PREDICTING YIELD RESPONSES OF COTTON TO GROWTH REGULATORS

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Abstract

There have been some significant recent improvements in the understanding of vegetative growth management in cotton using growth regulators. Successful advisory programs have been implemented for cotton growers to monitor their crops and apply growth regulators to prevent excessive vegetative growth. In some instances vigour indices and height:node ratios can disregard conditions where a crop is moving from good conditions to bad, or from bad to good. For example, a crop may have short seedling internodes from cool weather or other stress, then have better conditions where subsequent vegetative growth may be excessive. Although the crop vigour index may still be 'low', it has a high current rate of vegetative growth and could still respond to a growth regulator.

This aspect of monitoring and managing cotton crop vegetative growth has been examined in Australia for five seasons. Treatments included sowing dates and varieties. The crops ranged in final plant height from 60 to 160 cm; and yields ranged from 1100 to 2500 kg lint/ha. In every experiment, the rate of increase in internode length was measured prior to applications of Mepiquat chloride (MC - Pix). Results showed that when internode length increased at less than 5.5 cm/node, no response or even negative yield responses to MC were obtained. When internode length was increasing at more than 6.5 cm/node, significant yield increases were obtained. This association was generally true across cultivars, although there were indications that some cultivars were more or less responsive to MC. Since it is usually too late to obtain yield responses to MC once a crop is already too tall, this procedure allows problem situations to be diagnosed <u>before</u> excessive vegetative growth occurs.

Introduction

As an indeterminate perennial, cotton is susceptible to excessive vegetative growth during conditions of high temperature, water supply and soil fertility. Thirty years ago there were guidelines for 'managing' vegetative growth to the extent where it was recommended to stress a cotton crop at the early flowering stage to promote early fruit retention. With more intensive crop management and with higher yielding varieties, the practice of early stress has been replaced with the use of a growth regulator to restrict excessive vegetative growth.

Mepiquat chloride (MC - Pix) has become available in the past 20 years. Studies on application rates and strategies have developed good guidelines for use. Positive responses are found to varying degrees for plant size, earliness and yield. Tall crops and short seasons in particular have shown greatest yield responses in California (Kerby, 1985). Cothren (these proceedings) has reviewed the use of growth regulators and Edmiston (these proceedings) presents a structured way of deciding on MC use in the field.

There have been some significant recent improvements in the understanding of managing plant growth in cotton with growth regulators. Dr Tom Kerby of the University of California has implemented some very successful advisory programs for Californian growers to monitor their cotton crops to achieve optimum growth. The general principles of that work are excellent and specifies <u>regular monitoring</u> of development, crop vigour and fruit retention. The concept of regular monitoring is important for many aspects of cotton management (e.g. pest levels, water supply, nutrients). An example of the original Californian vigour index estimation is shown in Figure 1.

The relationship in Figure 1 is often not interpreted correctly. The California standard Acala line is <u>not</u> intended to denote ideal internode lengths. In both California and Australia, the ideal plant size is smaller than indicated in this relationship - ie the internodes should be shorter. This relationship can disregard conditions where a crop is moving from good conditions to bad (line A), or from bad to good (line B). A crop may have short seedling internodes as in line B, then have better conditions where subsequent vegetative growth maybe excessive. Although the crop vigour index may still be 'low', it has a high rate of vegetative growth and could still respond to MC.

MC has been used in Australia since it became available. The early use of MC in Australia tended to have a later than desired application timing and on many occasions the product was applied in situations that were not justified. As a result, the full benefits of this technology were wasted or not realised. However because Australia has its own unique combinations of variety, pests, climate and soil type, it was necessary to confirm overseas guidelines under local conditions.

Methods

The experiments were done at the Australian Cotton Research Institute (lat 30˚S; long 140˚E). The soil type was a grey cracking clay (Typic Pellustert or Vertisol) and the crops were irrigated and controlled for insect pests as required. There was one experiment in each of five seasons.

One objective of the experiments was to evaluate the following MC application strategies:

1. Split applications where MC at about 200 ml/ha is applied to the crop in the early squaring phase, at first flowering and finally about ten days after flowering.
2. Single application of MC at 600 ml/ha at first flowering.
3. Late application of MC at 1200 ml/ha at 'cutout' (when new square production had ceased, ie when there were four nodes above the last flower). This was a common practice in Australia to restrict unwanted late vegetative growth.

The experiments were:

In 1989/90 and 1990/91 four MC application strategies (split, single, late, control) were applied to four cultivars (Siokra 1-4, Siokra L22, Sicala 33 and DP90), each with two levels of pre sowing nitrogen fertilizer application (150 and 200 kg N/ha). There were six replications of a split plot design.

In 1991/92 the same four MC application strategies (split, single, late, control) were applied to four cultivars (Siokra 1-4, Siokra L22, Sicala 33 and DP90), at three sowing dates (October (normal), November (late) and December (very late)). There were four replications of a split plot design at each sowing date.

In 1992/93 and 1993/94 two MC application strategies (single and control) were applied to 15 different genotypes including current commercial cultivars and promising lines from the CSIRO breeding program. There were four replications of a split plot design.

Plot size in each experiment was eight 100 cm rows at least 15 m long. MC was sprayed using a self propelled high clearance spray rig, using a volume of 150 l/ha. Lint yields were measured by harvesting two rows from each plot with a mechanical picker and a 300 gm sub sample was ginned in a 20 saw gin. All plots were monitored weekly from squaring to cutout for plant height and mainstem node numbers. Plants tipped out were not used for plant monitoring. In every experiment, the rate of internode increase in length has been measured prior to applications of MC. The calculation was as follows:

$$\textbf{Rate of internode increase} = \frac{\textbf{This week's height - Last week's height}}{\textbf{This week's nodes - Last week's nodes}}$$

Results and Discussion

The split applications were never better than the single application strategy and late applications were never different from the control. This paper will only use data from the single MC application strategy at flowering compared with the control.

The crops ranged in final plant height from 60 to 160 cm; and yields ranged from 1100 to 2500 kg lint/ha. The results from the experiments in 1989/90, 1990/91 and 1991/92 are summarised in Figure 2. They show that internode increases of less than 5.5 cm led to no response or even negative yield responses to MC. Note that the Acala line in Figure 1 produces internode increases of more than 8 cm, so California should expect MC responses - which is generally the case. Since it is usually too late to obtain yield responses to MC once a crop is already too tall, this procedure allows problem situations to be diagnosed <u>before</u> excessive vegetative growth occurs.

Note that Figure 2 represents pooled data across a wide range of seasons, sowing dates and varieties. For 1992/93 where 15 cultivars were tested, the association between internode increase and yield response to MC (Figure 3) was similar to that established in Figure 2. However there was variation of yield response by cultivars for the same level of internode increase.

When the data from 1992/93 and 1993/94 for cultivar response differences were averaged, it was found that cultivars differed considerably in their MC response (Table 1). The ranking for response was not expected, as early maturing cultivars Siokra S324 and CS 8S had greater average responses to MC than later maturing cultivars Siokra L23 and Siokra V-15.

Conclusions

Regular monitoring of plant size is the only way to accurately determine the need to manage crop growth. These results have shown that there is a useful correlation between vegetative growth and yield response to MC. Cultivar differences appear to exist and should be considered in management decisions.

References

Cothren, J.T. (* these proceedings). Use of Growth Regulators in Cotton Production.

Edmiston, K.L. (* these proceedings). The Use of Plant Monitoring Techniques as an Aid in Determining Mepiquat Chloride Rates in Rain-fed Cotton.

Kerby, T. A. (1985). Cotton response to Mepiquat Chloride. *Agron J.* **77**, 515-518.

Table 1. The yield response of Australian commercial varieties to 600 ml MC/ha applied at first flower. Data averaged for the 1992/93 and 1993/94 seasons.

Variety	Response to MC (% yield increase over control)
CS 189+	9.1
CS 50	8.4
Sicala V-2	5.5
Siokra S324	5.5
CS 8S	4.9
Siokra 1-4	2.7
Siokra L23	2.5
Siokra V-15	0.6

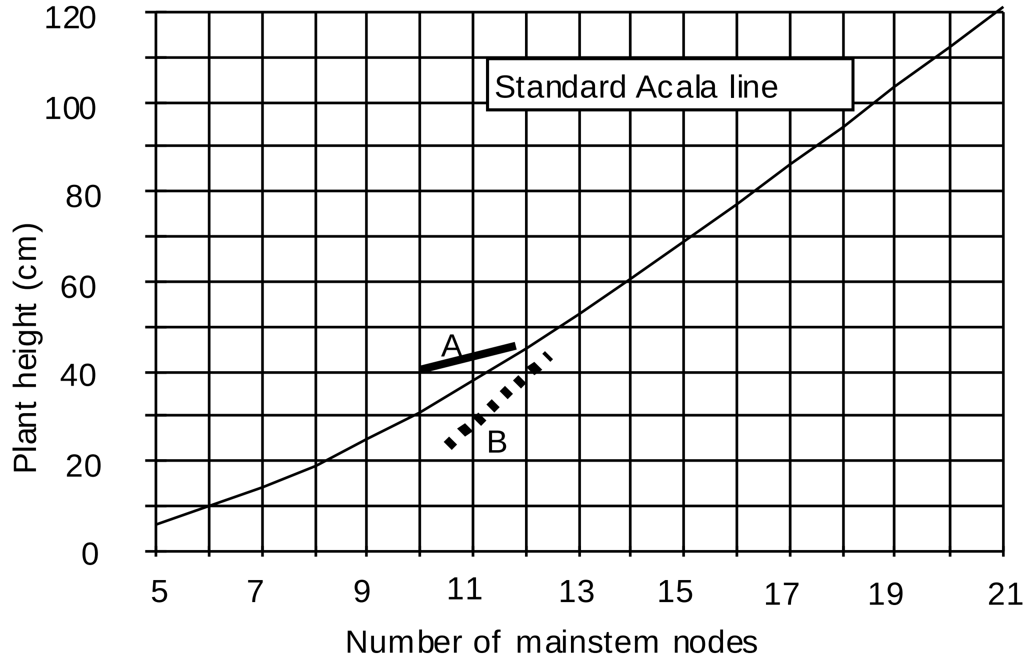

Figure 1. The standard relationship between mainstem nodes and plant height used in California to determine the vigour index of a cotton crop (from Kerby, University of California). Lines A and B are described in the text.

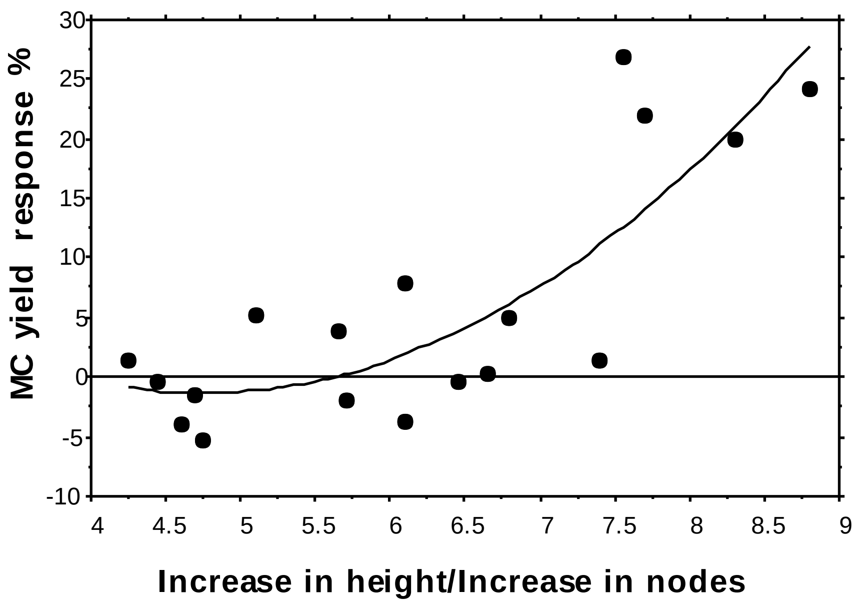

Figure 2. The relationship between rate of plant internode increase at early flowering and the subsequent yield response of that crop to MC. Pooled data for 1989/90, 1990/91 and 1991/92 seasons with four varieties. Curve is $Y = 37.9 - 16.6X + 1.756X^2$; $R^2 = 0.69$.

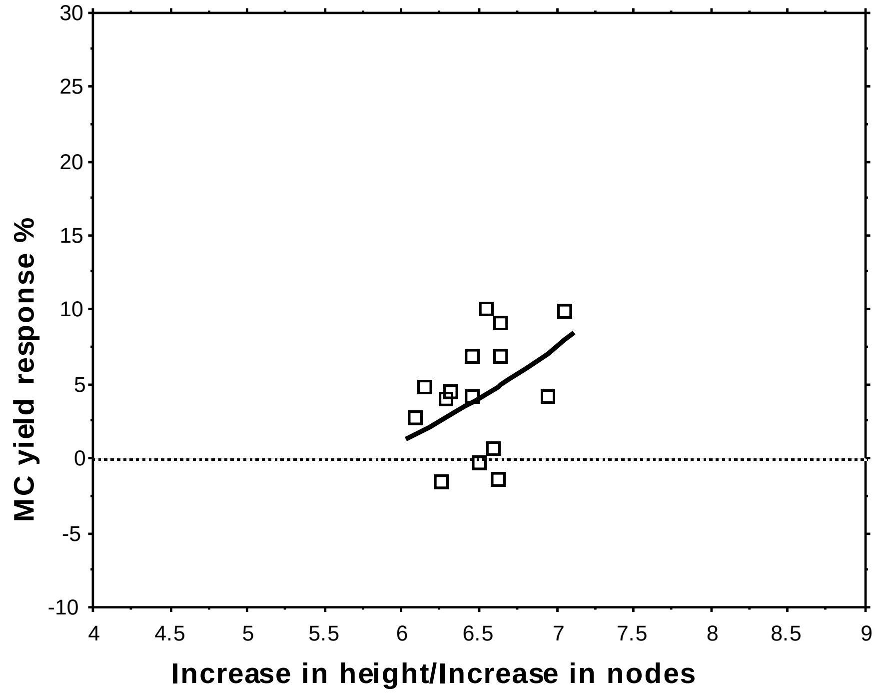

Figure 3. Association between MC yield response and rate of internode increase of 15 cultivars in the 1992/93 season. The relationship plotted in Figure 2 is shown as a line.