0.0001$.

Irrigation counts and water applied

Number of irrigations and amount of infiltrated irrigation water were different in Namoi (Table 1). Extending the Tc irrigation to a mild stress modified Temperature-Time Threshold of 64.7h (mean LWP of -2.0MPa) resulted in two less irrigations. This also caused a slight yield loss even though more water was used to flood the furrows (Table 1).

Table 1: Cotton lint yield and irrigation

Region	Variables	Lint yield (Bales ha^{-1})*	Irrigation water (mm)
Namoi	Control	12.3±0.8	201±16 (6)
	Tc	11.3±0.1	140±18 (5)
	Mild stress Tc	10.8±0.2	220±14 (4)
	l.s.d.	1.4	48
Emerald	Control	10.4±0.5	--- (6)
	Tc	10.1±0.1	--- (6)
	t statistic	0.7	

* values ± s.e.m. in parentheses are number of irrigations

--- = not available

Conclusion

This study shows for the first time the feasibility of scheduling furrow irrigation by Tc. Irrigation scheduled by Tc matched high yielding traditional schedules in two different environments. Preliminary result suggest potential for optimising water use in Australian cotton production systems.

FOR FURTHER INFORMATION

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REFERENCES

Wanjura, D. F., Upchurch, D. R., Sassenrath-Cole, G., and DeTar, W. R. (1995). Calculating time-thresholds for irrigation scheduling. *1995 Proceedings Beltwide Cotton Conferences, San Antonio, TX, USA, January 4-7, 1995: Volume 1.*, 449-452.

Mahan, J. R., Burke, J. J., Wanjura, D. F., and Upchurch, D. R. (2005). Determination of temperature and time thresholds for BIOTIC irrigation of peanut on the Southern High Plains of Texas. *Irrigation Science* **23**, 145-152

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