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# AGRONOMY

## Wick Applicator for Applying Mepiquat Chloride on Cotton: I. Rate Response of Wick and Spray Delivery Systems

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**INTERPRETIVE SUMMARY**

The use of mepiquat chloride (PIX™, Mepichlor™, and others) to control excessive vegetative growth in cotton is widespread. Applications of mepiquat chloride to cotton are typically made as a broadcast spray by ground or air. A wick application system that can be calibrated has become available recently and may provide an alternative method of applying mepiquat chloride. The objective of this experiment was to compare the effect of mepiquat chloride at five rates applied through a wick delivery system and as a conventional broadcast spray.

The wick delivery system differs from a conventional broadcast spray in that it wipes the growth regulator on only the top three to four nodes of the plant, while a broadcast spray contacts all accessible foliage. The wick applicator consists of a perforated plastic pipe covered with a 100% cotton canvas material. The canvas material is 18 in wide and situated directly over the row. A mepiquat chloride solution is gravity-fed onto the canvas by holes drilled through the pipe under the canvas. An air-intake orifice mounted above the pipe controls the flow of solution onto the canvas. The flow rate allows the wick to be accurately calibrated.

The wick delivery system allows the growth regulator to be effectively applied in a band and results in very low volumes of application, compared with a broadcast spray. Producers could benefit from this method because it requires less tank size and allows more acreage to be covered before refilling. Also, the wick applicator can be mounted to implements or sprayers for simultaneous application with other crop protection chemicals. Preliminary research comparing the wick delivery system to a broadcast spray indicated that mepiquat chloride rate reductions may be possible with the wick system with no detrimental effects.

An experiment was conducted to establish and compare mepiquat chloride rate response curves for cotton growth and yield when applied through a wick and as a spray. Five rates, ranging from 1 to 12 fl oz per acre (0.003 to 0.038 lb a.i. $acre^{-1}$) were applied at early bloom through a wick and as a spray in eight environments in North Carolina. Plant height, main-stem nodes, nodes above white flower, lint yield, lint percentage, micronaire, fiber length, and fiber strength were measured.

Mepiquat chloride reduced plant height when delivered through both systems. However, plant-height control per ounce of mepiquat chloride leveled off with the broadcast spray between 9 and 12 oz per acre. Height continued to be reduced at 12 oz per acre when applied through a wick, suggesting mepiquat chloride has a greater effect when applied through a wick compared to a spray. Main-stem nodes, height-to-node ratios, and nodes above white flower were all reduced more by mepiquat chloride applied through a wick, although the differences are probably too small to be of practical benefit to producers. Lint yield was not affected by mepiquat chloride applied in either system. However, increasing rates of sprayed mepiquat chloride reduced lint percentage. Mepiquat chloride applied in a wick exhibited no relationship. This result may be due to more specific application to the top three to four nodes of the plant, and it suggests that further research is warranted to investigate the effect of mepiquat chloride on plant structure when applied through a wick. Mepiquat chloride reduced micronaire, had little overall effect on fiber length, and increased fiber strength irrespective of delivery systems. However, these observed changes in fiber properties were so small as to be of little practical value to producers.

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Results show that a greater reduction in plant height can be obtained with mepiquat chloride applied through a wick rather than a spray, suggesting that substantial rate reduction is possible with wick delivery systems. Data do not indicate that potential enhanced earliness or positive yield responses will be realized with a wick delivery system in situations different from a spray. The lower volume of application and potential rate reductions of mepiquat chloride in the wick delivery system could result in lower application costs for producers.


## ABSTRACT

**Typical applications of mepiquat chloride (1,1-dimethylpiperidinium chloride) to control excessive vegetative growth in cotton (*Gossypium hirsutum* L.) are broadcast- sprayed by ground or air. Mepiquat chloride also can be applied through a wick mounted to implements or sprayers that apply the chemical to only the top three to four nodes of the plant. In 1998 and 1999, the wick delivery system was compared with broadcast spray at five mepiquat chloride rates in eight environments in North Carolina. A linear reduction in plant height was observed over five increasing rates of mepiquat chloride delivered through a wick, while a quadratic response was observed for the spray, indicating mepiquat chloride better controls plant height when applied through a wick delivery system. Reductions in lint proportion were well-correlated with increasing mepiquat chloride rate delivered through a spray, but correlated poorly when delivered through a wick. Main-stem nodes, height-to-node ratios, nodes above white flower, lint yield, micronaire, fiber strength, and fiber length generally did not differ between delivery systems at equal rates of mepiquat chloride. Our results show that rate reductions of mepiquat chloride are possible with a wick delivery system, compared with a broadcast spray, with no detrimental effects on cotton. In situations where mepiquat chloride is needed, the wick delivery system may provide a less costly alternative to conventional broadcast sprays.**


Due to the indeterminate growth habit of cotton, vegetative growth often occurs at the expense of reproductive growth. Under conditions of excessive vegetative growth, lower fruiting forms may abscise and delay maturity, boll rot pathogens may become more prolific, and harvest efficiency can decrease. Cotton producers attempt to manage excessive growth with the judicious use of nitrogen, water, and sometimes the plant growth regulator mepiquat chloride (Silvertooth et al., 1999).

Mepiquat chloride has been widely used on cotton in the United States since the 1980s, and its effects on plant structure have been well documented. Studies have reported reduced plant height, main-stem nodes, internode length (Kerby, 1985; Reddy et al., 1990; Stuart et al., 1984; York, 1983a), branch length, nodes per branch (Reddy et al., 1990), and greater first-position fruit retention (Kerby et al., 1986) following treatment with mepiquat chloride. In general, use of mepiquat chloride results in a more compact plant with more fruit set at lower first positions.

Yield responses to mepiquat chloride have been inconsistent and depend on environmental conditions. A positive yield response was noted in previous studies when planting was delayed (Cathey and Meredith, 1988), when plant populations were higher than optimal (York, 1983b), and when irrigation was used (Tracy and Sappenfield, 1992). Conditions in which neutral yield responses were observed included early plantings (Cathey and Meredith, 1988) and limited moisture (Boman and Westerman, 1994; Edmisten, 1994). York (1983a) suggested that a variety of environmental factors influence potential yield response to mepiquat chloride as regressions for rainfall and heat units to yield were not significant.

Mepiquat chloride generally is applied between 12 to 49 g a.i. $ha^{-1}$ as single or sequential applications from first square until full bloom. Applications typically are made as a broadcast spray to achieve thorough coverage of cotton foliage, as recommended on the product specimen label (BASF Corp., 1999). Broadcast spray is an effective means of applying crop protection chemicals, but it requires large tanks mounted to tractors or dedicated sprayers. Tank size and application volume limit the number of hectares that can be covered before refilling. Additionally, broadcast sprays require nozzles, pumps, and hoses that can be expensive and require operator expertise to adjust and maintain.

Mepiquat chloride also can be applied through a wick delivery system that wipes the chemical on the terminal of the plant, because the wick is mounted at a constant height and moved through the field. Preliminary research by Stewart et al. (1999)

suggested lower use rates were possible with the wick delivery system, compared with a broadcast spray. The volume of application is very small in the wick delivery system, compared with a broadcast spray, and the wick applicator requires no nozzles, pumps, or hoses. The objective of this study was to compare the effects of mepiquat chloride delivered through wick and spray systems on cotton growth and yield.

## MATERIALS AND METHODS

The experiment was conducted eight times in eight environments in North Carolina in 1998 and 1999. Soils and locations in 1998 included Norfolk loamy sand (fine-loamy, siliceous, thermic Typic Paleudult) near Clayton; Roanoke silt loam (clayey, mixed, thermic Typic Ochraquult) near Edenton; Torhunta loam (coarse-loamy, siliceous, thermic Acid Typic Humaquept) near Goldsboro; and Wando fine sand (siliceous, thermic Typic Udipsamment) near Scotland Neck. The 1999 locations were: Dothan loamy sand (fine-loamy, siliceous, thermic Plinthic Paleudult) near Clayton; Wando fine sand near Scotland Neck; Norfolk sandy loam near Snow Hill; and Nahunta loam (fine-silty, siliceous, thermic Aeric Paleaquults) near Trenton. Standard production practices for eastern North Carolina, with the exception of mepiquat chloride applications, were followed. Both Scotland Neck locations were irrigated.

The experimental design was a randomized complete block with treatments replicated four times. Treatments consisted of a factorial arrangement of delivery systems (wick and spray) and mepiquat chloride rates (3, 9, 18, 28, and 37 g ha$^{-1}$). A nontreated control was included in all environments. Treatments were applied when cotton reached the first-bloom stage, defined as three white blooms per 3 m of row. The wick applicator was set to treat the top 8 cm of the cotton and calibrated to deliver 5 L ha$^{-1}$ while broadcast sprays were applied with a $CO_2$-pressurized backpack sprayer delivering 150 L ha$^{-1}$ through two flat-fan nozzles per row at 207 kPa. Plots were 15 m long with four rows of 92- or 97 cm.

The two-row wick applicator (Dixie Wick Co., Grifton, NC) consisted of a perforated plastic pipe reservoir covered with a 100% cotton canvas material (Fig. 1). The canvas material is 45 cm wide

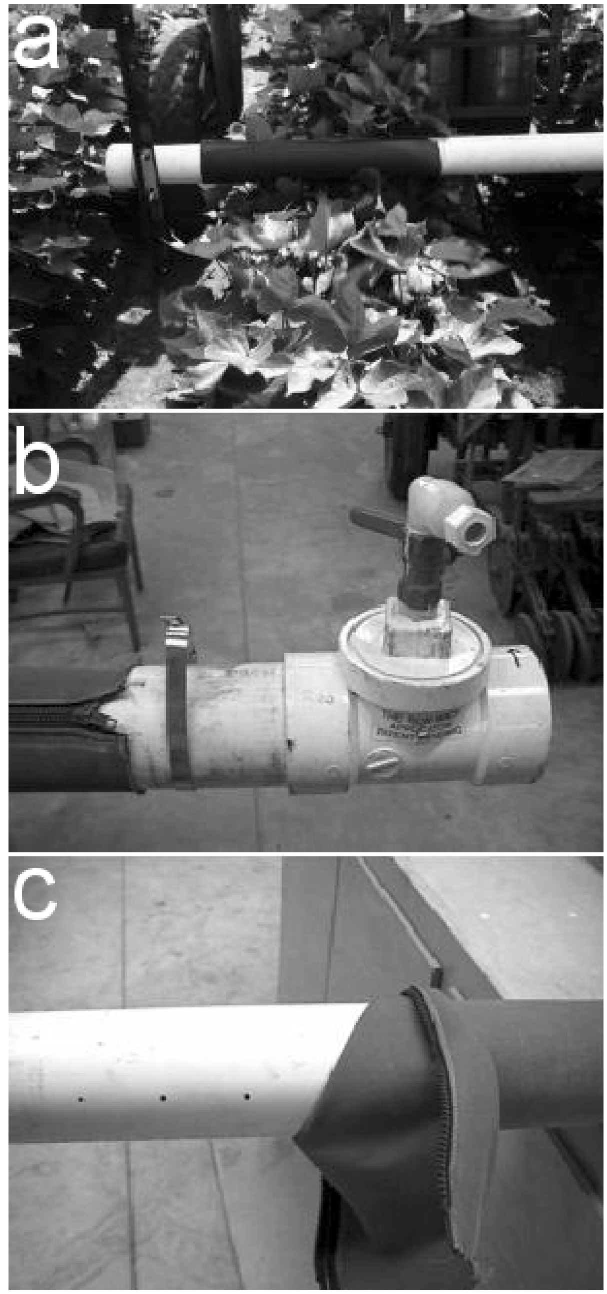


**Fig. 1. Wick applicator showing field application (a), orifice for controlling air flow (b), and holes for wicking solution onto canvas (c).**

and situated directly over the row. A mepiquat chloride solution is gravity-fed onto the canvas-wiping surface by holes drilled through the pipe under the canvas. A metering air orifice mounted above the pipe controls flow rate. The flow rate allows the wick applicator to be accurately calibrated at constant ground speeds.

Plant height, main-stem nodes, and nodes above white flower were determined from a random sample of five plants from the center two rows of each plot when the earliest maturing treatments at each location were judged to have reached cutout. First- and second-position fruit retention by node was determined by plant mapping prior to defoliation. The two center rows of each plot were harvested once with a two-row spindle picker modified for small-plot harvesting. Approximately 300 g of seedcotton were obtained and ginned on a 12-saw gin to determine lint percentage. For the 1999 locations, micronaire, fiber length, and fiber strength of recovered lint were determined by high-volume instrumentation testing (HVI) at the Cotton Incorporated HVI laboratory in Raleigh, NC.

Data were subjected to analysis of variance and regression equations for predicting responses to simple effects were obtained using SAS Proc GLM procedures (SAS, 1987). For plant height, the untreated control was removed from the ANOVA. No significant environment- by-treatment interactions were observed; therefore, data are presented as pooled across environments.

## RESULTS AND DISCUSSION

Mepiquat chloride delivered through the wick system reduced plant height more than the sprayed application did (Fig. 2). Boman and Westerman (1994) reported a quadratic rate response to mepiquat chloride for plant height reduction. In our study, mepiquat chloride delivered through a broadcast spray exhibited a quadratic relationship with a diminishing effect as the rate increased to 37 g ha$^{-1}$; the wick delivery system showed a linear response over the rates tested. The data suggest that the maximum amount of height control was not achieved at 37 g ha$^{-1}$ with the wick delivery system.

Due to the 45-cm width of the canvas-wiping surface on the wick applicator, the apparatus makes a banded application. However, the total amount of mepiquat chloride per hectare being applied with the wick is equal to that via spray. The wick applicator is mounted at a constant height, and the amount of foliage coming into contact with the wiping surface is a function of the individual plant height. Although the wick applicator makes a banded application of mepiquat chloride, the exact width of the band is unknown and, in fact, would change constantly as the apparatus moves through the field. This factor is inherent in the wick

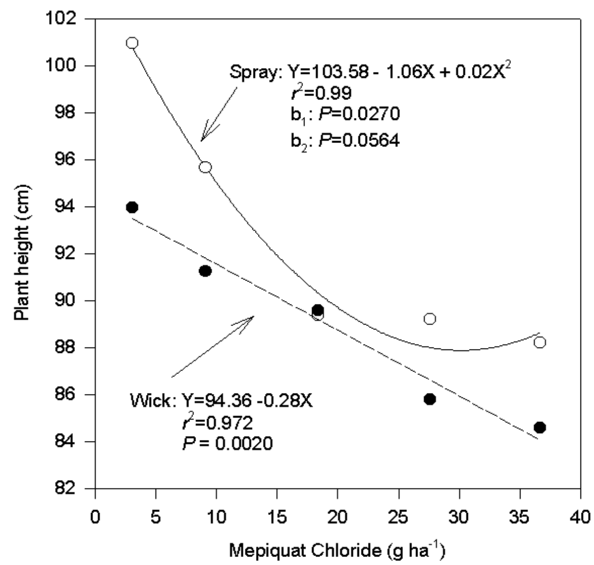


**Fig. 2. Effect of mepiquat chloride wicked ( ! ) and sprayed (") on plant height. Data pooled over eight environments.**

application system. Treatments in this study compare equal amounts of mepiquat chloride per hectare, although it is being concentrated in a band by the wick delivery system.

In our experiment, a similar reduction in main-stem nodes was observed with increasing rates of mepiquat chloride, irrespective of the delivery system. As with plant height, the rate response of height-to-node ratio to mepiquat chloride applied through the wick delivery system was linear, while the response for the broadcast spray was quadratic. Differences between the delivery systems, however, were small and probably of no practical value to producers.

When water and nitrogen are not severely limited, mepiquat chloride can enhance maturity (Kerby, 1985; York 1983a). In our experiment, mepiquat chloride reduced nodes above white flower relative to nontreated cotton by one node at the 37 g ha$^{-1}$ rate, irrespective of delivery system (Fig. 3). Plant mapping data revealed no differences in fruit retention and distribution between delivery systems; therefore, possible fruit shed as a result of the wick was negligible. Depending on boll load and available heat units, one node may represent a difference in maturity of 2 to 4 d; our results are in agreement with differences found in North Carolina by York (1983a). The effect of mepiquat chloride on maturity appears to be similar for wick and spray

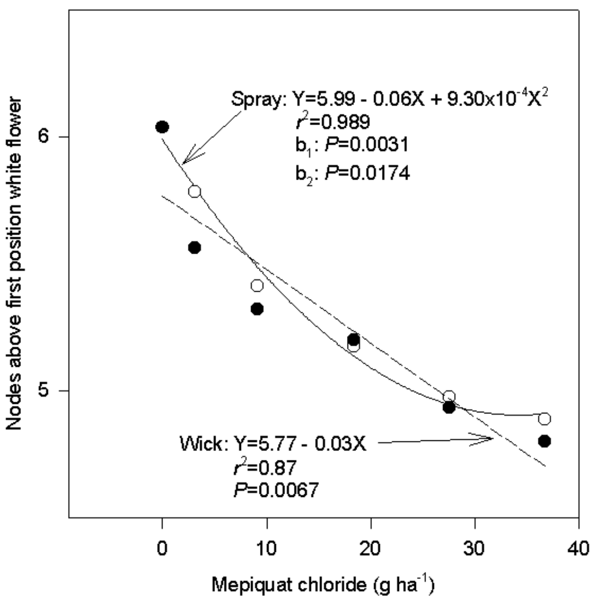


**Fig. 3. Effect of mepiquat chloride wicked ( ! ) and sprayed (") on nodes above white flower measured in late bloom. Data pooled over eight environments.**

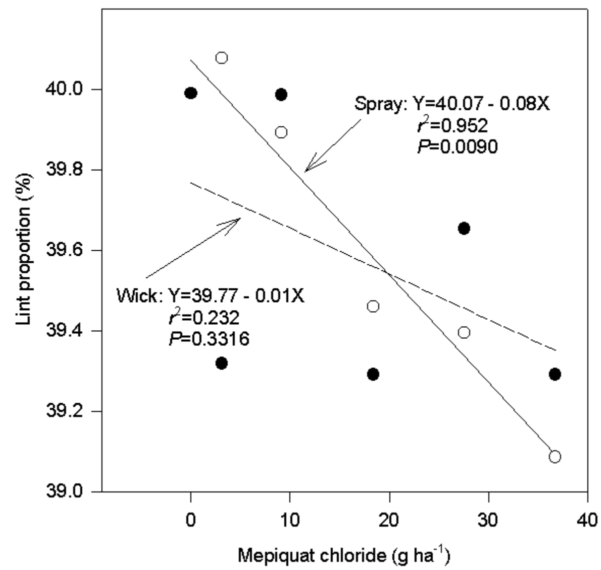


**Fig. 5. Effect of mepiquat chloride wicked ( ! ) and sprayed (") on lint proportion of yield. Data pooled over eight environments.**

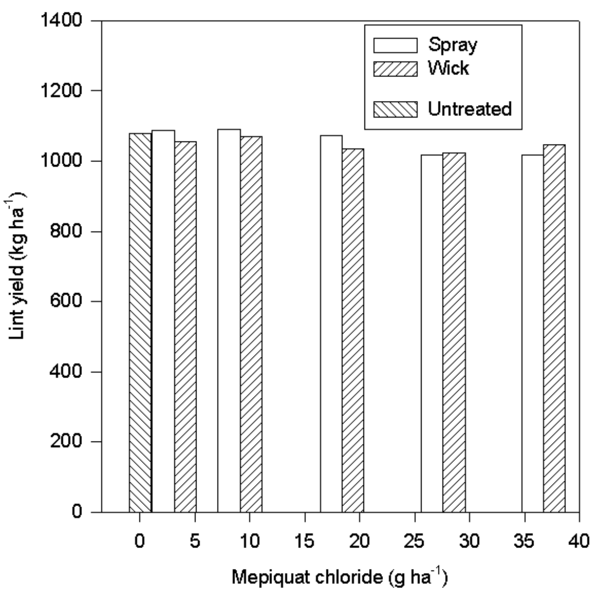


**Fig. 4. Effect of mepiquat chloride wicked and sprayed on cotton lint yield. Data pooled over eight environments.**

delivery systems. Enhanced maturity at the 37 g ha$^{-1}$ rate of mepiquat chloride did not translate into a yield increase, irrespective of delivery systems (Fig. 4). In fact, neither mepiquat chloride rate nor delivery system affected yield in our experiment.

Mepiquat chloride has been reported by Kerby (1985) and York (1983a) to increase seed size, indirectly reducing the lint proportion after ginning. In our experiment, increasing mepiquat chloride rates delivered as a broadcast spray inversely affected lint proportion (Fig. 5). Although mepiquat chloride delivered through the wick delivery system also inversely affected lint proportion, the relationship was poorly correlated ( $r^2$ = 0.23). A possible explanation for the lack of correlation with the wick delivery system is that the mepiquat chloride affected only the top three to four nodes of the plant, while a broadcast spray impacted virtually all the fruiting branches. The weak relationship between increasing mepiquat chloride rates and lint proportion for the wick delivery system may reflect the more specific application of the growth regulator. Plant mapping, however, revealed no differences or apparent trends for fruit retention and distribution.

Boman and Westerman (1994) reported that increased mepiquat chloride rate linearly increased fiber strength in one year. Other researchers have noted mepiquat chloride increased fiber strength compared with nontreated cotton (Kerby, 1985) and decreased micronaire (York, 1983b). In our experiment, fiber strength, length, and micronaire were similarly influenced by mepiquat chloride delivery systems, although the observed changes may be too small to be of practical value to producers.

Our results show that for cotton growth, the effect of mepiquat chloride applied with a wick is similar to that for a spray, except for plant height. The effect of the delivery system on plant height indicates that mepiquat chloride rate reductions of at least 33% are possible when applied through a wick, compared with a broadcast spray. This result is probably due to the inherent banding effect in the wick delivery system. Future research should compare the wick delivery system to a banded application of mepiquat chloride directed at the terminal of the cotton plant. Other benefits include a lower volume of application that translates into greater application efficiency. The need for large tanks, nozzles, pumps, and hoses is eliminated in the wick delivery system. The simplicity of the wick delivery system facilitates simultaneous application of mepiquat chloride with other crop protection chemicals.

Our results do not suggest that mepiquat chloride delivered through the wick will achieve the benefits of the plant growth regulator in situations different from a broadcast spray. Where mepiquat chloride is needed, the wick delivery system can provide producers with a less-expensive alternative to a spray application. The two delivery systems place mepiquat chloride on the plant in different ways and may differentially affect vegetative growth. Future studies should investigate the effect of mepiquat chloride delivery systems on plant structure and fiber properties.

## ACKNOWLEDGMENT

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