EFFECTS OF FLOWERING DATE, IRRIGATION AND MEPIQUAT CHLORIDE ON COTTON FIBER PROPERTIES

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Abstract

Fiber quality is the result of interactions between genetics and environment. Fiber property variability has been related to boll location. Fiber properties may be modified by soil water availability and growth regulating chemicals. Cotton (*Gossypium hirsutum* L.) was grown in Corpus Christi, Texas under rainfed and irrigated conditions and treated with mepiquate chloride (MC). Fiber lengths were highest in earlier set first position rainfed bolls, while fiber maturity values were higher in later set first position bolls (rainfed and irrigated). Comparisons of fiber from untreated and MC treated plants revealed a few significant differences in 1994 and none in 1995. The differences were pronounced in 1996 which was characterized by very low rainfall. Mepiquat chloride treated plants had first position bolls with longer fibers and higher maturity values than untreated cotton. The effects of MC on cotton fiber properties were not limited to early set first position bolls.

Introduction

Fiber properties have been mapped by boll location in cotton (*Gossypium hirsutum* L.). First position bolls on lower fruiting branches had long fibers and lower micronaire values than later season bolls (Kerby and Ruppenicker, 1989). Fiber length and micronafis (micronaire) values fluctuated by node location under rainfed and irrigated conditions (Bradow et al., 1997). Water deficits during cotton plant growth have been related to decreased fiber length and changes in micronaire values (Marani and Amirav, 1971; Shimshi and Marani, 1971). The effect of mepiquat chloride (MC) on fiber properties has been inconsistent but trends toward increased fiber length have been reported (York, 1983; Kerby, 1985; Livingston and Wilde, 1990; Ebelhar et al., 1996). The objective of this paper is to compare first position boll fiber properties under rainfed and irrigated conditions by flowering date. The effect of MC will be assessed at each flowering date.

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Materials and Methods

Cotton varieties DPL 50 (1994, 1995) and DPL 5409 (1996) were planted mid March in a field at the Texas A&M University Agricultural Research and Extension Center, Corpus Christi, Texas. Soil type was Victoria clay. Field plots were 12 rows wide and 15 m long (1994 and 1995) and 8 rows wide and 15 m long (1996). Row spacing was 96 cm with an average of 11 plants m^{-1} row. Fertilizer, weed and insect control were accomplished using the recommendations of the Texas Agricultural Extension Service. Two water regime treatments were applied, no irrigation (rainfed) and irrigated. A drip irrigation system consisting of 3.8 L h^{-1} emitters spaced 0.8 m apart was used to supply water. Lines were placed every other row. Rainfall and irrigation amounts are reported in Table 1. Total rainfall from March through July was similar in 1994 and 1995 (Table 1). The monthly pattern of rainfall revealed that 1995 had the highest prebloom rainfall (March through May) amounts while 1996 had the lowest prebloom rainfall amounts. With irrigation water input amounts rose to 219, 196 and 200 mm for 1994, 1995 and 1996 respectively. In 1994, mepiquat chloride was applied at 0.009 kgha^{-1} on rainfed plots, while irrigated plots received 0.043 kg ha^{-1} in two prebloom applications. In 1995, MC was applied at 0.018 kg ha^{-1} on rainfed plots, while irrigated plots received 0.043 kg ha^{-1} in two prebloom applications. In 1996, MC was applied at 0.022 kg ha^{-1} on rainfed plots and at 0.036 kg ha^{-1} on irrigated plots (one application).

First position flowers were tagged weekly for four weeks beginning the second week of flowering. Harvest aid chemicals were applied at 60% open bolls. Bolls were hand picked seven to ten days later. Weight of seed plus fiber was recorded for individual bolls. Fiber from seeds located in the middle of a boll was taken for fiber property analysis using the Advanced Fiber Information System (AFIS). Fiber length properties include length by weight, L(w) and short fiber content (SFC). Short fiber content by weight [SFC(w)] is the percent of fibers less than 12.7 mm in length. Fiber fineness and maturity properties include cross sectional area by number [A(n)] fiber circularity (theta), immature fiver fraction (IFF) and micronafis. Immature fiber fraction is the percent of fibers with theta < 0.25. 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 (P) as that of the fiber. Perimeter (P) can be calculated from theta and area values:

$$\Theta = \frac{4\pi A(n)}{P^2}$$

Analysis of variance was conducted on field grown bolls with PROC MIXED (SAS Institute). The experimental design was a split-split plot with four replications, with two water

regimes as main plots, two MC treatments as subplots and the four flowering dates as sub-sub plots.

Results and Discussion

Boll weights for rainfed cotton decreased with later flowering dates in 1994 and 1995 (Tables 2a , 3a). Fiber properties associated with length revealed that as fiber length decreased short fiber content increased (Tables 2a, 3a). Fiber maturity (theta), A(n), micronafis and perimeter values were larger in later set bolls (Tables 2a, 3a). The immature fiber fraction did not vary in 1994, while in 1995 one flowering date had a higher percentage of immature fibers (Tables 2a, 3a).

Irrigation reversed the trend in boll weights so that later season bolls had higher boll weights than early season bolls (Tables 2b, 3b). Fiber length did not decrease in later set bolls in 1994 but did decrease in 1995. The same trends for theta, A(n) and micronafis seen in rainfed cotton were present in irrigated cotton in 1994 and 1995 (Tables 2, 3). The immature fiber fraction decreased in later set bolls in 1995 (Table 3b). Perimeter values fluctuated in irrigated cotton.

A comparison of fiber properties from untreated plants and MC-treated rainfed plants (1994) revealed some significant differences. Mepiquat chloride-treated plants had larger boll weights (June 27, 1994), fewer short fibers (June 6, 1994), fewer immature fibers (June 27, 1994) and smaller perimeters (June 6, 1994). No significant differences ($P > 0.05$) were found in irrigated cotton (1994) or in rainfed and irrigated cotton in 1995.

In the extremely dry season of 1996, rainfed plants retained few bolls that were tagged on June 20, 1996 and June 27, 1996. The number of bolls was too small for statistical analysis (< 9). Fiber from MC-treated plants had larger area and micronafis values for the first flowering date (June 5, 1996) (Table 4a). Bolls set one week later revealed that MC-treated plants had fewer shorter fibers and more mature fibers (Table 4a). Under irrigation, MC-treated plants had longer fibers and fewer short fibers (June 5, 1996) and, in later set bolls (June 27, 1996), more mature fibers (Table 4b). These data suggest that if plants are under significant drought stress that MC should not be applied.

Previous reports of the effects of MC on fiber properties did not assess the interaction with flowering date or main stem node location. In 1995, there were no significant differences between fiber from first position bolls in untreated and MC-treated plants. In 1994, MC effects were noted under rainfed conditions and were related to fiber shape (length and perimeter) in early set bolls while in later set bolls effects were related to fiber maturity. In 1996, MC effects were present under rainfed and irrigated conditions. Significant differences were found in length and maturity properties. The differences in fiber properties (1996) at the flowering date level were not of practical significance since HVI fiber properties of a bulk sample containing fiber from all boll positions showed no significant differences in length or micronaire between untreated and MC-treated cotton. The extent of the contribution of fiber properties from a specific boll location to overall fiber quality depends on the contribution of that boll position to yield.

Summary

Boll weight and fiber properties of first position bolls vary according to day of anthesis. The trends in mepiquat chloride treated plants were similar but there were exceptions. The exceptions highlighted the fact that the effect of mepiquat chloride on fiber properties is not limited to early season bolls.

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References

Bradow, J. M., P. J. Bauer, G. F. Sassenrath-Cole, and R. M. Johnson. 1997. Modulations of fiber properties by growth environment that persist as variations of fiber and yarn quality. Proc. 1997 Beltwide Conf., Natl. Cotton Council of Amer., Memphis, TN. pp. 1351-1360.

Ebelhar, M. W., R. A. Welch, and W. R. Meredith. 1996. Nitrogen rates and mepiquat chloride effects on cotton lint yield and quality. Proc. 1996 Beltwide Cotton Conf., Natl. Cotton Council of Amer. Memphis, TN. pp. 1373-1378.

Kerby, T. A. 1985. Cotton response to mepiquat chloride. Agron. J. 77:515-518.

Kerby, T. A. and G. F. Ruppenicker. 1989. Node and fruiting branch position effects on fiber and seed quality characteristics. Proc. 1989 Beltwide Cotton Prod. Res. Conf., Natl. Cotton Prod. Res. Conf., Natl. Cotton Council of Amer. Memphis, TN. pp. 98-100.

Livingston, S. D. and L. B. Wilde. 1990. The effects of Pix multiple applications on fiber quality and boll position in irrigated cotton. Proc. 1990 Beltwide Cotton Prod. Res. Conf. Natl. Cotton Council of Amer. Memphis, TN pp. 650-652.

Marani, A. and A. Amirav. 1971. Effects of soil moisture stress on two varieties of upland cotton in Israel I. the Coastal Plain region. Expl. Agric. 7:213-224.

Shimshi, D. and A. Marani. 1971. Effects of soil moisture stress on two varieties of upland cotton in Israel II. the Northern Negev region. Expl. Agric. 7:225-239.

York, A. C. 1983. Cotton cultivar response to mepiquat chloride. Agron. J. 75:663-667.

Table 1. Monthly rainfall and irrigation amounts, Corpus Christi, Texas

a. Rainfall (mm)

Planting Date	March	April	May	June	July
3/23/94	57	57	39	81	18
3/31/95	89	8	81	57	16
3/20/96	2	33	24	59	1

b. Irrigation (mm)

Planting Date	March	April	May	June	July
3/23/94	0	0	66	58	155
3/31/95	0	0	18	89	140
3/20/96	13	67	61	130	84

Table 2. Boll weight and AFIS fiber properties for first position bolls in 1994 (DPL 50).

a. Rainfed

	Day of Anthesis			
Parameter	June 6	June 13	June 20	June 27
Boll weight (g)	4.7 a	4.0 b	3.7 b	2.7 c
L(w) (mm)	26.1 a	23.8 b	23.6 bc	22.6 c
SFC (%)	5.2 b	5.2 b	3.9 c	6.7 a
Theta	0.52 b	0.53 b	0.54 ab	0.55 a
IFF (%)	7.5 a	7.7 a	8.5 a	8.5 a
A(n) (μm^2)	119.6 b	121.3 b	121.b	132.6 a
Micronafis	4. 7 b	4.8 b	5.0 b	5.5 a
Perimeter (µm)	53.5 b	53.7 b	52.8 c	54.8 a

b. Irrigated

	Day of Anthesis			
Parameter	June 6	June 13	June 20	June 27
Boll weight (g)	4.7 b	5.0 ab	5.3 a	5.4 a
L(w) (mm)	25.6 a	25.4 a	25.9 a	25.9 a
SFC (%)	5.7 a	5.2 ab	4.5 b	4.9 b
Theta	0.52 c	0.55 bc	0.57 b	0.60 a
IFF (%)	7.9 a	6.8 a	6.1 ab	5.1 b
A(n) (μm^2)	118.6 c	122.2 bc	125.3 b	138.3 a
Micronafis	4.7 c	5.1 bc	5.3 b	6.1 a
Perimeter (µm)	53.5 a	52.9 b	52.6 b	53.5 a

Values followed by the same letter are not significantly different at the 0.05 probability level.

Table 3. Boll weight and AFIS fiber properties for first position bolls in 1995 (DPL 50)

a. Rainfed

	Day of Anthesis			
Parameter	June 7	June 14	June 21	June 28
Boll weight (g)	4.4 a	4.1 b	3.7 bc	3.4 c
L(w) (mm)	26.6 a	25.0 b	23.9 c	22.7 d
SFC (%)	4.4 b	4.6 ab	5.2 a	5.3 a
Theta	0.50 b	0.50 b	0.49 a	0.55 a
IFF (%)	9.0 b	8.9 b	10.8 a	7.6 b
A(n) (μm^2)	111.0 b	114.1 b	109.4 b	126.5 a
Micronafis	4.2 b	4.4 b	4.2 b	5.2 a
Perimeter (µm)	52.9 b	53.1 ab	52.5 b	53.6 a

b. Irrigated

	Day of Anthesis			
Parameter	June 7	June 14	June 21	June 28
Boll weight (g)	4.5 b	4.5 b	4.7 ab	4.9 a
L(w) (mm)	27.0 a	25.8 b	25.4 b	25.7 b
SFC (%)	5.0 ab	4.8 ab	4.3 b	5.1 a
Theta	0.50 b	0.50 b	0.51 ab	0.52 a
IFF (%)	9.3 a	8.6 a	8.8 a	8.1 a
A(n) (μm^2)	111.0 b	114.8 ab	112.4 b	117.0 a
Micronafis	4.2 b	4.4 ab	4.4 ab	4.5 a
Perimeter (µm)	53.1 ab	53.4 a	52.5 b	53.2 ab

Values followed by the same letter are not significantly different at the 0.05 probability level.

Table 4. Comparison of boll weight and AFIS fiber properties for first position bolls between untreated (UT) and mepiquat chloride-treated (MC) DPL 5409 plants in 1996.

a. Rainfall

	Day of Anthesis			
	June 5		June 12	
Parameter	UT	MC	UT	MC
Boll weight (g)	3.4	3.3 ns	3.0	34. ns
L(w) (mm)	22.1	21.8 ns	23.4	24.1 ns
SFC (%)	4.6	4.1 ns	5.2	3.3**
Theta	0.56	0.57 ns	0.54	0.59**
IFF (%)	5.8	4.9 ns	7.5	4.7**
A(n) (µm)	126.5	131.1*	120.4	129.3**
Micronafis	5.3	5.6*	4.9	5.6**
Perimeter (μm^2)	53.4	53.6 ns	53.1	52.6 ns

b. Irrigated

	Day of Anthesis			
	June 5		June 27	
Parameter	UT	MC	UT	MC
Boll weight (g)	3.9	4.1 ns	3.8	4.0 ns
L(w) (mm)	24.4	25.1*	25.9	26.7 ns
SFC (%)	3.1	2.7*	4.1	3.0*
Theta	0.56	0.56 ns	0.56	0.60*
IFF (%)	6.0	5.9 ns	7.3	5.4*
A(n) (μm^2)	123.2	123.7 ns	118.5	126.4*
Micronafis	5.1	5.2 ns	5.1	5.7*
Perimeter (µm)	52.8	52.5 ns	51.4	51.4 ns

The symbols *, ** indicated significant differences at the p = 0.05 and 0.01 levels respectively.

ns = non significant.