

Using Mepiquat Chloride (Pix)

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Once a cotton plant has flowered, competition for water, nutrients and carbohydrates between vegetative and reproductive growth commences within each plant. This is normally well regulated by the plant itself, but in some situations can become unbalanced. It is in these situations when the need for growth regulators like Mepiquat Chloride (Pix) should be considered.

When excessive vegetative growth has been prevented, Mepiquat Chloride can improve yield. This is a result of increases in canopy light penetration and air circulation reducing in physiological shedding, increasing fruit retention. Mepiquat Chloride is also credited for a range of responses including inducing cutout, achieving earliness, reducing attractiveness to late season pests and improving crop uniformity.

This chapter explains Mepiquat Chloride's mode of action and how to make the decision on whether an application is needed.

Mode of action

Mepiquat Chloride reduces the production of Gibberellic acid (GA) in a plant by partially inhibiting one of the enzymes involved in the formation of GA.

GA belongs to a group of plant hormones, Gibberellins, which are natural growth regulators in plants. They

BEST PRACTICE

- Mepiquat Chloride manages excessive vegetative growth by shortening internodes and reducing leaf area to restore the balance between reproductive and vegetative growth.
- There are many factors that should be considered when making the decision to apply Mepiquat Chloride.
- Simple observations of height will not necessarily identify accurate Mepiquat Chloride response.
- **Caution:** Some defoliant products containing Ethephon, such as Prep, are labelled as a 'Growth Regulator'. Ethephon on a growing cotton crop has devastating consequences. Ethephon is used for preparing the crop for harvest and may cause significant fruit loss if used at inappropriate times.

play an important role in stimulating plant cell wall loosening which allows stretching of the wall by internal pressure. This is known as cell expansion and is one mechanism allowing a plant to grow. In addition to GA, cell expansion is driven by a number of factors including water availability, humidity and temperature.

Impact on cotton growth

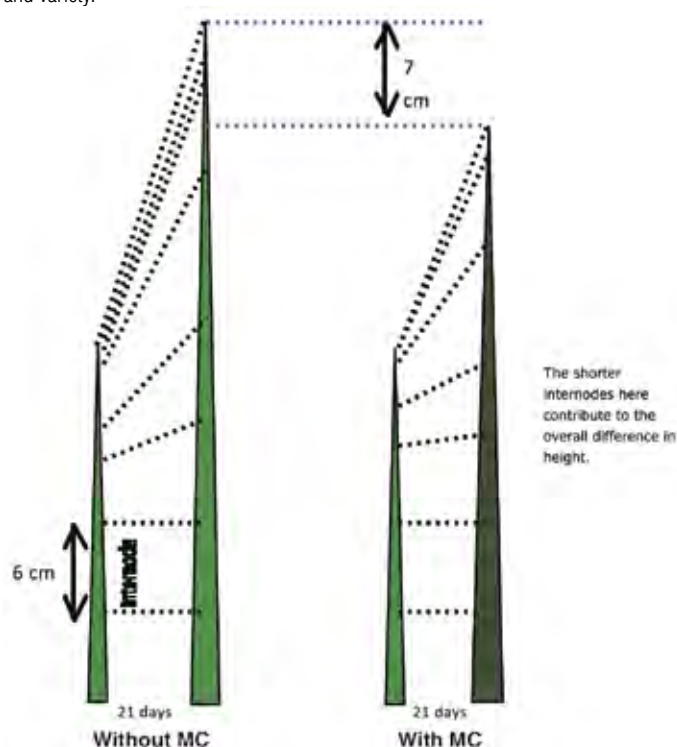
When cell expansion is inhibited following an application of Mepiquat Chloride, any new plant growth will normally have shortened internode length (refer to Figure 1) and smaller, thicker leaves. As cells are smaller and denser, and because the green coloured chlorophyll molecules are sitting closer together, the leaf colour is generally a darker green.

Even though Mepiquat Chloride is rapidly distributed throughout the entire plant, it only significantly limits the cell expansion in new growth. So generally it is only the top 3 or 4 internodes that will be shortened. The concentration of Mepiquat Chloride becomes diluted as growth continues and the formation of GA and normal cell expansion resume at the growing point. Thus larger plants growing more rapidly will require higher rates of Mepiquat Chloride to slow cell expansion.

Figure 1 is an example of the impact of Mepiquat Chloride on an actively growing plant terminal. The

FIGURE 1:

An example of an actively growing cotton plant terminal over a period of 21 days with and without a Mepiquat Chloride (MC) application. In this example the total reduction in plant height after 21 days is approximately 7cm less than a plant that hasn't received an application of Mepiquat Chloride. This calculation is based on the plant's current fully expanded internodes being an average length of 6cm. Following the application of Mepiquat Chloride, differences in plant height will be a result of responses of plant growth to field and environmental conditions, boll load and variety.





plant on the right has been treated with Mepiquat Chloride. In this example, after a period of 21 days the overall height difference is not large as the production of new nodes continues on the treated plant. However this difference in height will become larger over time unless the vegetative/reproductive imbalance is addressed. The treated plant can resume normal growth if the fruit load is enough to keep the vegetative growth in check.

Vegetative growth

Maintaining vigorous vegetative growth before flowering is important as it is these leaves, fruiting branches and roots that will support its future boll load. After flowering this vegetative growth will normally slow down as the plant prioritises its resources to the boll (water, nutrients and carbohydrates). Only when there are excess resources to the needs of fruit growth does vegetative and reproductive growth continue. Eventually, when all of the resources are allocated and there is no excess, further growth (both vegetative and reproductive) ceases and the crop will cutout.

Competition for water, nutrients and carbohydrates between vegetative and reproductive growth is constantly occurring within each cotton plant. This is normally well regulated by the plant itself, but in some situations can become unbalanced. It is in these situations when the need for growth regulators like Mepiquat Chloride comes about.

When fruit is lost, such as shedding during prolonged cloudy weather, very high temperatures, or due to insect attack, the resources that were being used by the fruit are now available for other growth. If growing conditions are good, the plant will respond by growing larger leaves and more stem. New fruiting sites will continue to be produced.

Similarly in conditions where there is abundant moisture, humidity, heat, ample nutrients, no soil constraints etc, there may be an excess of resources above the needs of the developing bolls. The crop will respond by growing more lush vegetative growth. Excessive vegetative growth can be a symptom of too much nitrogen, or too frequent irrigations. All cotton varieties have a similar response in vegetative growth.

Yield

Research conducted in the USA has shown that Mepiquat Chloride, applied at early flowering can have a positive effect on boll retention in the lower part of the canopy if there was excessive vegetative growth. Excessive vegetative growth (leaf area and stem growth) can result in canopies which limit penetration of light into lower parts of the plant. This results in leaf shading (sometimes referred to as self shading) reducing photosynthesis and reducing retention or growth of lower bolls; and increase humidity in the canopy predisposing leaves and bolls to disease.

The use of Mepiquat Chloride in these circumstances essentially acts as a 'brake' on vegetative growth, allowing better penetration of light into the canopy and allow fruit growth to 'catch-up' and re-establish

the crops ability to balance its own vegetative growth, and then continue to meet the needs of further fruit production.

Maturity

An effect of Mepiquat Chloride is to assist earlier cutout and thus crop maturity. Restricting vegetative growth means that there are less assimilates (products of photosynthesis) produced by the plant from new leaves to continue new growth at optimal rates thereby causing the plant to approach 'cutout' more rapidly. The time of cutout is generally directly related to maturity. Applications late in the season to reduce unnecessary vegetative growth can assist in maturing the crop for a timely harvest. Applications applied at early flowering (to control excessive vegetative growth) to allow fruit growth to 'catch-up' will also help the crop reach maturity at a normal rate. Although in this case, optimal nitrogen and water are also important factors to consider in assisting earlier crop maturity.

In shorter growing regions close attention to appropriate and timely use of Mepiquat Chloride is required to ensure no delays in maturity.

Crop uniformity

On occasions a crop can become patchy with excessive vegetative growth, for example when the crop has had a pest infestation that has not affected all plants, cases of uneven soil types, or head ditch and tail drain effects. In these situations Mepiquat Chloride applications can assist in making the crop more uniform allowing for uniform defoliation and timely harvest. Crops that do not have uniform maturity can be attractive to late season pest infestations, and are susceptible to fibre quality issues such as lower micronaire (due to increased numbers of immature bolls) and increased leaf trash.

The use of variable rate technology in these situations can offer significant opportunities to optimise the effectiveness of Mepiquat Chloride applications.

Making the decision at early flowering

Cotton's response to Mepiquat Chloride application/s depends on a range of factors, the most critical being whether there are other sources of stress already controlling growth, and the rate and timing of the application. Since GA plays an important role in cell expansion, preventing the plants production of GA can be detrimental to plant growth. Hence using a high rate of Mepiquat Chloride at an inappropriate time can result in yield reductions.

In making a decision as to whether Mepiquat Chloride can help, it is important to consider causes behind any excessive growth such as those described previously. In assisting these decisions at early flowering one should consider information on vegetative growth rate (VGR), field history, fruit retention, irrigation scheduling, current and future weather conditions, and cotton variety.

Measuring VGR – early flowering

Vegetative Growth Rate (VGR) is an effective technique to monitor vegetative growth. VGR is the rate of change of plant height relative to the rate of node development. The VGR measures the rate of internode increase and is better able to capture situations where crops are moving from optimal to poor conditions, or vice versa. This method is also able to identify the need for canopy management before crops are excessively vegetative. Simple observations of height will not necessarily identify accurate Mepiquat Chloride response.

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

Measurements should commence as the crop approaches first flower, which is normally late November for many regions and the plant has roughly 12 mainstem nodes. The monitoring should continue during the first half of the flowering period as rapid increases in growth rate can occur at anytime in this period.

Plant height and node information can be entered into the CottASSIST Crop Development web tool which calculates the VGR and compares this number to the ideal range for the crops growth stage.

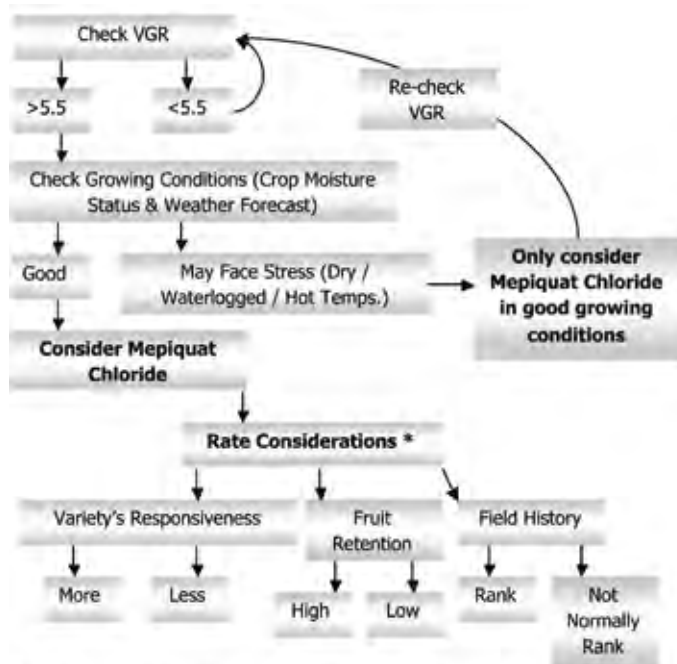
During early flowering, if the VGR is over 5.5 then applying Mepiquat Chloride should be considered. However before deciding on the timing and the rate, other factors need to be taken into consideration (refer to flow chart 1).

Field history/soil type

Knowing how the cotton is likely to grow in each field is the key factor in making the decision to apply Mepiquat Chloride

FLOW CHART 1 – EARLY FLOWERING DECISION TREE:

This flow chart incorporates all of the factors and the decision processes that should be considered when making the decision to apply Mepiquat Chloride early in the season around flowering.



* Use Table 1 and Figure 2 for assisting with decisions regarding Mepiquat Chloride rates.

Chloride. Some fields, often due to lighter textured soil types allow better access to soil water and nutrition; and have a tendency for rank growth. In these situations you would expect to get a positive response from Mepiquat Chloride application/s, although it is still important to monitor these fields to determine the correct application rate and timing.

Fruit retention

After flowering the cotton plant will naturally become committed to giving more and more of its resources to the developing bolls. Therefore a high fruit load may already reduce the tendency for a crop to produce excess vegetative growth, hence a reduced need for Mepiquat Chloride. Caution should be applied to crops with early high fruit retention (like many Bollgard II crops) as research has shown any limitations to canopy size early in flowering will impact yield more than crops with lower fruit retention. Crops with larger boll loads will need larger canopies to support the growth of fruit. Refer to the Crop Development Tool on CottASSIST site.

Future stress events

It is always important to ensure that crops are not stressed for at least a week after the Mepiquat Chloride application as additional stresses can substantially limit vegetative growth and thus limit yield. Hot weather and/or water stress from being unable to irrigate the crop on time are examples.

Stress, especially moisture stress, will reduce vegetative growth and production of new fruiting sites allowing existing fruit on the plant to develop. This may lead to early termination of flowering and a probable yield reduction.

In cases of severe stress (water, prolonged period of cloudy weather, or a period of very high temperatures) fruit loss may occur. In these cases a symptom can be excessive vegetative growth once stress has been removed. Crops should be monitored closely following these events. Strategies to apply Mepiquat Chloride in anticipation of stress events that cause these affects are not recommended as the growth regulator could add to the stress or the event may not eventuate and therefore limit vegetative growth needed for continued fruit growth.

Variety

Research has shown that our Australian cotton varieties vary in their yield responsiveness to applications of Mepiquat Chloride (see Table 1). Varieties may differ in the response to Mepiquat Chloride because of determinacy (ability to regrow), rate of canopy development or fruit production, or because of differences in their architecture. Less responsive varieties may still require Mepiquat Chloride, so monitoring their VGR and taking into account all other factors remains important.

TABLE 1:

Yield responsiveness between varieties under irrigated conditions

More responsive	Intermediate responsiveness	Less responsive
e.g. Siokra 24BRF, Sicot 75, Sicot 70BL, Sicala 340BRF	e.g. Sicot 74BRF, Sicot 72BL, Siokra V-18BL, Sicot 730	e.g. Sicot 71BRF, Sicot 71RRF, Sicot 71, Sicala 43BRF, Siokra V-18BRF

Rate considerations at early flowering

Figure 2 has been designed to take all factors into consideration when deciding on the rate of Mepiquat Chloride to apply. The following examples will explain how to use the graph.

Example one: A crop has a VGR Measurement of 8, low fruit retention and the field is normally prone to rank growth. Information from the seed company has indicated that the variety is moderately responsive to Mepiquat Chloride, so using Figure 2 the application rate may be at a higher rate (For example 600-1000mL/ha).

Example two: A crop has a VGR of 6, good fruit retention, the field has no history of rank growth and information from the seed company has indicated that the variety is not greatly responsive to Mepiquat Chloride, therefore using Figure 2 applying Mepiquat Chloride may not be a benefit, although monitoring should continue.

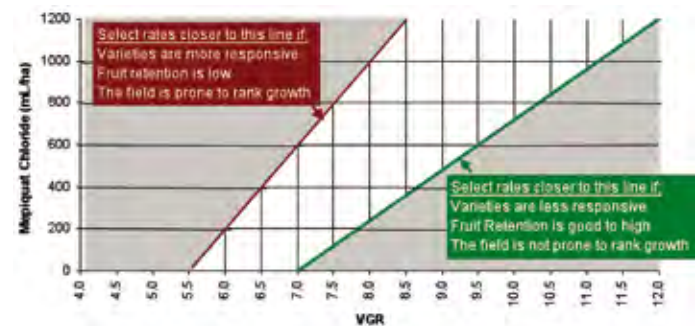
Making the decision before cutout

Given the right conditions, cotton will continue to grow late in the season. This late growth can increase the crops attractiveness to late season pests and can also increase the number of immature (low quality) bolls at harvest. This is when Mepiquat Chloride maybe considered in order to slow down further vegetative growth. It is also important that if earlier or timely cutout is to be achieved water and nutrient management should specifically aim to meet only the requirements of the fruit that will be taken through to harvest.

Decisions regarding a late application of Mepiquat Chloride are based on whether or not the crop is already

FIGURE 2:

Mepiquat Chloride requirement graph incorporating VGR and other factors. Rates assume Mepiquat Chloride formulation of 38 g/litre. (Source: CSD)



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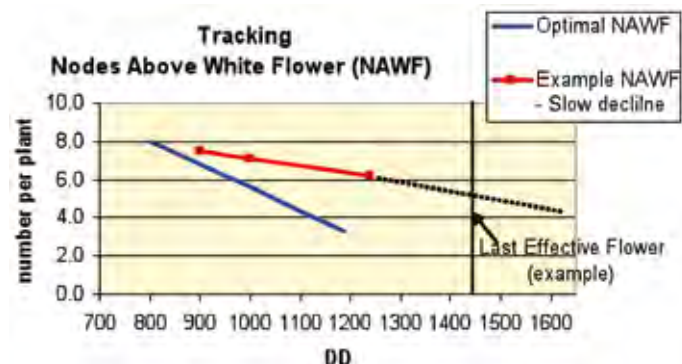
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FIGURE 3:

An example of using the number of Nodes Above White Flower to forecast the timing of cutout.



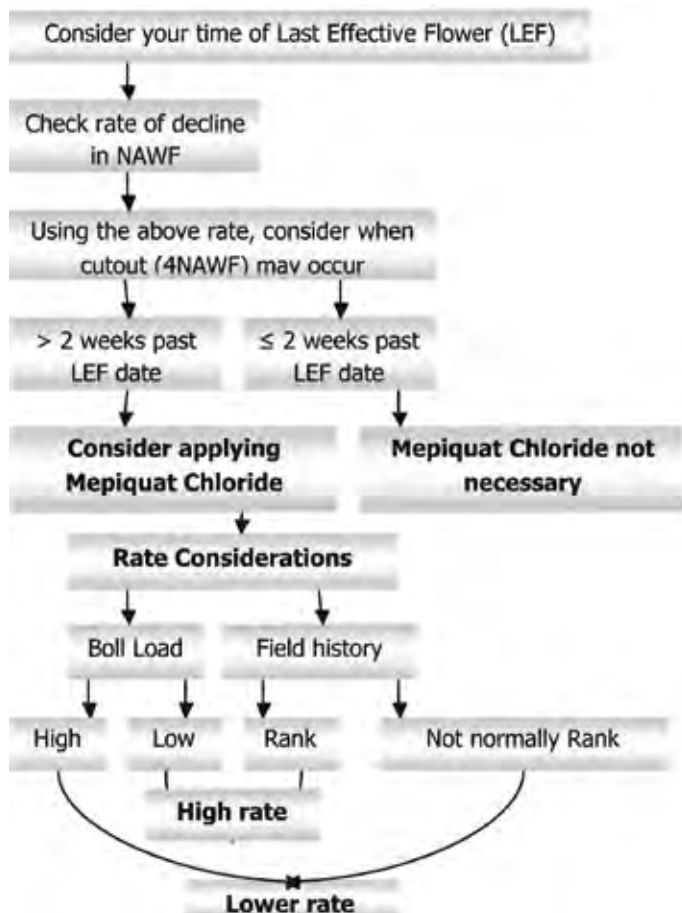
approaching cutout at an acceptable pace. These decisions are generally made in late January for most regions or about 3 weeks before the last effective flower (LEF) date. The LEF date can be determined by using the CottASSIST Last Effective Flower Tool (LEFT) or from local experience.

Monitoring NAWF – late season

An effective technique used to assess how quickly cutout is approaching is monitoring the number of Nodes Above the White Flower (NAWF). This measures the position of first position white flowers relative to the plant terminal.

FLOW CHART 2 – CUTOUT DECISION TREE:

This cutout chart is designed to help with late season decisions to apply Mepiquat Chloride.



The closer a white flower is to the terminal means that there has been less nodes produced since that particular flower was initiated as a new square.

NAWF: Count the number of mainstem nodes above the uppermost white flower in the first fruiting position. These counts are typically collected weekly from first flower until cutout. Monitoring should occur post cutout to ensure that any regrowth is identified and managed if necessary. NAWF counts can be entered into the CottASSIST Crop Development web tool to plot the rate of decline on a chart and compare this with the optimal rate of decline.

In an optimal situation, the NAWF should fall at the rate of one per 55–65 Day Degrees. Where there is a slow rate of NAWF decline and the forecast cutout (4 NAWF) is beyond the LEF, then applying a cutout rate of Mepiquat Chloride should be considered. Figure 3 compares an optimal rate of NAWF decline with a slow rate of decline. In this example the forecast of cutout (shown with the dotted line) will go beyond the LEF date, hence a cutout rate of Mepiquat Chloride should be considered.

For more information the following resources and tools are available at https://www.mybmp.com.au/auth_user/grower_tools_and_resources.aspx

- FibrePAK
- CottASSIST (Crop Development Monitoring and Last Effective Flower Tool)



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Get the latest information on Australian cotton varieties at www.csd.net.au