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ONTINUED discussion over the benefits and effects of using Mepiquat Chloride (MC) was the motive behind rigorous field experiments over the past two seasons with the main objective to re-evaluate best management practices for applying MC. Previous recommendations were based on conventional varieties rather than high-retention Bollgard varieties.

We investigated the use of Vegetative Growth Rate (VGR) for early season MC decisions in Bollgard II crops with different rates and timing of applications, and also explored the use of MC at cutout at different rates.

Data from the past two seasons have found positive effects on yield when applying MC to crops with high VGR, and negative effects on crops with low VGR.

But at flowering, the effects of MC on yield were less at higher VGRs compared to the response measured in non-Bollgard II (lower retention crops) currently used to support industry MC recommendations. In contrast, crops with MC applied at lower VGRs were more negatively affected than was previously measured in non-Bollgard II crops.

Other results showed that in these experiments we did not find any difference in using the same rate of MC applied in one application compared to multiple applications. There were also no effects on yield with various rates of MC applied at cutout, as the crops were already rapidly approaching cutout (as measured by nodes above white flower).

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. This research also supports the idea that high fruit retention crops are less responsive to MC at high VGRs compared to MC responses measured on non-Bollgard II crops in the past.

Early season MC

Once a cotton plant has flowered, competition for water, nutrients and carbohydrates between vegetative and reproductive growth commences. This balance is normally well regulated by the plant itself, but in some situations can become unbalanced where vegetative growth dominates, potentially impacting yield. In these situations the need for growth regulators like MC should be considered.

In making a decision as to whether MC can help, it is important to consider causes behind any excessive growth. One method to assist in making these decisions at early flowering is VGR. VGR is the industry recommended approach for identifying...
excessive growth. This method is able to identify the need for canopy management before crops become excessively vegetative. Information used to originally validate the VGR method was collected in conventional cotton and needs to be re-evaluated for higher fruit retention Bollgard II crops.

**Cutout MC**

Given the right conditions, cotton will continue to grow past cutout late into the season. This late growth can increase the crop’s attractiveness to late season pests and can also increase the number of immature (low quality) bolls at harvest. In addition, actively growing crops at the end of the season may be difficult to defoliate. In these cases, cutout rates of MC may be considered to slow this late growth.

Decisions regarding a late application of MC are generally based on whether or not the crop is already approaching cutout at an acceptable pace. Decisions to apply cutout rates of MC are generally made in late January for most regions or about three weeks before the last effective flower (LEF) date. But there is a lack of reliable information on crop responses to MC at different rates to assist crops in cutting out.

**About the experiments**

The experiments were based at the Australian Cotton Research Institute, Narrabri in the 2012–13 (Experiment 1) and 2013–14 (Experiment 2) growing seasons.

In Experiment 1 we established two different crop types – one with vigorous (rank) and the other with normal plant growth habits (non-rank). To grow these two crop types (using Sicot 74BRF) we used two planting dates – non-rank planted on October 17, 2012 and rank planted on December 5, 2012. The
rank crop type also received an extra side dress application of 200 kg per hectare of urea on December 20. In Experiment 2, we grew only the rank crop type, planted on November 13, 2013, and provided an extra 200 kg per hectare of urea on December 9. Both experiments at planting had in excess of 300 kg per hectare of available soil N.

**Treatments**

Our early season treatments compared a single application of MC (900 ml per hectare) with multiple applications of MC (three applications of 300 ml per hectare) and a control treatment (nil MC). The timing of the single application was at first flower, while the multiple application treatment had MC applied at squaring, first flower and two weeks after first flower application (Refer to Table 1 for application dates).

The late season treatments compared a low rate of MC (750 ml per hectare) with a high rate of MC (1.5 L per hectare) and a control (nil MC). In Experiment 1, cutout treatments were applied to the non-rank plots a little over three weeks before the Last Effective Flower date (February 27) estimated for Wee Waa by using the CottASSIST Last effective flower tool (www.cottassist.com.au). In the rank plots, significant delays in flowering associated with the late planting caused delays in applying all treatments (see Table 1).

At the time when late season treatments were applied, NAWF measurements in Experiment 1 (non-rank) and 2 were already indicating that the crop was suitably cutting out. But NAWF measurements in Experiment 1 (rank) indicated a much slower cutout.

Both experiments used a randomised complete block design with four replications.

**Measurements**

VGR was monitored weekly from first square (where 50 per cent of plants have squares) through to two weeks after the last application in the multiple application treatments. The measurement of height was taken from the plant cotyledon to the top of plant terminal, along with counting of the number of nodes starting above the plant cotyledon to the top of the plant terminal where the last subtending leaf is fully unfurled and about the size of a 10 cent piece. VGR was calculated using the following equation:

\[
\text{VGR (cm/node)} = \frac{\text{This week's height (cm)} - \text{Last week's height (cm)}}{\text{This week's node number} - \text{Last week's node number}}
\]

The number of Nodes Above White Flower (NAWF) was also monitored at the time of the cutout MC application and up until the treatments had all reached 4 NAWF.

Maturity picks were conducted weekly after 20 per cent open bolls, and conducted until all the cotton in the sampled metre had been removed. But the rank plots in Experiment 1 continued to grow well even after the cutout treatments of MC was applied. By mid April when the rank plots were still below 20 per cent open, we then made the decision to defoliate; therefore maturity picks were not taken.
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After defoliation, full plant maps were conducted. Measurements included: Final plant height, total nodes, number of fruiting branches, number of vegetative branches, number of vegetative fruit, total fruit and retention of fruit on all positions for each fruiting branch.

Lint was harvested using a specialised cotton picker used for small plot experiments which is maintained by the CSIRO Plant Industry Breeding team at the ACRI.

**Results**

**Final plant height (cm)**

In Experiment 1, we measured a highly significant difference of over 20 cm increase in final plant height of the rank treatment over the non-rank treatment. In both experiments there was also no significant difference in final plant height between the two early season MC treatments (single and multi-rates), but we measured a highly significant difference in height between these treatments and the control. The control was approximately 10 cm less on average across both rank and non-rank treatments in Experiment 1 and 16 cm less in Experiment 2, on a rank plant type only.

**Final node count**

In Experiment 1, the non-rank crop had almost one node more than the rank crop, which was significant. In both experiments there were no differences found in final node number between the two early season MC treatments (single and multi-rate), although a significant difference of one extra node was measured in the control. Cutout rates in both experiments did not affect node number.

**Final Fruit Retention**

In Experiment 1 at harvest, the non-rank crop had almost 15 per cent more fruit retention than the rank crop, which was highly significantly different. Also in Experiment 1 there was a significant interaction of the early application treatment and plant type. In the rank treatment with no application of MC there was nine per cent lower retention at harvest. There were no significant differences across the early application treatments in the non-rank crop, and there were also no differences between the single and multi-rate treatments in the rank crop.

**FIGURE 2: Mean final yield (bales/ha), showing higher yields in the rank crop and lower yields in the non-rank crop from the MC treatments in Experiment 1 (2012–13)**

Yield differences between the non-rank and rank crop were most likely caused by the changes in planting time, but yields in this experiment were improved with the application of MC in the rank crop, and reduced in the non-rank crop. There were no significant differences in yield in Experiment 2 (2013–14).

In Experiment 2 which was only a rank crop, the single early application of MC had increased retention by five per cent over the control and multi-rate treatments, which were not significantly different from each other. The cutout rates of MC did not affect total fruit retention measured at harvest in either experiment.

**Maturity days from sowing to 60 per cent open bolls**

No differences were measured in crop maturity in either experiment.

**Lint yield (bales/ha)**

In Experiment 1 the non-rank crop out-yielded the rank crop by 4.6 bales per hectare which was highly significant and was more likely associated with the later planting time than from being rank. In both experiments the early application treatments were the only

**FIGURE 3: VGR (at flowering) and the corresponding yield response % when MC is applied**

The blue line is the original curve generated by Dr. Greg Constable (1994), the black dots are data included from Experiment 1 for the early application treatments and the blue dot is the mean of all treatments from Experiment 2. Note that the two lowest points for yield responses at low VGRs are MC applied to non-rank crops, while the two highest points for yield response associated with high VGR are associated with rank crops.
treatments to affect yield. Cutout applications of MC also did not impact on yield in either experiment.

As can be seen in Figure 2, there was a significant interaction of the early application MC treatment with crop type. In the non-rank crop, yield was seven per cent more in the control than both the MC treatments which were not different from each other. Conversely in the rank crop the application of MC treatments increased yield by 11 per cent over the treatment that had no MC applied. Again both the MC treatments (single and multi) were not different from each other.

In Experiment 2 (a rank crop) there were no significant differences between the early application MC treatments.

**Vegetative Growth Rate (VGR) compared with MC yield response**

In validating the use of early season VGR measurements to assist with MC decisions, we compared measured VGR at the time of MC application with the proportion difference in yield of the MC treatment compared to the control yield. In plotting this data we have used only the means of the early season treatments for Experiment 1 and the mean of all treatments in Experiment 2.

Figure 3 presents our data along with the original yield response curve from Constable (1994) who undertook a similar assessment on non-Bollgard II varieties. The graph shows there was a response of yield to the application of MC, but the degree of the response differed to that measured by Greg Constable:

- The effects of MC on yield were less at higher VGRs compared to the responses measured in non-Bollgard II crops; and,
- Yield of crops with low VGR at flowering were more negatively affected with the application of MC than was previously measured.

**Nodes Above White Flower (NAWF)**

As can be seen in Figure 1, the rate of NAWF in both experiments was slightly slower in the control compared to the high and low rate cutout treatments in rank crops. But there were minimal differences in the rate of NAWF between the cutout treatments.

**Take home messages**

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

Applications of MC to assist in crop ‘cut-out’ are becoming increasingly popular across many cotton growing regions. We measured no significant yield or maturity differences between the cutout treatments in either experiment.

Research is continuing to investigate the use of 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 (work undertaken by Paul Grundy and Steve Yeates), as the crop had a tendency to be more rank than crops grown elsewhere and the current industry VGR recommendations can lead to excessive MC being applied, affecting yield adversely.

1CSIRO Agriculture Flagship, Australian Cotton Research Institute, Narrabri.

The Cotton Research and Development Corporation provided partial financial support for this work.