

Temperature extremes and cotton performance

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Temperature plays many important roles in the growth and development of cotton. Low temperatures after sowing increase the time to emergence and reduce seedling vigour often leading to poor establishment, poor early growth and increased risk of seedling diseases. The timing of crop maturity, yield and fibre quality may also be affected. In addition there is some evidence to suggest that high temperatures may impact negatively on crop development. Research is being conducted to improve our understanding of the impacts of temperature extremes on cotton performance. These studies will help improve the precision of both research and management in scenarios where extremes of temperature are likely. This paper describes this ongoing work and presents some results that have enabled better estimates of crop development and attempts to quantify the impacts of cold shocks.

Introduction

Much of our current understanding of the impacts of temperature on cotton crop growth and development is based on experimental work undertaken by Greg Constable for early cotton growth in the early 70's with cultivars quite different than those used commercially today (Constable, 1976). It was from these experiments that, the base temperature (12 °C) used in estimating crop development was derived, and the definition of a cold shock (< 11 °C) was formulated. Constable acknowledged at the time there was considerable extrapolation of the information to derive these values. Since then, there has been no definitive attempt to better understand and quantify the effects of temperature extremes on cotton growth and development for early growth (nor at other stages) and subsequent impact on crop yield.

Our lack of understanding of the impacts of extreme temperatures on crop growth and development impedes our capacity to explore management opportunities to improve crop yield and profitability (both from a genetic and agronomic perspective) under such temperature extremes. These factors take on greater importance with the expansion of the industry into regions to the north and to the south which has increased the range and duration of hot and cold temperature to which the crop may be exposed. This paper presents some results from two components of ongoing temperature research, they are: the development of refined functions for the prediction of cotton crop development; and attempts to quantifying the effects of cold shock on crop growth.

Estimating Temperature Influences on Crop Development

An alternative approach to degree days is to describe the rate of a process, or the rate of progress toward a developmental stage, directly as a function of temperature. This allows functions to be used to more accurately reflect the variation in rate over a wider range of temperatures.

A series of experiments using variety Siokra L22 was conducted in a temperature controlled glasshouse under natural light conditions. Average daily average temperatures treatments ranging from 16 to 32 °C were imposed. Frequent observations were made on an individual plant basis to determine the date of appearance of the first square. Similarly, data recording the time of first square was also collated from a number of field experiments to compare with those results collected in the glasshouse (Table 1). This field experiments however, had a range of different cultivars and sowing times.

Table 1: Field experiments used in collating data from a range of temperature regimes for estimating the rate of development to the appearance of the first square.

Location	Date of Experiments	Source
Narrabri	1972-74	Constable (1976)
Narrabri	1994-98	Bange and Milroy (2000)
Narrabri	1990-92	Wells (previously unpublished)
Kununurra	1995-97	Yeates (previously unpublished)

The rate of development between sowing and the appearance of the first square was calculated as the inverse of the duration of the period between the two events. Measurements taken from plants grown in the glasshouse experiments showed that at high temperatures, a maximum rate of 0.034 was approached and the rate fell to zero at an average temperature of around 15°C (Fig. 1). The fact that the curve fitted to the controlled environment data lies at the upper edge of the scatter of field data suggests that it represents a maximal rate of development with other factors reducing the rate for individual field observations.

These results show that that the rate of development to first square does not keep increasing as temperature increases. Secondly, it shows that the base temperature (temperature below which no crop development occurs) for this early period of crop growth is closer to 15 °C than 12 °C that was estimated in the work by Constable (1976).

A comparison in the ability to predict first square was then made between the function presented above and the present DD12 function (using 505 day degrees to first square). The results showed that there was less variability overall in using the new function compared with the present DD12 (Fig. 2). It is also important to note that the predictions using the rate function did not require any adjustments for cold shocks.

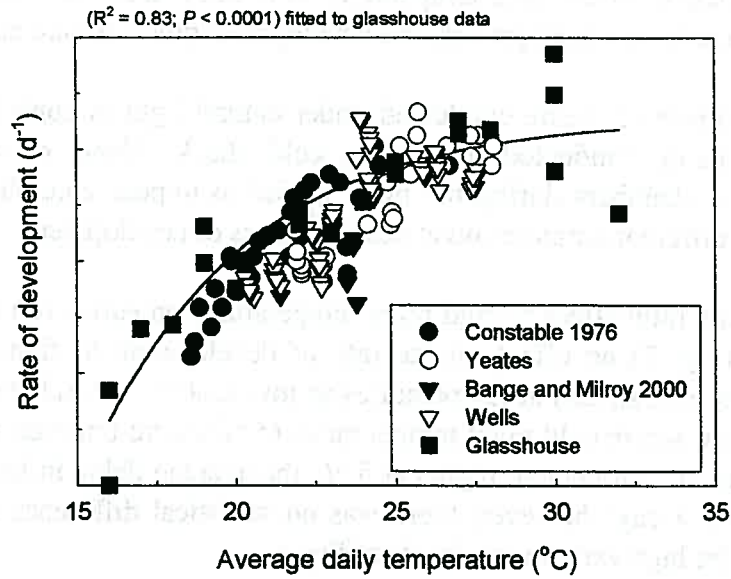


Figure 1. Rate of development to first square versus average daily temperature. Response derived from experiments performed in the glasshouse. Data collated from a number of field experiments included for comparison.

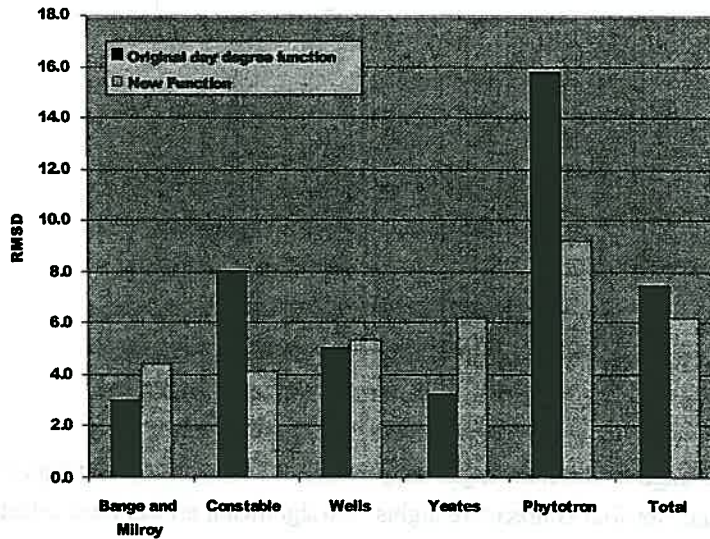


Figure 2. Root Mean Square Deviation (RMSD) which is a measure of the variation of the ability of the functions (new function and DD12) to predict time of first square. The smaller the RMSD the better the function is able to predict first square.

Quantifying cold shock

It is widely held within the Australian cotton industry that minimum temperatures below 11 °C delay the development of cotton seedlings beyond what would be expected based on the accumulated degree day sum. However, this has not been tested explicitly. Glasshouse experiments have been conducted to: 1. test for the existence of cold shock; 2. determine

the temperature below which cold temperature will delay early development of cotton seedlings; and 3. establish which growth and development processes are effected.

A series of experiments is being conducted under natural light in controlled temperature glasshouses are being conducted to explore cold shock. Plants of cultivar V2i are transferred to cold chambers during the night period to impose cold shocks at different temperatures, for different durations on at desired stages of development.

Results so far show little effect of cold night temperatures on early crop development. In one experiment (Fig. 3) no effect on the rate of development to first square could be detected after four cold shocks at temperatures as low as 8 °C. A subsequent experiment was then conducted where cold night temperatures (5 °C) were imposed for either 5 or 10 days. After 5 and 10 consecutive nights at 5 °C the average delay in time to first square was approximately 4 days however, there was no statistical difference in the five night treatment due to the high variation in the data (Fig. 4).

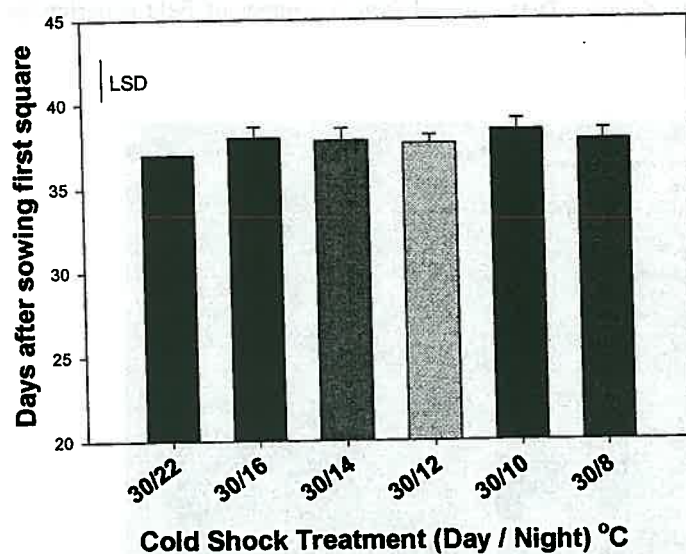


Figure 3: The impact of a range of different night temperatures on the time to first square. Treatments applied at the four true leaf stage for four consecutive nights. No significant effects were detected.

These results so far are in line with those discussed in the previous section on crop development. Using the new function with a higher base temperature of 15 °C we were able to predict crop development better than the existing DD12 function without accounting for cold shock. The prediction of crop development with the DD12 function using a cold shock in some ways makes up for lack of accuracy in using a lower base temperature. Research is continuing in an effort to determine those temperatures and situations where cold shock does in fact occur.

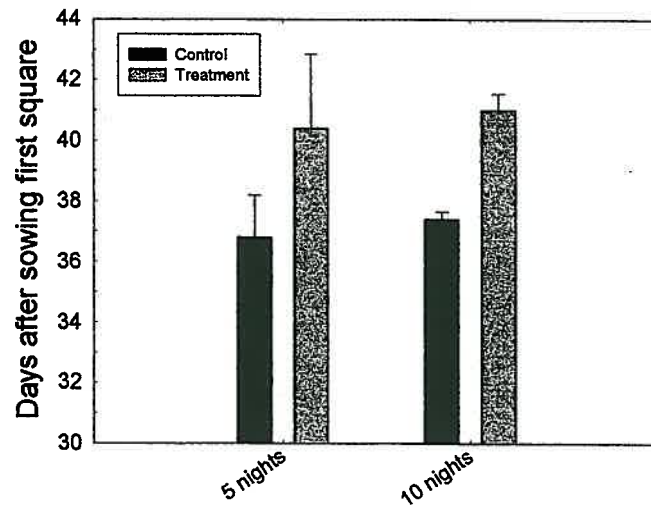


Figure 4: The impact of duration (5 or 10 nights consecutively) of cold night temperatures (5 °C) at different stages of cotton development. Treatments were applied at the four true leaf stage. Control plants used for comparison were grown at night temperatures of 19 °C.

Conclusions

In gaining a better understanding of the impacts of temperature extremes we will be able this information to develop more functional decision support tools and field management strategies which will enable both research and management to be done more accurately in scenarios where extremes of temperature are likely. Further research is also exploring: the impacts of cold temperatures on other stages of crop development; the impact of higher night temperatures; and quantifying more clearly the impacts of frost on seedling survival and on crop maturation.

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References:

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1. Einleitung

Die vorliegende Arbeit beschäftigt sich mit der Analyse der Auswirkungen der Digitalisierung auf den Arbeitsmarkt. In den letzten Jahren hat die Digitalisierung einen erheblichen Einfluss auf die Arbeitswelt gehabt, was zu Veränderungen in den Arbeitsbedingungen, den Anforderungen an die Arbeitnehmer und den Möglichkeiten der Arbeitgeber führt.

Im Zentrum der Untersuchung stehen die Auswirkungen der Digitalisierung auf die Beschäftigung, die Arbeitszeiten und die Arbeitsbedingungen. Es wird untersucht, wie die Digitalisierung die Nachfrage nach Arbeitskräften beeinflusst und welche Auswirkungen dies auf den Arbeitsmarkt hat.

Die Arbeit ist in drei Hauptkapitel unterteilt: Einleitung, Hauptteil und Schluss. Im Hauptteil werden die verschiedenen Aspekte der Digitalisierung im Detail analysiert und die Auswirkungen auf den Arbeitsmarkt diskutiert.

2. Hauptteil

2.1. Die Digitalisierung des Arbeitsmarktes

Die Digitalisierung des Arbeitsmarktes ist ein Prozess, bei dem digitale Technologien in den Arbeitsprozess integriert werden. Dies führt zu einer Erhöhung der Produktivität und der Effizienz, aber auch zu einer Veränderung der Arbeitsbedingungen. Die Digitalisierung führt zu einer Erhöhung der Nachfrage nach hochqualifizierten Arbeitskräften, während die Nachfrage nach niedrigqualifizierten Arbeitskräften sinkt.

2.2. Auswirkungen der Digitalisierung

Die Digitalisierung hat erhebliche Auswirkungen auf den Arbeitsmarkt. Sie führt zu einer Erhöhung der Beschäftigung in den Dienstleistungssektoren und einer Verringerung der Beschäftigung in den industriellen Sektoren. Die Digitalisierung führt auch zu einer Erhöhung der Arbeitszeiten und einer Verringerung der Arbeitsbedingungen. Die Digitalisierung führt zu einer Erhöhung der Anforderungen an die Arbeitnehmer, was zu einer Erhöhung der Arbeitslosigkeit führt.

3. Schluss

3.1. Zusammenfassung

In der vorliegenden Arbeit wurde die Digitalisierung des Arbeitsmarktes analysiert. Es wurde festgestellt, dass die Digitalisierung zu erheblichen Veränderungen im Arbeitsmarkt führt. Die Digitalisierung führt zu einer Erhöhung der Beschäftigung in den Dienstleistungssektoren und einer Verringerung der Beschäftigung in den industriellen Sektoren.

