MEPIQUAT CHLORIDE EFFECTS ON FIBER QUALITY ARE RELATED TO BOLL LOCATION

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Abstract

Early, normal and late planted cotton may have different boll distribution patterns due to environmental changes during the season. Mepiquat chloride (MC) offers the potential to alter boll distribution patterns and fiber properties. This study was conducted to compare fiber properties on a boll location basis in early, normal and late planted untreated and MC-treated cotton. Planting dates were early March, mid March and early April. Mepiquat chloride was applied to produce a plant concentration of 38 ppm in 1997 and 12 ppm in 1999. Fiber quality was assessed using the Advanced Fiber Information System (AFIS) on an individual boll basis. Boll distribution patterns were not altered by MC-treatment. Mepiquat chloride treatment increased fiber length of first position bolls at nodes 11-13 for all planting dates in 1997. Theta, the degree of cell wall thickening is related to maturity. A maturity ratio of 1 is equivalent to a theta value of 0.577. In both years MC-treatment increased fiber maturity (theta) values in first position bolls at nodes 14 and greater in the early planting date. In 1997, MC-treatment increased fiber maturity (theta) values at several boll locations in late planted cotton. In management decisions MC application rates and planting date should be considered since MC had the potential to increase or decrease fiber maturity.

Introduction

Mepiquat chloride (MC) treatment increased the number of bolls set at nodes 7 through 12 and decreased the number of bolls set at upper nodes (Kerby et al., 1986). Fiber quality differences have been reported for first and second harvests. Fiber quality is a composite of fiber shape and maturity properties. Fiber shape includes length and perimeter (fineness). Micronaire values are an amalgam of shape and maturity properties. Micronaire values cannot distinguish between fineness and maturity. Theta has been related to maturity ratio. A maturity ratio of 1 is equivalent to a theta of 0.577. (Thibodeaux and Evans, 1996). Maturity ratios above 1 are characteristic of mature fibers and combined with large perimeters are indicative of coarse high micronaire cottons. Fiber length was increased in first and second harvests while effects on second harvest micronaire occurred in two years out of a four year study (Ebelhar et al., 1996). Environmental conditions during boll development can be altered by early or late planting dates. When early, normal and late planting dates were compared MC-treatment increased first harvest yields in normal and late planted cotton (Cathey and Meredith, 1988). Fiber length increases occurred in late planted cotton treated with MC (Cathey and Meredith, 1988). In previous studies fiber property differences found in mepiquat chloride treated cotton were not related to specific boll locations. The objective of this paper is to compare fiber properties on a boll location basis in untreated and MC-treated cotton, over three planting dates.

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Material and Methods

Plant Material and Growing Conditions

The experiment was conducted at the Texas A&M University Agricultural Research and Extension Center, Corpus Christi, TX on Victoria clay soil. *Gossypium hirsutum* L. Deltapine 5409 seed was sown 1 March 1997, 23 March 1997 and 11 April 1997. Planting dates in 1999 were 1 March, 22 March (normal) and 12 April. Standard production practices were followed during the season. Insect control was accomplished using pesticides and rates recommended by the Texas Agricultural Extension Service. One application of MC (Pix) was made for each planting date 13 May (7oz/ac) planting date 1 March 1997, 20 May (11.4 oz./ac) planting date 22 March and 3 June (29.3 oz/ac) planting date 10 April, 1997. Mepiquat chloride concentration (38 ppm) was the same for all application dates (first bloom) and was calculated based on the amount of active ingredient and plant dry weight (Landivar et al., 1995). In 1999 MC was applied 30 June (7.4 oz/ac), 13 May (5.8 oz/ac) and 27 May (7.4 oz/ac) respectively for the first, second and third planting dates, Mepiquat chloride concentration was 12 ppm (Landivar et al., 1995).

Experimental design was a randomized complete block with planting dates as the main plots and untreated or MC-treatment as subplots. Subplot size was 6 rows by 12 m. Treatments were replicated four times. One meter of row was harvested from each subplot and plant mapped. The early cotyledonary node was designated as node 0. The boll position nearest to the main stem is fruiting position 1 (FP1). Bolls on monopodial branches (mon) were mapped.

Fiber Property Measurement

Fiber from seeds located in the middle of a boll, two seeds per locule, was taken for fiber property analysis. If a boll weighed 1.4 g or less all fiber from the boll was used for fiber property analysis. Boll constituents include seed and motes. Short fiber motes were defined as having fibers less than half the length of fibers from normal seeds within the same locule. Long-fiber motes have fiber longer than one half the length of fiber on normal seeds and weighed 60 mg or less (Davidonis et al., 1996). If a boll contained more than 6 long fiber motes, mote fibers were added to the boll sample in a proportional manner. Fiber properties were analyzed on a per boll basis using the Advanced Fiber Information System (AFIS). Fiber fineness and maturity properties include cross sectional area, circularity and perimeter which can be calculated from area and circularity. Fiber circularity (theta) is the degree of cell wall thickening and is the ratio of the cross sectional area of the cell wall to the area of a circle having the same perimeter as that of the fiber. Analysis of variance was conducted using PROC MIXED in SAS (SAS Institute, 1997).

Results and Discussion

Rainfall patterns in 1997 and 1999 (Table 1) differed and yields ranged from 500-800 kg/ha in 1997 and from1000-1300 kg/ha range in 1999. Yields decreased with lateness of planting in 1997. No yield decrease occurred in 1999 in late planted cotton. MC-treatment did not increase yields within a planting date.

Mepiquat chloride treatment did not alter boll distribution. Planting date altered boll distribution. In 1997 the percentage of bolls at first position on nodes 3 through 7 increased with lateness of planting date while the percentage of second position bolls decreased in both control and MC treated plants. In 1999 the percentage of bolls at the first position on nodes 4 through 7 did not increase with lateness of planting date while the percentage of second position bolls increased with later planting in both control and MC-treated plants.

In 1997, MC-treatment increased fiber length at first position bolls at nodes 11-13 for all planting dates (Tables 2, 3, 4). Mepiquat chloride-treatment

increased fiber length in FP1 bolls at nodes 8-10 in planting date 1 (Table 2). In late planted cotton MC-treatment increased theta values in three of the four boll locations (Table 4). Mepiquat chloride treatment decreased fiber perimeters at some boll locations for normal and late planted cotton. (Table 3, 4)

Mepiquat chloride was applied at a lower rate in 1999 than in 1997. Fiber lengths did not increase with MC-treatment nor did MC affect fiber perimeter (Tables 5, 6, 7). In early and late planting dates MC-treatment reduced theta values in FP1 bolls at node 14 and above (Table 5, 7). At the normal planting date MC-treatment reduced theta values in early set bolls (Table 6). Since theta values for planting date 2 were high, a reduction in theta values would not be detrimental to fiber quality.

It has been concluded that MC induces a water conservation behavior and delays the onset of water stress in plants growing under water deficit conditions (Fernandez et al., 1991). In 1997 water deficit conditions increased as the season progressed so that planting date 3 plants would be expected to show signs of water stress. Mepiquat chloride treatment had no effect on yield in late planted cotton (1997). A comparison of fiber lengths across planting dates at all boll locations revealed that fiber lengths were significantly shorter for planting date 3 boll locations compared to planting date 1 in untreated cotton. In late planted (1997) cotton MC-treatment increased theta values at three boll locations.

Conclusions

In 1997 rainfall patterns were more typical of the Coastal Bend Area than in 1999. Boll distribution varied with planting date. Application of a higher than recommended MC rate in 1997 increased fiber lengths in first position bolls nodes 11-13 for all planting dates. In both years MC-treatment lower fiber maturity values for late season bolls from the early planting date. Mepiquat chloride treatment of early planted cotton does have the potential to lower micronaire values. This potential may be significant if a large portion of the crop is composed of late season bolls. On the other hand mepiquat chloride has the potential to increase micronaire values in late planted cotton (1997). The effects of MC on bulk fiber properties depend on the contributions of bolls at specific boll locations. If the contribution of the boll location to bulk fiber properties is small then differences in bulk fiber properties between control and MC-treated plants would not be significant.

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Table 1. Monthly rainfall accumulation (mm) at Corpus Christi, TX.

	Year	
Month	**1997**	**1999**
March	94	53
April	100	30
May	91	49
June	34	62
July	11	92

Table 2. Fiber properties for planting date 1 (1997).

Fruiting position	Length (mm)		Theta		Perimeter (μm)	
(node location)	C	MC	C	MC	C	MC
FP1 (4-7)	27	27.4	0.53	0.541	53	53
FP1 (8-10)	27	27.4	0.54	0.536	53	52.5
FP1 (11-13)	26	27.2**	0.53	0.534	52	51.7
FP1 (14>)	25	26.2	0.53	0.486*	52	51.5
FP2	26	26.4	0.52	0.491*	52	51.5
mon	26	26.7	0.54	0.503*	52	51.6

Control (C), mepiquat chloride (MC)-treated comparisons followed by *, **, ***, indicate significance at the p=0.05, 0.01, and 0.001 levels respectively.

Table 3. Fiber properties for planting date 2 (1997).

Fruiting position	Length (mm)		Theta		Perimeter (μm)	
(node location)	C	MC	C	MC	C	MC
FP1 (4-7)	26	26.7	0.5	0.507	52.5	53
FP1 (8-10)	25	25.9*	0.5	0.504	52.5	51.9*
FP1 (11-13)	22	23.9*	0.49	0.486	53.4	52.0***
FP2	24	24.1	0.47	0.485	53.1	52.1*
mon	23	24.9	0.5	0.497	53.1	52

Control (C), mepiquat chloride (MC)-treated comparisons followed by *, **, ***, indicate significance at the p= 0.05, 0.01 and 0.001 levels respectively.

Table 4. Fiber properties for planting date 3, 1997.

Fruiting position	Length (mm)		Theta		Perimeter (μm)	
(node location)	C	MC	C	MC	C	MC
FP1 (3-7)	25	25.6	0.5	0.528*	52	51.8
FP1 (8-10)	23	24.4	0.5	0.517	53	51.7*
FP1 (11-13)	22	24.4*	0.49	0.550**	53	51.9
FP2	23	23.6	0.47	0.521**	53	52

Control (C), mepiquat chloride (MC)-treated comparisons followed by *, **, ***, indicate significance at the p= 0.05, 0.01 and 0.001 levels respectively.

Table 5. Fiber properties for planting date 1, (1999).

Fruiting position (node location)	Length (mm)		Theta		Perimeter (μm)	
	C	MC	C	MC	C	MC
FP1 (4-7)	25	24	0.51	0.5	55	54.5
FP1 (8-10)	24	24	0.51	0.513	55	54.5
FP1 (11-13)	23	23	0.52	0.495	55	54.8
FP1 (14>)	24	25	0.57	0.518*	53	53.4
FP2	23	24	0.49	0.503	55	54.5

Control(C), mepiquat chloride (MC)-treated comparisons followed by *, **, ***, indicate significance at the p= 0.05, 0.01 and 0.001 levels respectively.

Table 6. Fiber properties for planting date 2 (1999)

Fruiting position (node location)	Length (mm)		Theta		Perimeter (μm)	
	C	MC	C	MC	C	MC
FP1 (4-7)	25	24	0.57	0.529**	54	55
FP1 (8-10)	26	25	0.57	0.554	53	53.7
FP1 (11-13)	27	26	0.56	0.547	51.9	51.9
FP (14>)	26	25	0.58	0.567	51.1	52.7
FP2	25	25	0.55	0.526	53.2	53.8
mon	26	26	0.56	0.536	52.8	52.5

Control, mepiquat chloride (MC)-treated comparisons followed by *, **, ***, indicate significance at the p= 0.05, 0.01 and 0.001 levels respectively.

Table 7 Fiber properties for planting date 3 (1999)

Fruiting position (node location)	Length (mm)		Theta		Perimeter (μm)	
	C	MC	C	MC	C	MC
FP1 (4-7)	28	27	0.53	0.527	52.8	53.4
FP1 (8-10)	26	27	0.52	0.52	53.3	53.1
FP1 (11-13)	25	26	0.52	0.493	53	52.9
FP (14>)	26	27	0.52	0.464*	52.6	51.9
FP2	26	26	0.5	0.476	52.9	52.8

Control, mepiquat chloride (MC)-treated comparisons followed by *, **, ***, indicate significance at the p= 0.05, 0.01 and 0.001 levels respectively.