EVALUATION OF MEPIQUAT CHLORIDE MANAGEMENT IN IRRIGATED COTTON

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Introduction

Baja California cotton production ranks second to the state of Chihuahua in Mexico. In 2006 about 23,000 hectares of seed cotton were harvested in Baja California, all of this acreage was exclusively planted in the Mexicali valley. Yield in 2006 averaged 1,910 ton/ha (SAGARPA, 2006).

Much of the dynamic nature of the cotton (*Gossypium spp*.) plant arises from the fact that it is a true perennial. This presents specific challenges when managing the plant as an annual in a cropping system. Foremost among these challenges is that of maintaining a proper balance between vegetative and reproductive growth. Excessive vegetative tendencies in cotton can often lead to a loss of reproductive structures (squares, flowers, and bolls) (Gausman, et al., 1979; York, 1983b; and Fletcher et al., 1994). The actual physiological mechanism involved in the control of the vegetative/reproductive balance is a subject of considerable debate and research. Many processes have been reported to be associated with this phenomenon. The loss of carbohydrate sinks (reproductive structures) can shift energy from reproductive to vegetative portions of the plant, resulting in rapid proliferation of the vegetative main stem (Mauney, 1986). Self-shading may contribute to the loss of these reproductive structures in some cases due to the fact that the major portion of the assimilate supply for these structures is obtained from the subtending leaf (Ashley, 1972; Benedict and Kohel, 1975). When these leaves are shaded by excess vegetative growth, assimilate supply is depleted due to decreased photosynthetic ability and the abortion of fruiting structures can result (Mauney, 1986; York, 1983b).

Environmental stresses can exacerbate these problems. The most likely culprit is not one single event, however, but combinations of these factors and several processes acting in concert. Collectively, these morphological and physiological processes can serve to initiate a cycle of reproductive structure loss and a decline of overall fruit retention (FR) on the plant (Guinn, 1982).

Mepiquat chloride (MC) is a plant growth regulator that has been used in cotton production for several decades as a management tool in controlling vegetative growth. Mepiquat chloride is a gibberellic acid suppressant that is absorbed by the green portions of the plant and serves to reduce cell elongation, thus reducing overall plant height (York, 1983a and Kerby, 1985). Theoretically, the plant is then allowed to redirect energy from vegetative structures to reproductive structures. Much research has been devoted to determining optimum rates and application regimes (McConnell, et al., 1992; Boman and Westerman, 1994). However, application strategies that result in consistent significant increases in lint yield from MC have yet to be identified or demonstrated.

Many studies have been conducted in several years in Arizona (Silvertooth et al., 1989, 1990, 1991c, 1993b, and Fletcher et al., 1994) to determine optimal rates and application regimes of multiple MC applications for Upland (*G. hirsutum* L.) and American Pima (*G. barbadense* L.) cotton. The results from these studies have been used to develop a feedback type approach to MC applications based upon actual crop conditions and measured growth parameters in-season that has been incorporated into the University of Arizona (UA) crop management guidelines. Naturally, this type of feedback approach with respect to inputs such as MC requires established baselines. Being able to understand and interpret what is "normal" with regards to the vegetative/reproductive balance of the plant is crucial. Accordingly, guidelines relative to height to node ratios (HNRs) and fruit retention (FR) levels have been developed for this purpose (Silvertooth et al., 1991a; Silvertooth et al., 1992a; Fletcher et al., 1994; Silvertooth et al., 1995b; and Silvertooth and Norton, 1996b, 1997b, and 1998b). Management guidelines for fertilizer N inputs to cotton have also been developed and tested with the same basic rationale in a feedback versus scheduled type approach for crop system management (Silvertooth et al., 1991b, 1992b, 1993a, 1994, 1995a; and Si1vertooth and Norton, 1996a, 1997a, and 1998a). Collectively, this information has provided the basis for UA Cotton Production Extension Guidelines (Silvertooth, 2001a, 2001b, and 2001c).

The present study was conducted with two main objectives.

1. - Compare six MC treatment regimes on irrigated cotton in the Mexicali Valley in terms of crop vigor control, fruit retention, crop maturity, lint yield, and fiber quality.
2. - Update and revise MC recommendations for Mexicali Valley cotton growers in combination with the Arizona information with tangible information from their valley under local conditions.

Materials and Methods

A field experiment was established in a commercial cotton field under the management of Algodonera de Baja California in Ejido Tula in the Mexicali Valley, Baja California, Mexico. The soil type was a Gadsden clay (Vertic Haplustoll, fine, montmorillonitic, hyperthermic). Sure Grow 747, a common cotton upland variety was dry planted on 32-inch rows on 9 March and afterward furrow irrigated on an as-needed basis when plant-available soil moisture reached a level of approximately 40-45% depletion. Management of the field with respect to irrigation and pest control was carried out in a uniform and optimal manner for the entire study area (Table 1). Each irrigation event consisted of the delivery of approximately 8-10 acre-inches/acre.

Table 1. Irrigation, fertilization, and pest control inputs in the evaluation of Mepiquat Chloride (MC) application regimes on irrigated Cotton in Mexicali Valley, Baja California, Mexico.

Irrigation Schedule	
First Irrigation	03/09/06
Second Irrigation	05/17/06
Third Irrigation	06/05/06
Fourth Irrigation	06/24/06

Fertilization Program				
Product	Rate (kg/ha)			Observations
	N	P_2O_5	K_2O	
Urea	92			Side-dress application in first irrigation.
Anhydrous Ammonia Humiforte®	66 0.04	0.02	0.03	Applied during second irrigation
UAN 32	48			Applied during third irrigation
TOTAL	206.04	0.02	0.03	

Insecticide Application Program		
Common name	Rate (l/ha)	Date of Application
Pyriproxyfen	0.5	06/05/06
Endosulfan	3.0	06/05/06
PB-Rope L®	1 strip every 5 meters	07/04/06

Plots consisted of one entire border (14 rows * 984 ft. irrigation runs ~ 1.0 acre plots). Each plot was managed in a manner consistent with one of the three treatments (management strategies) under evaluation (Table 2). Treatments were arranged in a randomized complete block design with three replications (Figure1). The MC treatments were applied via ground rig applications with 20 gallons/acre carrier. A complete set of plant measurements (plant height, mainstem node numbers, bloom per 50 ft., nodes above top white flower (NAWF), percent fruit retention (FR), and percent canopy closure) were taken on approximately 14-21 day intervals from each plot throughout the course of the season. This information was used to make management decisions in-season according to the UA guidelines.

Table 2. Outline of treatments in the evaluation of Mepiquat Chloride (MC) application regimes on irrigated Cotton in Mexicali Valley, Baja California, Mexico.

Application Stage of Growth	Application HUAP*	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Treatment 6
First Square	May/16/06 901	0**	1	1	0	0	1
First Bloom	May/31/06 1217	0	1	1	2	2	2
Peak Bloom	Jul/04/06 2103	0	0	1	0	2	1

*HUAP = heat units accumulated since planting, 86/55^{o} F thresholds
**Treatment designations: 0 = no MC, 1 = 0.5 L MC /ha, and 2 = 1.0 L MC /ha

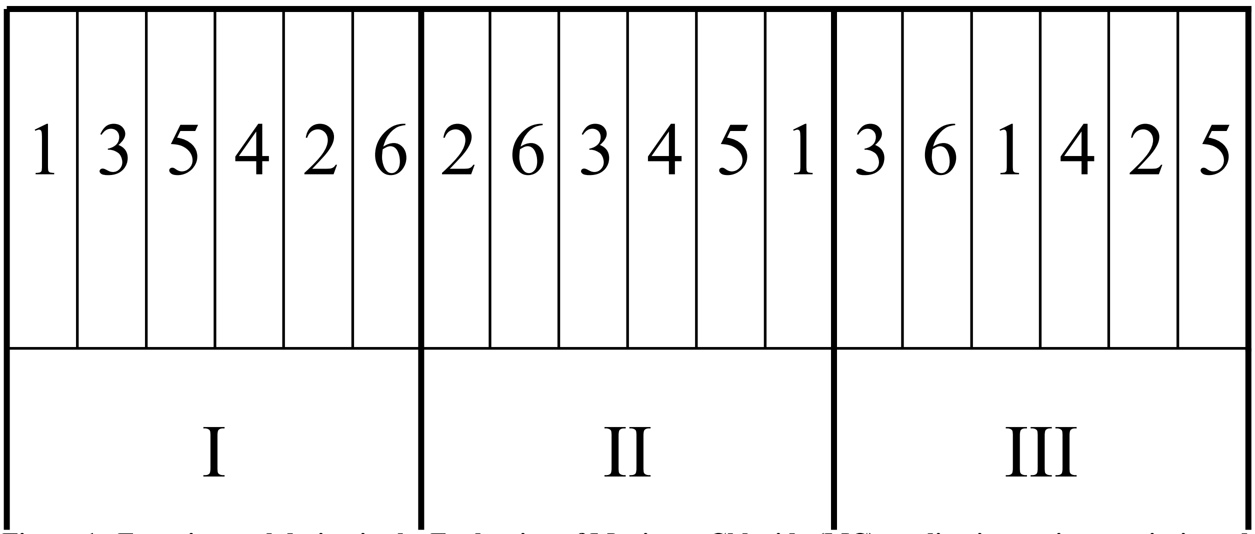

Figure 1. Experimental design in the Evaluation of Mepiquat Chloride (MC) application regimes on irrigated Cotton in Mexicali Valley, Baja California, Mexico.

Plots were defoliated when the youngest bolls in the crop were sufficiently mature to complete fiber development. In order to estimate lint yield, the central eight rows of every individual plots were machine picked and weighed out as appropriate for each treatment under study. Sub-samples of seed cotton were ginned for turnout analysis; fiber was submitted to obtain HVI properties. Result and data were analyzed in accordance with procedures outlined by Steele and Torrie (1980) and the SAS Institute (1997) consisting of an analysis of variance and the use of a means comparison test as appropriate.

Results and Discussion

Plant Height

A variation on plant height due to the addition of MC on cotton plants was observed among treatments (Table 3). This variation was statistically significant at the peak bloom stage (2103 HUAP) and by the end of the season, the control plots were on average 10 to 20 cm taller than the different MC treatments. No statistical difference in height was observed among the different MC treatments. These data show the lack of response in plant height reduction with supplementary additions of MC than those required on treatment 2 (two applications of 0.5 l/ha of MC).

Table. 3. Cotton growth and development variables: Plant eight (PLTHT), number of nodes, height to node ratio (HNR), nodes to first fruiting branch (FB), nodes above white flower (NAWF), blooms per 50 ft(BL), percent canopy closure (CC), and percent of fruit retention (FR), in the evaluation of Mepiquat Chloride (MC) application regimes on irrigated Cotton in Mexicali Valley, Baja California, Mexico.

DATE	TRMT	HUAP	PLTHT (cm)	NODES No.	HNR (in.)	FB	NAFW	BL 50 ft	CC (%)	FR (%)
5/16/06	1	901	27.7	10.7	1.02	6	-	-	24	100.0
	*0SL_{0.05} ¶LSD_{0.05} †CV%		------	------	------	----	------	------	-----	------
5/31/06	1	1217	45.0a	11.3a	1.57a	6a	8a	8ab	38a	92.38a
	2		41.9a	11.8a	1.40a	6a	8a	5ab	37a	92.54a
	3		43.4a	12.1a	1.41a	6a	9a	4 b	44a	92.99a
	4		45.0a	11.3a	1.57a	6a	8a	8ab	38a	92.38a
	5		45.0a	11.3a	1.57a	6a	8a	8ab	38a	92.38a
	6		44.5a	11.5a	1.53a	6a	9a	10a	3a8	93.37a
	*0SL_{0.05} ¶LSD_{0.05} †CV%		0.88 §NS 8.6	0.57 NS 5.5	0.16 NS 6.6	0.9 9 NS 1.4	0.59 NS 6.4	0.2 5.4 40.7	0.31 NS 9.8	0.99 NS 3.4
6/24/06	1	1807	90.2a	19.0ab	1.87a	6a	7a	124a	80a	86.43a
	2		81.8a	19.0ab	1.69a	6a	6a	92a	79a	84.50a
	3		86.1a	19.4a	1.75a	6a	6a	105a	77a	90.71a
	4		85.9a	19.0ab	1.78a	6a	6a	111a	74a	89.10a
	5		86.9a	18.8b	1.82a	6a	6a	104a	81a	87.71a
	6		77.0a	18.5b	1.64a	6a	6a	108a	81a	88.98a
	*0SL_{0.05} ¶LSD_{0.05} †CV%		0.35 NS 6.8	0.10 0.56 1.2	0.37 NS 6.1	0.8 2 NS 2.8	0.5 NS 4.7	0.93 NS 19.9	0.48 NS 5.2	0.36 NS 3.1
7/04/06	1	2103	95.5a	22.2a	1.69a	6a	6a	104a	86a	78.42ab
	2		83.3 b	20.9a	1.57a	6a	6a	73a	83a	81.03a
	3		83.6 b	21.7a	1.52a	6a	6a	95a	83a	78.46ab
	4		83.8 b	20.9a	1.58a	6a	6a	89a	79a	75.33ab
	5		86.1ab	20.8a	1.63a	6a	6a	93a	79a	78.95ab
	6		84.6 b	21.6a	1.54a	6a	6a	94a	85a	73.81 b
	*0SL_{0.05} ¶LSD_{0.05} †CV%		0.13 9.9 4.5	0.62 NS 4.3	0.60 NS 6.6	0.5 NS 4.2	0.75 NS 9.3	0.75 NS 22.2	0.52 NS 5.5	0.23 6.7 3.4
7/31/06	1	2944	122.2a	28.8a	1.67a	7a	3a	2a	98a	54.79ab
	2		104.4 b	28.3a	1.47a	7a	5a	3a	98a	49.15 b
	3		107.4 b	26.5a	1.60a	7a	5a	3a	98a	57.02a
	4		108.2 b	26.4a	1.62a	7a	5a	2a	96a	50.23 b
	5		112.0ab	26.3a	1.68a	7a	4a	2a	96a	51.03ab
	6		102.6 b	27.8a	1.45a	7a	5a	2a	98a	52.67ab
	*0SL_{0.05} ¶LSD_{0.05} †CV%		0.5 11.2 4.0	0.33 NS 4.6	0.20 NS 6.12	0.5 5 NS 3.3	0.17 NS 14.5	0.41 NS 35.6	0.5 NS 1.8	0.11 5.9 4.4

§NS = not significant; *OSL = Observed Significant Difference; ¶CV = Coefficient of Variation; †LSD = least significant difference - means followed by the same letter are not significantly different according to Fisher's means separation test (α = 0.05).

Number of Nodes

Overall, no significant difference in the number of mainstem nodes was observed due to the addition of MC to cotton plants (Table 3). The final number of mainstem nodes varied from 26 to 28. This is to be expected since the crop did not experience water stress and mainstem node production would be consistent based on HU accumulations (Silvertooth, 2001d).

Height to Node ratio

No statistically significant differences in the vigor of cotton plants (as expressed by the height to node ratio) were observed due to MC applications (Table 3). Also, as shown in Figure 2, the vigor values of cotton plants along the growing season showed an adequate vegetative/reproductive balance for all treatments. This suggests that the environmental conditions for this particular study did not promote an excessive vegetative growth on cotton plants.

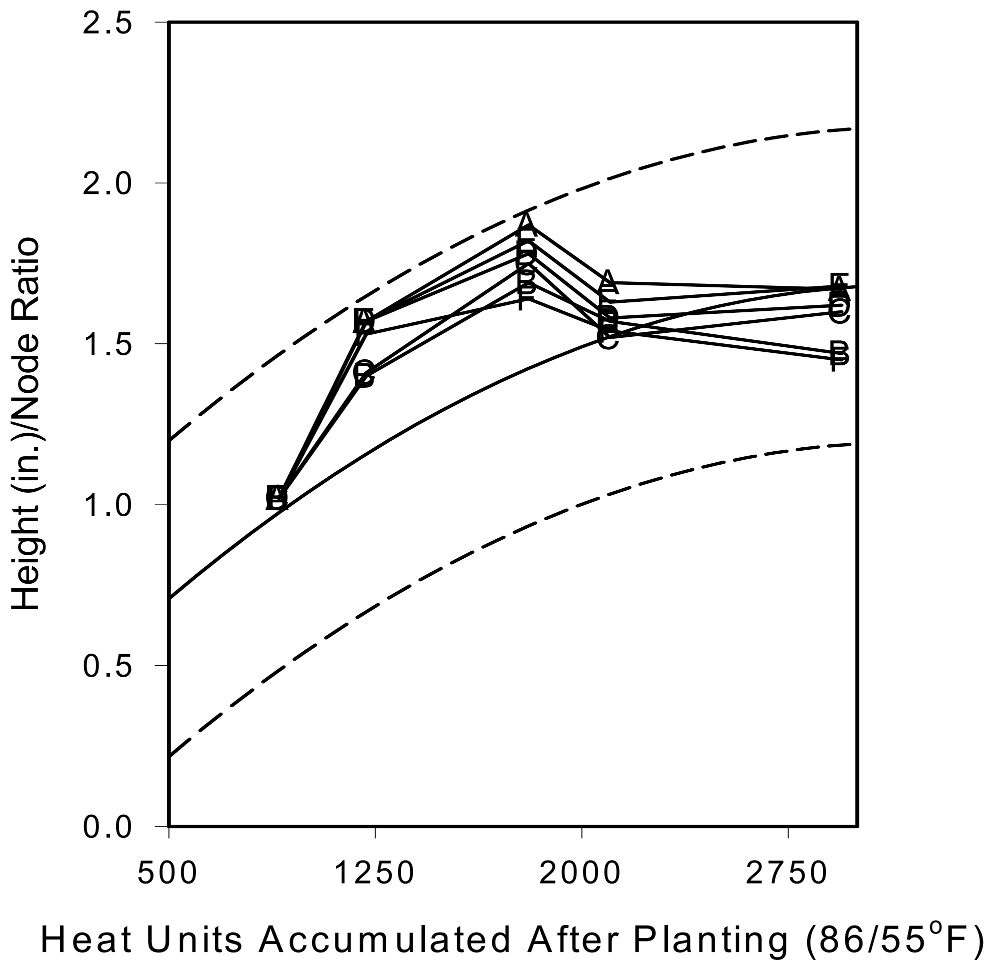

Figure 2. Height to Node ratio along the growing cycle; in the evaluation of Mepiquat Chloride (MC) application regimes on irrigated Cotton in Mexicali Valley, Baja California, Mexico.

Percent Fruit Retention

Overall values of FR all along the growing season remained above the average, according to cotton production standards in Arizona. No differences in FR among the treatments were observed due to the addition of MC. By the end of the season, FR values varied between 49 to 57% (consistent with established baselines for this region).

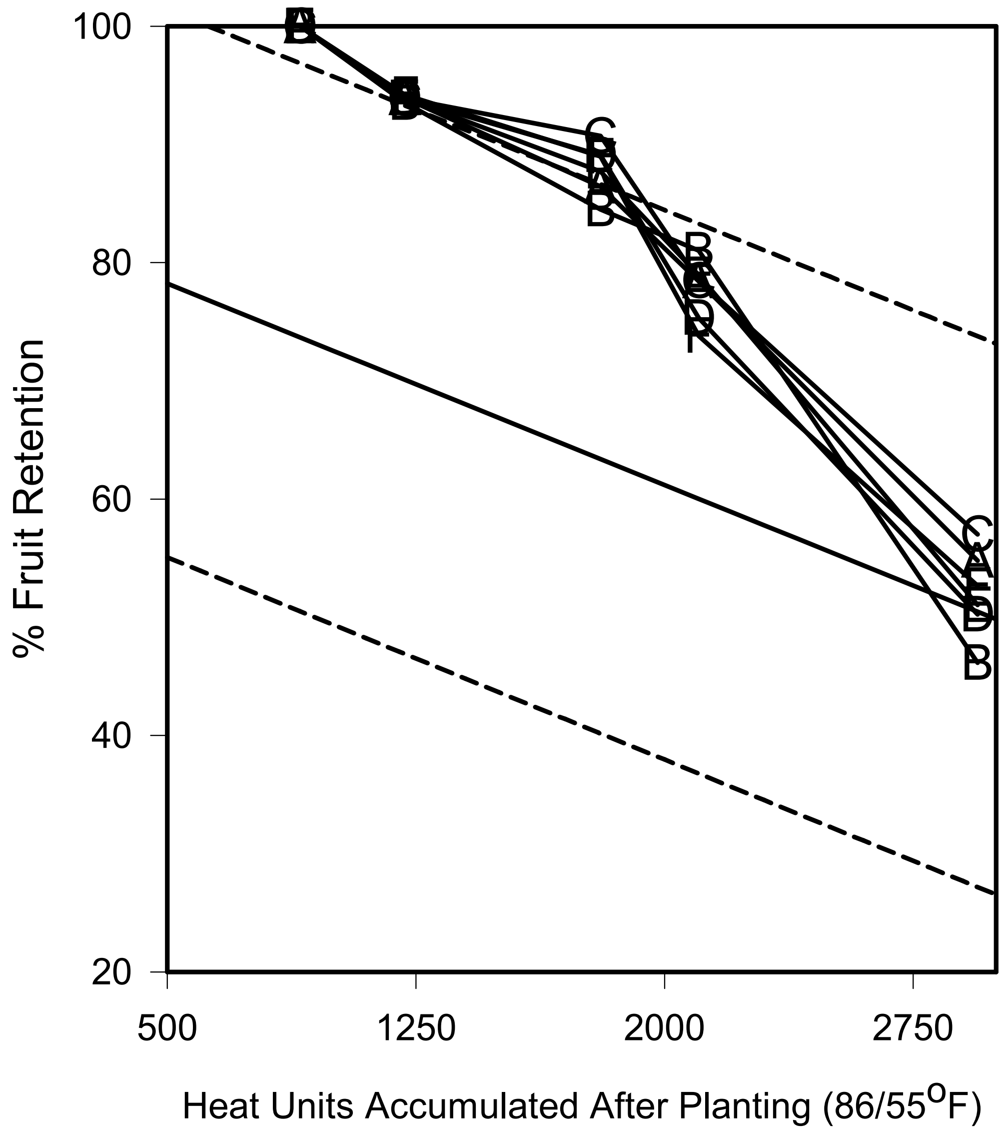

Figure 3. Percent fruit retention along the growing cycle; in the evaluation of Mepiquat Chloride (MC) application regimes on irrigated Cotton in Mexicali Valley, Baja California, Mexico.

NAWF, Blooms per 50 ft, and percent canopy closure

No statistical difference in the NAWF variables was observed due to the addition of MC to cotton plants (Table 3).

Lint yield

No statistical difference in lint yield (Table 4) was observed due to the addition of MC treatments to the cotton plant. Lint yield varied from 7.5 to 8.4 bales/ha.

Table. 4. Lint yield in the evaluation of Mepiquat Chloride (MC) application regimes on irrigated Cotton in Mexicali Valley, Baja California, Mexico.

Treatment	Lint yield (Bales/ha)
1	8.37a
2	8.37a
3	7.97a
4	8.03a
5	7.53a
6	8.23a
*0SL$_{0.05}$	0.4035
¶LSD$_{0.05}$	§NS
†CV%	6.4

§NS = not significant; *OSL = Observed Significant Difference; ¶CV = Coefficient of Variation; †LSD = least significant difference - means followed by the same letter are not significantly different according to Fisher's means separation test.

Conclusions

The results from this study serve to demonstrate and reinforce the UA guidelines that have been developed for irrigated cotton production systems in the desert Southwest. This is not surprising considering the fact that environmental conditions are basically the same for the lower Colorado River Valley in Arizona and Mexico (Baja California and Sonora). However, this experiment does provide important information in terms of a local demonstration in the field and an update and validation of crop production guidelines which is always an important element in the transition of research-based information into crop production guidelines (e.g. Extension recommendations).

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