Re-evaluating mepiquat chloride use in Bollgard II® Cotton

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Abstract
During the reproductive growth phase, there is competition for water, nutrients and carbohydrates between vegetative and reproductive growth in cotton plants. Plant growth regulators (PGR) such as mepiquat chloride (anti-gibberellin, MC) may be useful to slow new vegetative growth and instead promote reproductive growth. Previous PGR recommendations were based on conventional cotton cultivars rather than high lint-retention Bollgard II® cultivars. This paper describes field experiments over two growing seasons (2012/13 and 2013/14) with the main objective being to re-evaluate the use of Vegetative Growth Rate (VGR) for early season MC decisions in Bollgard II. Experiments also evaluated a multiple rate approach versus a single application of MC. Results showed that that relative yield responses to VGR differed compared with past experiments. At high VGRs yield was improved with the application of MC, however at low VGR yield reductions were substantially greater than previously reported. Yield reduction was associated with the higher fruit load in Bollgard II crops. Use of MC on Bollgard II crops require caution especially if crops have low VGRs, and this information will be used to revise industry recommendations.

Key words
Squaring, *Gossypium hirsutum*, Vegetative Growth Rate (VGR), mepiquat chloride

Introduction

After flowering, there is competition for water, nutrients and carbohydrates between vegetative and reproductive parts of the cotton plant (*Gossypium hirsutum* L.). This is normally regulated by the plant as described by Williams et al. (2012), but in some situations can become unbalanced where vegetative growth dominates, potentially reducing yield. In this situation, use of growth regulators such as mepiquat chloride (MC) could be considered by industry to modify the pattern of growth and development of cotton plants.

In making the decision to apply MC, it is important to consider why excessive vegetative growth occurs in cotton. One method used by industry to assist in making these decisions is by measuring Vegetative Growth Rate (VGR) at the early flowering growth stage to identify excessive growth. To date VGR however has only been validated in conventional cotton and not higher yielding Bollgard II® cotton crops; hence there is a need to re-evaluate the effectiveness of this method for the newer varieties.

Methods

The experiments were based at the Australian Cotton Research Institute, Narrabri, NSW, Australia. Experiments were conducted over two growing seasons 2012/2013 (Exp. 1) and 2013/2014 (Exp. 2). In Exp. 1 two different crop types with low and high vigour (VGR) were established using Bollgard II® cultivar Sicot 74BRF according to current production methods. The low VGR crop was planted mid October (normal planting time) and the high VGR crop was planted late (early December). The high VGR crop received an additional 200kg/ha of urea in late December. In Exp. 2, only the high VGR crop was grown. Both experiments had in excess of 300 kg/ha of available soil N at planting.

Three MC treatments (nil, single application of 900 ml/ha, and three applications of 300 ml/ha) were applied in experiments 1 and 2. The timing of the single application was at first flower (where 50% of plants have a white flower), while the multiple application treatment had MC applied at squaring (i.e. budding), first flower and 2 weeks after first flower application (Table 1).

All experiments used a randomised complete block design with four replications. Plots were 12m long by 4 m (4 rows) wide. There was also a 22 m buffer located at both the head ditch and tail drain. MC was applied using a calibrated hand held spray boom (width 4m).

Table 1: Date (including days after planting) of Mepiquat Choliride applications

	Single Treatment (First flower)	Multiple Treatments		
		Squaring	First flower	2 wks> First flower
Exp. 1 Low VGR	27/12/2012 (72)	06/12/2012 (51)	27/12/2012 (72)	04/01/2013 (80)
Exp. 1 High VGR	31/01/2013 (58)	16/01/2013 (43)	31/01/2013 (58)	14/02/2013 (72)
Exp. 2	15/01/2014 (64)	06/01/2014 (55)	15/01/2014 (64)	28/01/2014 (77)

Measurements

VGR was monitored weekly from first square (where 50% of plants have squares) to 2 weeks after the last application in the multiple application treatments. Measurements included height and number of nodes from the plant cotyledon to the terminal node. VGR was calculated using Equation 1 where H and N refer to height (cm) and number of nodes, respectively, measured at weekly intervals (1, 2 week), as described by Constable (1992).

$$VGR\ (cm/node) = (H2 - H1) / (N2 - N1) \qquad \text{[Equation 1]}$$

Measurements before harvest included final plant height, total nodes, number of fruiting branches, number of vegetative branches, number of vegetative fruit, total fruit and % fruit retention. Cotton lint was harvested using a specialised cotton picker used for small plot experiments.

Results and discussion

At flowering, the effects of MC on yield were less at higher VGRs compared with the response measured in conventional cotton that retains less fruit, which is currently used to support industry MC recommendations. In contrast, lower VGR's were more negatively affected by the application of MC than was previously measured.

Final plant height (cm)

In Exp. 1 there were significant increases of over 20 cm in final plant height in the high compared with low VGR treatments. No differences in final plant height were measured between early season single treatment and the multiple MC treatments in Exps 1 and 2.

Final node count

In Exp. 1, the low VGR crop had almost one node more than the high VGR crop. In both experiments there were no differences in the number of nodes between the two early season MC treatments (single and multi-rate), although a significant difference of one extra node was measured in the control.

Final Fruit Retention

In Exp. 1 there was no difference in % fruit retention in the low or high VGR crop types (data not shown). However there were significant differences measured between crop types. The low VGR plots had almost 15% more fruit retention than the high VGR plots. In Exp. 2 (which was only a high VGR crop type), the single early application of MC had increased fruit retention by 5% over the control and multi-rate treatment, which were not significantly different from each other.

Lint Yield

In Exp. 1 the low VGR crop out-yielded the high VGR crop by 1044 kg/ha, which was likely to be more associated with the later planting time than from having a high VGR alone. As can be seen in Figure 1, where there was a significant interaction of the early application MC treatment with crop type. In the low VGR crop, yield was 7% more in the control than both the MC treatments, which were the same. Conversely in the high VGR crop the application of MC treatments increased yield by 11% compared with the control. Again both the MC treatments (single and multi) were not different from each other.

In Exp. 2 (a high VGR crop) there were no significant differences between the early application MC treatments.

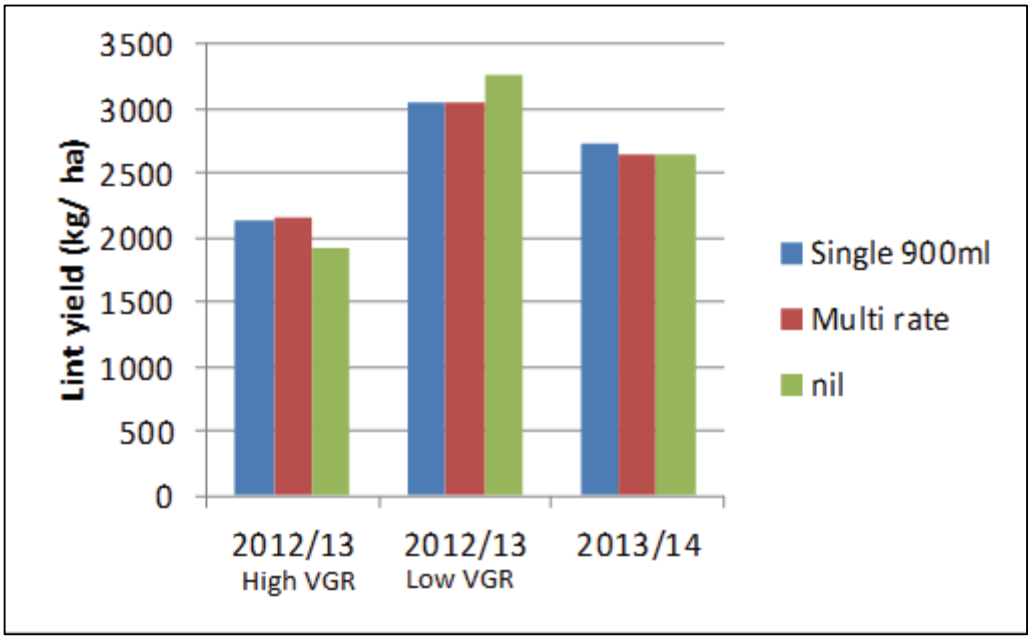

Figure 1: Mean lint yield (kg/ha) for VGR and MC treatments in Exp. 1 (2012/13) (Standard error of the difference 136 kg/ha).

Vegetative Growth Rate (VGR) compared with MC yield response

Figure 2 presents our data along with the original lint yield response curve from Constable (1994) who undertook a similar assessment on conventional cotton varieties. Lint yield increased in response to the application of MC, however the degree of the response differed to that measured by Constable (1994). The effects of MC on lint yield were: less at higher VGRs compared with traditional varieties; and yield of cotton with low VGR at flowering was much less with MC than previously measured.

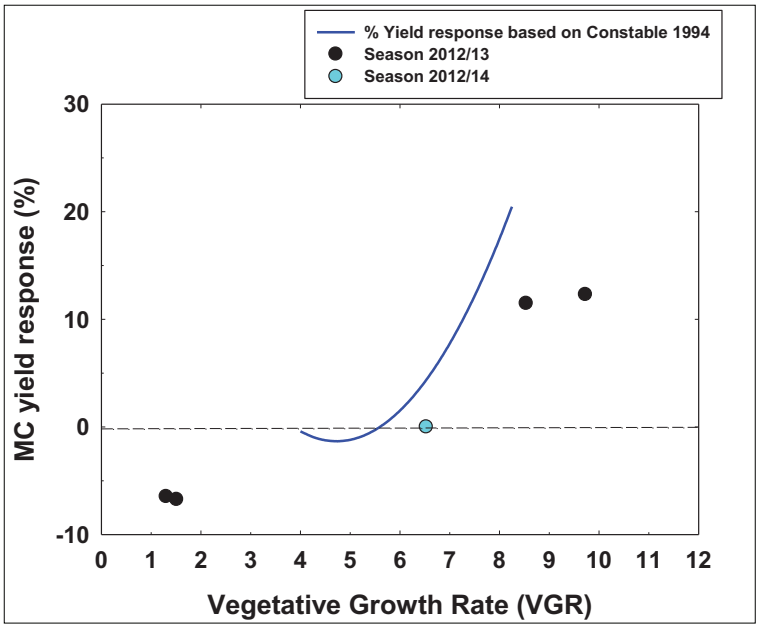

Figure 2: VGR (at flowering) and the corresponding yield response % when MC is applied. The plotted response is the original curve generated by Constable (1994), the black dots are data included from Exp. 1 for the early application treatments and the blue dot is the mean of all treatments from Exp.2.

Conclusions

Our results have shown that in a Bollgard® II crops there are a reasonably good correlation between VGR at flowering and yield response to MC. Therefore monitoring VGR for early season MC requirements should remain a very important component of the decision making process.

While more research is needed across the industry to support these findings (especially for other regions), it does highlight that the use of MC around flowering does require some caution. Additionally this research also supports that Bollgard® II crops are less responsive to MC at high VGRs compared with MC responses measured in conventional cotton varieties, such as by Constable (1994). The recommended VGR threshold of 5.5 cm/node for a conventional cotton crop may need to be increased to 6.5 cm/node for a Bollgard® II crop.

Research is continuing to investigate the use of measuring VGR on crops across a greater range of environments and rates of MC. This is important as the current VGR approach may not be applicable to all environments. For example VGR was inappropriate in tropical Australia (Grundy et al. 2012), as cotton has a tendency to produce more vegetative growth than crops grown elsewhere and the current industry VGR recommendations can lead to excessive MC being applied, affecting yield adversely.

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