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Using Mepiquat Chloride on the Texas Coast to Reduce Cotton Plant Height

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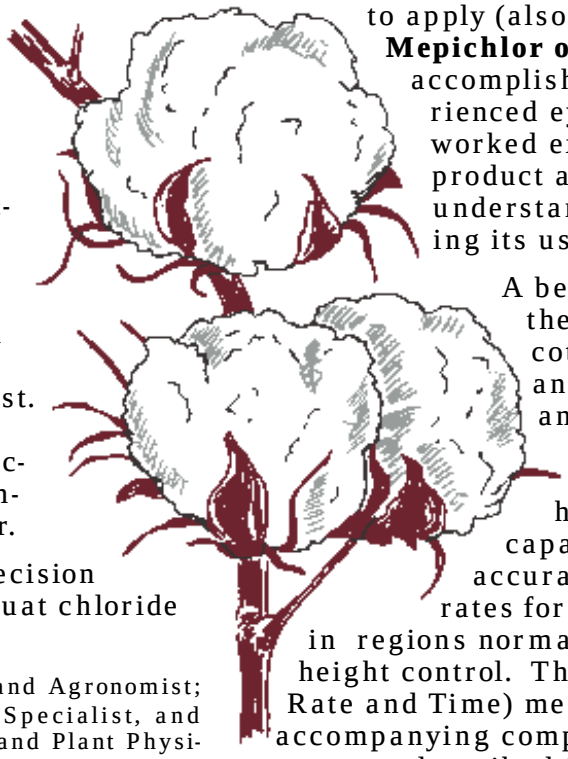
Timing the first application of mepiquat chloride has caused concerns among cotton producers in that too much applied too soon can result in serious damage to plant structure and subsequent lint yields. However, too little material applied too late can increase production costs and still leave the grower with a rank plant and difficult harvest. Application rates and timing that worked well in one production year may be useless or impractical in a subsequent year.



For almost two decades the decision of when and how much mepiquat chloride to apply (also known as **Pix, Mepichlor or Mepex**) has been accomplished through the experienced eye of those who have worked extensively with the product and have come to understand the factors affecting its usage.

A better understanding of the physiology of the cotton plant, its nitrogen and water requirements and the influence of its environment (temperature, rainfall) has resulted in new capabilities to prescribe accurate mepiquat chloride rates for use in cotton grown in regions normally requiring plant height control. The MEPRT (Mepiquat Rate and Time) measuring stick and accompanying computer software program are described for practical field use.

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Benefits and Effects of Mepiquat Chloride (MC)

Plant Height

To provide the best plant structure and leaf area index, final plant height should be 30 to 35 inches for 30-inch rows, and not greater than 40 to 45 inches for 40-inch rows. These limits ensure that row middles are covered but are not so dense as to cause boll rot. A rule-of-thumb used by cotton producers to predict optimum plant heights is to multiply the row width times 1.1. If fruit retention is high, plant height will not be excessive under normal field conditions.

The cotton plant produces more lint when it hasn't used its valuable water supply and carbohydrates to grow a plant structure at the expense of reproductive growth. MC will help retard excessive plant height. Growing regions with low rainfall, low heat units and higher fruit retention may not require MC during most growing seasons. Different plant biomass and plant height may be more effective in obtaining optimum yields under certain growing conditions. Occasionally, treated cotton fields will be observed having plants with less than optimal plant height, that produce excellent yields because of high fruit retention.

Leaves and Canopy

MC suppresses cell enlargement. Leaf surface area is reduced by 5 to 10 percent. This is seen as a darker green leaf that while smaller, is thicker. Some cotton varieties have typically small leaves (specific MAR varieties) and benefit less from this leaf area reduction. If the variety is a taller, mid-to-full-season type, then a shorter, narrower plant with smaller leaves allows for improved air circulation and insecticide penetration. The shorter, flattened canopy top facilitates a lower incidence of boll rot and affords better protection of fruiting forms against insects. Boll rot is a bigger problem along the more humid, higher rainfall and irrigated regions of the Texas Gulf Coast.

Internodes

The cotton plant produces a new node in the terminal every three days. Each new internode continues to extend and thicken over the next 12 to 15 days, depending on temperature and growing conditions. The most rapid expansion (85 percent) occurs in the first 6 to 10 days. MC suppresses stem elongation of newly formed internodes (uppermost 3 or 4 in the plant top) by limiting gibberellin biosynthesis which is responsible for normal cell elongation. The minimum MC concentration in the plant necessary to provide a maximum level of reduction is 12-15 ppm. Regardless of how much MC is applied in excess of 12-15 ppm per acre, internodes will not grow shorter than approximately 50 percent of normal growth.

Earliness

Low rate multiple applications of MC beginning Matchhead Square (MHS) contribute 5 to 7 days to earliness through earlier fruit retention and loading of the plant. As long as lint yields are unaffected, any reduction in the time required to mature and protect the crop from insects will reduce insecticide costs and risk due to weather. High lint yields, lower input cost and improved earliness are important goals for all cotton growers.

Fiber Quality

Mature lower bolls frequently have superior fiber quality to those in the top of the plant. If these lower bolls are not retained or are hard locked from boll rot, overall fiber quality may be reduced. MC has no known effect on fiber quality otherwise.

Lint Yields

In years when production is greater than 700 to 800 pounds/acre, increases of 5 to 12 percent have been observed in MC-treated plants. Additional lint may be realized through improved fruit set and larger bolls being filled through greater available water and nutrients during certain growing seasons. MC is not pro-

moted as a yield enhancer, but as a management tool to reduce boll rot and rankness, that can ultimately reduce final yields.

Nitrogen Utilization

Even when fields have been heavily fertilized with nitrogen, cotton plants should not require any application of MC before the late pinhead square growth stage. At this time, the cotton plant has developed just 6 or 7 nodes and its uptake of nitrogen is limited by root development. At MHS growth stage the first MC application should not contain less than 2 oz/ac. Lower initial rates will not supply active MC levels (10 ppm). MC applications made to reestablish a 10 ppm maintenance level enable the grower to backout quickly if drought conditions occur, by simply making no application 10 days later.

As the root system expands, transpirational pull (water loss from the leaves) increases, and larger amounts of water will carry larger amounts of nitrogen into the cotton plant. Quantitatively, nitrogen use is small until the plant reaches the reproductive stage when bolls are being formed and water use increases to its maximum rate.

As cotton plants enter the reproductive stage, larger quantities of nitrogen are required. An expanded root system supplies these needs. A cotton plant develops its fruitload over a 4- to 5-week period, with each newly-formed boll requiring approximately 42 days to reach an open-boll status. Peak nitrogen use is observed in bolls 12 to 35 days of age as seed is being formed. Figure 1 displays the time course of daily nitrogen requirements of a cotton crop at Corpus Christi, Texas, in 1989. The graph shows that during the boll-filling period, cotton plants can use as much as 2 pounds of nitrogen per day. If boll retention is good, and if nothing happens to damage the root system or to interfere with normal absorption and transport of nitrates, rank growth will normally not occur with conventional rates of fertilizer ($^1/_{10}$ pound N for each pound lint produced).

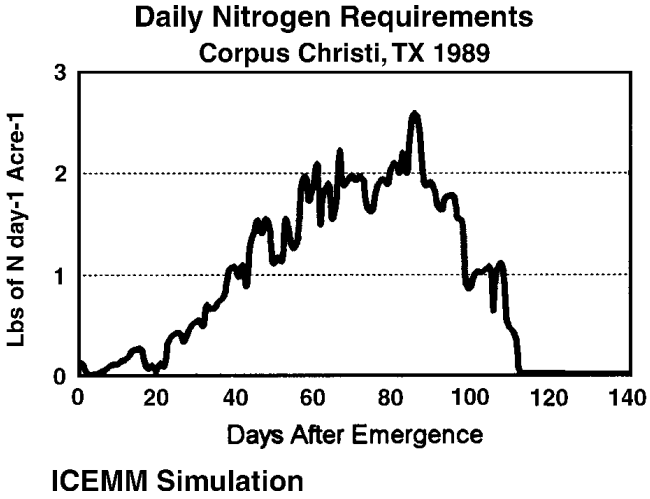

Figure 1. Daily nitrogen requirements of a cotton crop.

Managing Imbalances of Water, Nitrogen and Fruit Retention

The arrival of heavy rains or use of irrigation will cause cotton growers to assess the cotton's vegetative growth and fruit load. The addition of plentiful water increases N-uptake by cotton plants, resulting in rapid growth.

Early fruit losses (squares, small bolls) due to insects or weather events upset the utilization and balance of nitrogen. When as much excess nitrogen has been deposited in leaves as can be used as protein, excess nitrogen will stimulate new growth expressed as longer internodes and larger expanded leaf area.

The decision to apply the normal rate of MC [usually applied at Matchhead Square (MHS) or Early Bloom (EB)] or to increase application rates, is important. Previous square retention should be determined using some form of plant mapping.

Over-fertilization with nitrogen, early fruit loss, or too much rain in combination with high temperatures leads to rank growth and excessive plant height. There may be no requirement for MC as long as nitrogen and fruiting remain in balance.

Temperature

Cotton plant growth is stimulated by warm growing seasons. MC may not be needed when cool and overcast conditions exist. Weather station temperatures help to predict the need for the first applications of MC. The accumulated heat units received since the cotton emergence date are called DD60s. Average daily temperature is calculated by taking the maximum and minimum temperature for a 24 hour period and dividing it by two. DD60 is calculated by subtracting 60 from that value (cotton doesn't grow much below 60°F). These units are additive for the growing season, and are reported through various information sources.

A ratio of DD60s for the current year as compared with the last fifteen years is useful in determining how fast cotton is able to grow. If the curve relating the current year's temperatures to the historical year is above the base line (1.0), conditions exist for growth to occur at a faster rate than normal, and MC is likely to be necessary (particularly under high moisture conditions).

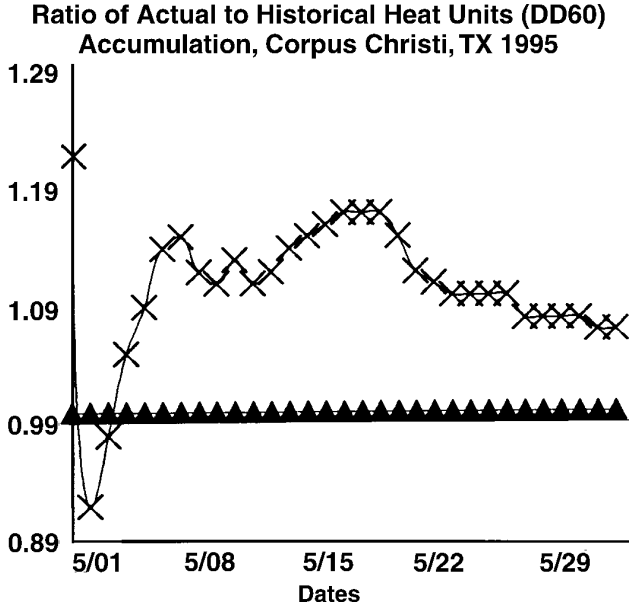

Figure 2. Heat unit ratios from first square through first bloom.

In Figure 2 heat unit ratios are depicted from first square through first bloom. The ratios plot well above this historical baseline, thereby predicting a clear status for needing MC.

Early Fruit Loss

The percent "square set" in a cotton field indicates the potential of the plants to produce a heavy set of bolls and to rapidly mature them. Square set prior to bloom should be above 75 percent. Square set by "week-of-squaring" (Table 1) should run as follows: week 1, >90 percent; week 2, >80 percent; week 3, >75 percent. If values are less than average, consider this a problem that will influence the decision to apply MC.

Table 1. Percent "square set" in a typical cotton field.

Week of Squaring	% Square Set		
	Excellent	Good	Average
1	96-100	92-95	89-91
2	93-100	87-92	80-86
3	90-100	82-89	75-82

Research has shown that about 80 percent of the harvestable fruiting sites are already on the plant at early bloom. After blooming, it will be difficult to protect or retain this high percentage of fruiting forms.

Subsequent MC Applications

The primary effects of MC become less with increases in plant growth (mass) because the initial dosage is diluted. When the concentration in the plant is less than 10 ppm, the plant resumes normal growth according to the nitrogen, water and temperature that modulate growth, and it may be necessary to make subsequent applications of MC if growth is too fast. The key to controlling growth with MC is to maintain 10 ppm in the plant.

How Late is Too Late to Apply MC?

At 15 days past first bloom, cotton has already achieved 85 to 95 percent of its total plant height if it has a full boll load. Plant growth can be represented with the sigmoidal curve in Figure 3. The linear phase of growth is between Pinhead Square (PHS) and 1st bloom +15 (40 to 50 days).

After 15 days post-bloom, the curve begins to flatten with a good early boll load.

If only a few bolls were retained at 15 days post-bloom, then the curve would not flatten until enough bolls developed to control rank growth. MC would help under those conditions, but large amounts would be necessary to reduce the length of new internodes.

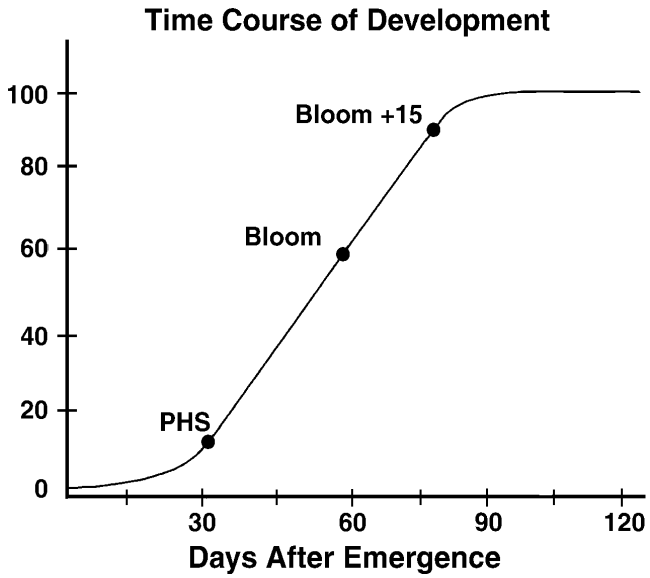

Figure 3. Time course of plant height development, assuming normal plant growth and heat units (Landivar, 1992).

It is extremely important to make the first applications of MC early enough to keep the plant's growth under control. Next, the field manager must maintain the balance if it is upset by lost fruiting positions, excessive water supply or nitrogen fertilization.

Monitoring plant height and the height/node ratio in the linear phase of the growth curve (same as nitrogen utilization curve) is essential in predicting the proper time to apply plant growth regulators.

How to Use the MEPRT System

The MEPRT System is made up of two components: The MEPRT stick and its software. The MEPRT stick measures the average length of the uppermost five nodes of the plant and determines the need for MC. The rate of application is determined by using the MEPRT software program. The reasons for considering only the top five nodes is that internodes below this zone have already completed most of their elongation phase and will no longer contribute to plant height.

If the MEPRT stick indicates the need for mepiquat chloride, the scout will be required to assemble the following information to determine how much to apply:

- Row spacing
- Plants/row foot
- Plant height
- Number of mainstem nodes (cotyledon node is zero)
- Amount of MC applied, to date.

The MEPRT stick is only to be used during the rapid growth phase of plant height development. In most cotton fields, the linear phase begins at approximately 35 to 40 days after emergence and lasts 15 to 20 days after the appearance of the first bloom (75 to 80 days after emergence).

1. Identify the uppermost internode; this internode should be at least one-half inch in length. The uppermost leaves are not fully unrolled. The leaf at the selected internode will be expanded (flattened, not wrinkled) and becomes leaf zero.
2. Count downward five internodes.
3. Place the MEPRT stick at the base of the petiole of the fifth internode leaf, and measure the distance up to the leaf zero petiole (terminal). At the right of the ruler, read the internodal lengths for the five uppermost nodes.
4. If the average internode length of the top five nodes is in the **RED** area, **STOP**; do not apply Mepiquat Chloride (MC). Plants growing at this growth rate may attain a plant height of 30 inches or less.
5. The **YELLOW** section means **CAUTION**. Apply MC at the judgment of the manager. He may not apply MC if it is suspected that near future growing conditions are not adequate (i.e., dry period). Plants growing at this rate may attain a plant height of 34 to 40 inches.
6. The **GREEN** area means **GO**; apply MC. The plants are growing at a rate that would obtain a final plant height of 40 to 45 inches or greater.

The MEPRT Stick (reduced)
Average Length of Top Five Internodes (Inch)

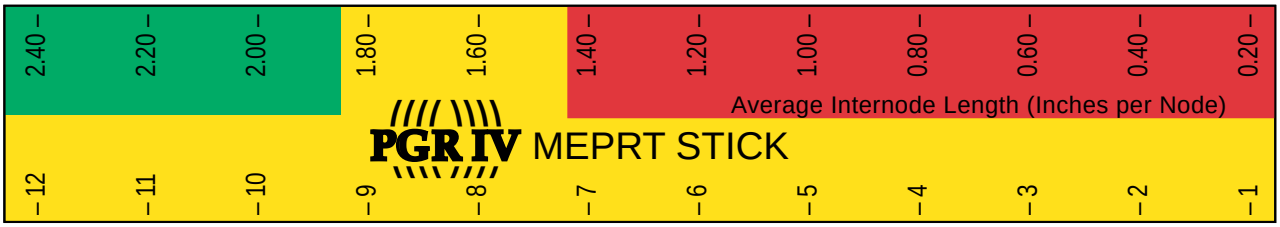

Figure 4. Measuring stick is color-coded for reference to uppermost five internodes. Upper left is colored green, center yellow and upper right is red. Upper scale is length (in inches) divided by five to give the average length of five selected internodes.

Internode Length

The following observations are important in using the MEPRT stick.

<1.4 Red Zone First of all, look at the internode length for the top five nodes. If they are 1.4 inches or less in length, growth is proceeding below optimum. No MC should be applied.

1.4-1.6 Yellow Zone If the plant measures between 1.4 and 1.8, treatment is optional. If conditions appear to be turning dry, it may be best to wait another 5 to 7 days and remeasure the cotton's internodes.

1.6-1.8 Yellow Zone If you are in this level and have just received rainfall or are planning to irrigate, you should consider the application of MC anyhow. This is especially true for heavily fertilized soils when temperatures are high and heat units are plentiful.

>1.8 Green Zone If the internode length is above 1.8, the crop is developing at a very high rate. MC should be applied.

Using the MEPRT software program provided with the MEPRT stick, a precise recommendation can be made to the field. Do not use the MEPRT software program

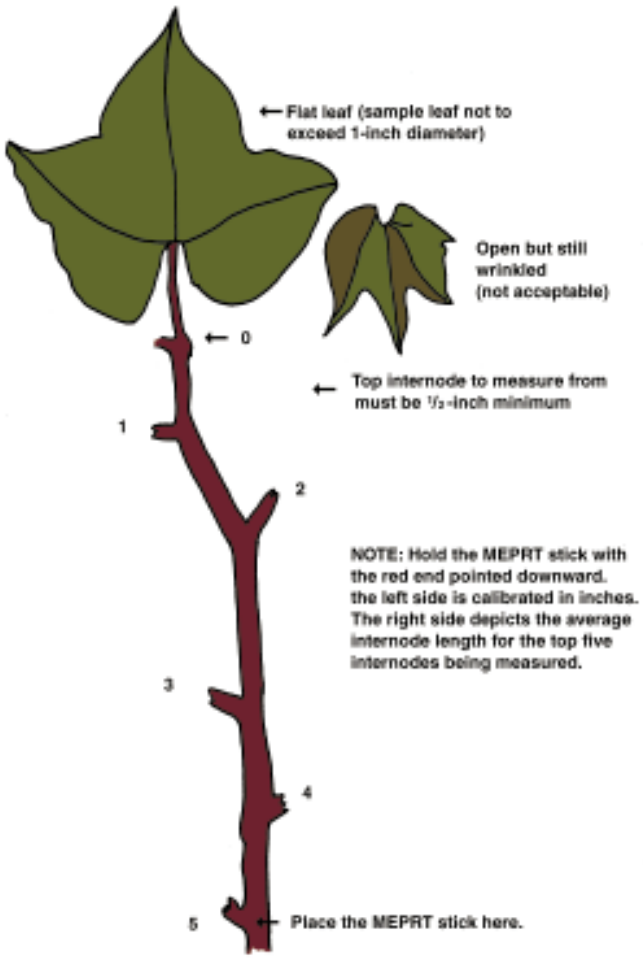

Figure 5. Selecting the upper internode reference point requires at least 1/2 inch of length, a distance that can just be pinched between the index fingertip and thumb. This internode usually has a leaf of the appropriate size at position "0". Counting downward for five additional nodes, place the stick on that branch and observe the position of the upper reference point on the color scale.

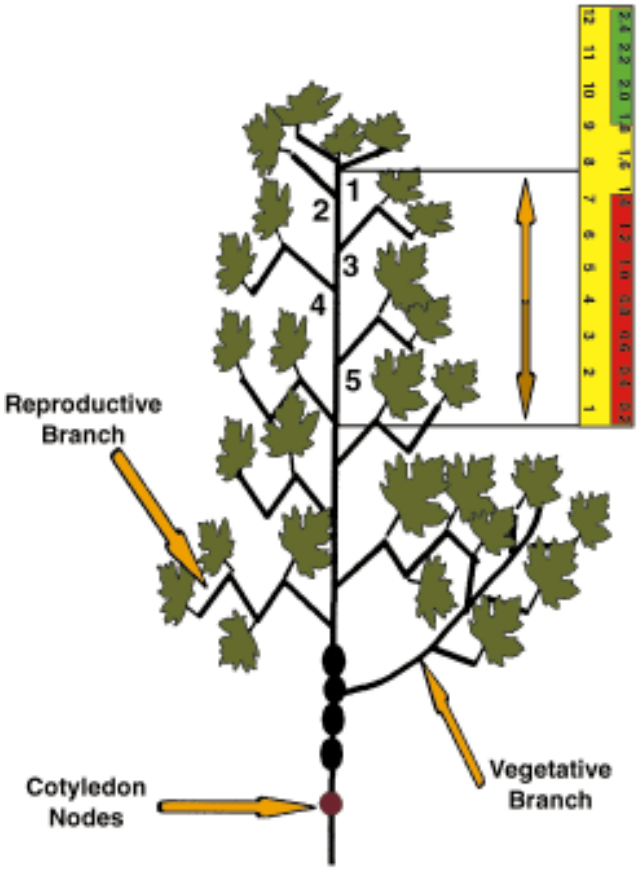

Figure 6. Diagram of a cotton plant with MEPRT stick spanning the five top internodes to be measured in the plant top.

if the MEPRT stick measurement is in the red zone. There is no reason to adjust the cotton plant to 10 ppm MC if no height control is required. Revisit the fields weekly or at least every 10 days to determine the need for additional product. This will provide time for 2 or 3 additional internodes to form.

If the cotton is blooming 5 or 6 internodes from the top of the plant (cut-out), additional MC applications are not required. The last two tables may be used to predict MC rates if the MEPRT stick is used and the MEPRT software is not available.

Time to Become Rain-Safe

Within 8 hours, 70 to 90 percent of the MC has entered through leaf surfaces. The addition of a surfactant can shorten this time to 4 hours. MC moves rapidly throughout the plant, and very little of the mepiquat chloride is degraded within the plant's biosystem.

Optional Tables

If MEPRT software and measuring stick are not available, tables have been used to predict MC rates at 10 to 14 nodes. These tables are more suited to regions with high rainfall and fully fertilized soils such as the Upper Eastern Texas and Gulf Coast states. Tables are also available for lower rainfall areas where shorter-season cottons are grown. These are available through county Extension offices statewide, and extend recommendations to as low as eight nodes.

Low N-Levels

See Extension Leaflet L-5147, Correcting Nitrogen Deficiencies in Cotton with Urea Based Products, for options to add nitrogen when soil levels are suspected to be inadequate. See Extension Leaflet L-5156, Cotton Petiole and Plant Testing, for a description of methods available to monitor cotton nutrition through testing laboratories and field assessments.

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