MAXIMUM INTERNODE DISTANCE METHOD FOR MEPIQUAT CHLORIDE DECISIONS: CALIFORNIA EVALUATIONS

R. B. Hutmacher, R. L. Delgado, M. P. Keeley, B.H. Marsh, S. Perkins, E. Weir and L. Sanchez
Univ. of CA Shafter Res. & Ext. Ctr.
Shafter, CA

Abstract

Field studies were conducted in Upland and Pima cotton in the San Joaquin Valley (SJV) of California to evaluate the variability of upper canopy internode distances as a tool for estimating the need for the growth regulator mepiquat chloride. Data collected in both types of cotton showed significant differences in internode distances with node location and growth stage, and across field areas differing in plant vigor. This approach provided a useful tool for deciding mepiquat chloride application rates across a broader time frame than current University of CA Mepiquat Chloride guidelines for Acala varieties. This research has not established, however, impacts of changes in recommended rates and timing on vegetative growth control or yield in SJV cotton.

Introduction

Decisions on Mepiquat Chloride (PIX and related materials) growth regulator applications for California Acala cotton *(Gossypium hirsutum* L.) have been based upon research done in the 1980's that determined a likely yield response based upon measurements of plant height and percent bottom-5 first position (FP1) fruit retention made at about 14 to 15 total main stem nodes. In field measurements, this timing corresponded well with typical timing of 1st bloom in SJV cotton under CA conditions. The "Acala Cotton PIX Guidelines" of the University of CA Cooperative Extension are available in written table formats for use as a guide in growth regulator applications, or in palm-top or personal computer versions from University of CA Farm Advisors and Specialists.

One characteristic of the existing University of CA method is that it is based upon decision-making for first bloom timing (about 14 to 16 total main stem nodes) of growth regulator applications. In general, this approach and timing have worked well for Acala cotton varieties that are at least moderately determinate even though they are full-season varieties. There are numerous situations, such as with more indeterminate varieties, however, where one mepiquat chloride application has been inadequate for growth control necessary to maintain a manageable plant size and good harvest date. This has resulted in grower interest in alternative tools to help with decisions on additional applications that could be made earlier or later than first bloom.

Researchers at Texas A&M University (Landivar et al) and Delta Pine Land Company have experimented in recent years with an approach that involves measurements of internode lengths. There is general agreement that the uppermost fully-expanded leaf on cotton plants is about 4 to 5 leaves down on the main stem from the uppermost leaf that is about quarter-sized (or about 1 inch in diameter). Research has therefore focused on use of the internode measurement between the fourth and fifth leaf down the main stem below that minimum 1 inch diameter leaf near the terminal. This measurement method has been called the "maximum internode distance" or "MID" method for evaluating timing and application rates for mepiquat chloride. Texas A&M University and Delta Pine Land Company researchers proposed specific Mepiquat Chloride application rates corresponding with total number of main stem nodes and 4th-5th internode length (see Fig. 1 based upon Delta and Pine Land Company guidelines). This approach is based upon the impact of plant size or mass and the total amount of growth regulator and concentration in tissue required to impact additional growth (ie. a bigger, more vigorous plant will require a larger amount applied per unit ground area).

This field test was set up to evaluate the consistency of measurements made with the "Maximum Internode Distance" method, and compare the resulting growth regulator recommendations with those obtained using the "PIX" Tables for Acala available in the University of CA "Cotton Production Manual" (UC-Agricultural and Natural Resources Publ.# 3352) or in the CPM computer PIX modules also available through the University of CA.

Materials and Methods

Measurement Sites

Field measurements were made in 2000 at two field research centers (clay loam soil at the Univ. of CA West Side Research and Extension Center in western Fresno County, and a sandy loam soil at the Univ. of CA Shafter REC in northern Kern County, California). Five different fields were sampled, and nine different varieties evaluated (three Pima and six Acala/Upland varieties). Pima varieties included Phytogen-57, Delta Pine DP-HTO, and S-7. Acala and Upland varieties included Maxxa, GTO Maxxa, Phytogen-33, Phytogen-72 and Suregrow 501BG/RR (*data will only be shown for limited sites*). Planting dates across these fields ranged from April 5 through April 26, and good plant densities (38,000 to 49,000 plants / acre) and stand uniformity was achieved in measured fields.

Timing of Measurements

Growers and consultant agronomists have been privately evaluating use of additional Mepiquat Chloride applications made both before and after first bloom (14-15 total main stem nodes) timing. For this reason, we focused on use of internode distance measurements made at the following timing:

- At 9 through 11 total main stem nodes
- At 14 through 16 total main stem nodes
- At 19 through 21 total main stem nodes

All these internode measurements were made on the node between the 4th and 5th leaves from the uppermost main stem leaf at least 1 inch diameter

Plant Measurements

Internode lengths were determined on seven plants per block in each of three field replications for each variety, and these same plants were used for repeated measurements. Plant height, total node # and fruit retention (bottom-5 and top-5 first position fruiting sites) were determined at specific times on plants within adjacent rows in the same area of the field (within 15-20 feet) where internode distances were measured.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:527-530 (2001)
National Cotton Council, Memphis TN

Results and Discussion

Effects of Growth Stage and Number of Nodes

Internode lengths change quite dramatically during development based upon a number of factors too numerous to go into here (including prevailing temperatures, plant water status, leaf area, insect pest and pathogen damage). Since all plants and varieties were subject to similar conditions, the focus of measurements in this study was to characterize how rapidly and consistently these measurements changed during the course of plant development. *Note that the internodes shown* in the following tables range from as low on the plant as the internode between the 4th and 5th nodes all the way through node # 16-17. The three groupings shown in Figures 2 and 3 represent the internode distances that would be measured if you were making a decision regarding a mepiquat chloride application when the plants had a total of:

- 9-11 main stem nodes *(a pre-bloom application timing)*
- 14-16 main stem nodes *(first bloom timing for application)*
- 19-21 main stem nodes *(late application for fields without adequate control achieved with earlier applications)*

Figure 2 shows average maximum internode lengths *(in cm)* for the Pima "S-7" variety as a function of main stem node number. Figure 3 shows the same for the Acala variety "Maxxa". Data for these varieties (and others – data not shown) showed that under year 2000 conditions in test locations, internode lengths were rapidly changing through the period of rapid vegetative growth that corresponds with development of the 4th or 5th through 11th or 12th node (Figures 2, 3).

Internode distances tended to become more stable during the period from about 11th through 16th-17th node in these measurements. It is recognized that the pattern of changes shown in these Figures will not always be found under different growing conditions and varieties. For instance, fruit retention problems and occurrence of water or high temperature stress could also impact internode growth. However, the dramatic changes in internode lengths as the plant develops points out that widely different mepiquat chloride recommendations could be achieved (using Figure 1) with some slight differences in dates of plant measurements.

Variation Across Field Replications

Mean internode distances (and standard errors shown as vertical lines) as a function of growth stage (internode 10-11 versus internode 15-16) are shown for example fields of Acala "Maxxa" in Figure 4. Similar data was obtained in other Upland and Pima varieties (data not shown). The two different types of bars shown in Figure 4 compare the differences in data obtained at two different locations for each variety (from a field with "high" (>65%) bottom-5 fruit retention versus one with "low" (>45%) bottom-5 retention). Internode lengths were quite variable within field reps (indicated by error bars) as well as across field replications. Even though the plant heights in the fields which had higher fruit retention were visually more uniform, there still was significantly within- and across-replication variability in internode lengths.

Impacts on Mepiquat Chloride Application Recommendations

As expected, varieties which differ in vigor show differences in maximum internode distance (MID) at both high fruit retention sites (Table 1) and lower early fruit retention sites (Table 2). Both tables show varietal differences in MID on plants grown within the same fields. Note that each variety shows large differences in MID lengths with just one unit change in the internode (for example: from the 5th-6th internode versus the 6th-7th internode). This high degree of variability has little impact on the PIX application recommended when the plant vigor is moderate (in the high early fruit retention field shown in Table 1). When higher vigor occurs with lower early fruit retention, the variability in MID across internode ranges shown in Table 2 results in very different PIX recommendations depending upon the timing of measurements (which node was measured). Also shown in Tables 1, 2 is the variability in PIX recommendation that would be found across measurements in different field replications, just for one variety ("Maxxa") at each location

Comparison of Recommendations made using MID versus University of CA Acala Guidelines

The University of CA Mepiquat Chloride (PIX) guidelines only provide information for 1st bloom application timing, and the basic rates recommended for Acala are 8 oz/acre and 12 oz/acre for Pima using this method. Higher rate recommendations with this method are based upon the size of the estimated yield response to mepiquat chloride. By contrast, the MID approach also provides recommendations which can be used for other timings of applications as well as for varying (Tables 3, 4). Under conditions of high early fruit retention, where there typically is less need for growth regulators, differences in recommendations between the two approaches are relatively small. With low early fruit retention, however, more total PIX would be applied using the MID method in most cases (including data from fields not shown in Table 4).

Summary

Variability across field replications in the MID measurement can be large but most likely the variability is a good representation of true within-field variability in plant vigor. Variability in MID values across different timing of measurements (or said another way, across different node #'s for making the measurement) was also large, and could lead to difficulties in deciding upon growth regulator recommendations, since one part of the field may call for a different recommendation than other areas. The MID approach has potential for broader use under San Joaquin Valley conditions if future efforts can demonstrate that variability in node lengths with node position on the plant does not lead to problems with improper (too high or too low) growth regulator recommendations.

Acknowledgments

The assistance of staff of the Shafter and West Side Research and Extension Centers of the University of CA is gratefully acknowledged. Financial assistance for this project was provided by the University of CA Cotton Research programs, the AG Futures Internship program and the Stockdale Exchange Club, and CA Planting Cotton Seed Distributors. Dr. Brian Marsh, Mr. John Peterson and Ms. Freddie Swing also provided valuable assistance in coordinating efforts on this project.

Table 1. Average internode distance (cm) as a function of internode location and variety at high fruit retention site (West Side REC) in 2000.

	Average internode distance @ 4th-5th node below uppermost leaf >2.54 cm diameter (in cm)			Resulting PIX application decision (for Maxxa only) (in oz PIX/acre)		
Inter-node Range	Phy-33	DPL Nucott-33B	CPCSD Maxxa	Rep. #1	Rep. #2	Rep. #3
4-5	2.67	1.55	2.13	0	0	0
5-6	1.96	1.22	2.10	0	0	0
6-7	3.72	1.83	3.19	0	0	0
9-10	4.58	3.36	5.96	0	0	0
10-11	7.54	4.51	6.70	6	0	0
11-12	7.33	5.32	7.90	8	6	8

Table 2. Average internode distance (cm) as a function of internode location and variety at low fruit retention site (Shafter REC) in 2000.

	Average internode distance @ 4th-5th node below uppermost leaf >2.54 cm diameter (in cm)			Resulting PIX application decision (for Maxxa only) (in oz PIX/acre)		
Inter-node Range	CPCSD Riata	Sure-grow 501	CPCSD Maxxa	Rep. #1	Rep. #2	Rep. #3
4-5	7.08	7.48	8.19	8	6	8
5-6	4.16	5.48	5.74	0	0	0
6-7	7.99	8.63	7.88	8	5	6
9-10	8.04	9.39	5.88	0	0	4
10-11	9.08	10.22	8.28	12	6	6
11-12	7.53	7.24	6.11	0	0	6

Table 3. Selected plant growth characteristics, PIX application recommendations by MID and Univ. of CA Acala Guidelines methods for cotton at low early fruit retention sites (Shafter REC) in 2000.

				Recommended PIX application rate at specific # of nodes by MID method (in oz PIX/acre with 4.2% formulation)			Univ. of CA Acala Guidelines – with measurements at 14-15 nodes	
Fld #	Variety	Ht. to node ratio @ 15 nodes	Bot-5 fruit retention (%)	@ 10 nodes	@ 15 nodes	@ 20 nodes	Estim lbs/ac yield response to PIX	Rec. PIX application rate in oz/ac
19	Pima S-7	1.63	45	0	0	6	42	12
19	Pima Phy57	1.80	40	0	0	8	45	12
15	Max-xa	2.32	33	6	6	0	82	8
15	SG-501 BR	2.79	37	6	12	8	119	12
17	Phy-33	2.36	29	6	8	8	91	12
17	GTO Max-xa	2.48	31	6	10	8	82	8
17	Phy-72	2.29	36	4	8	8	83	8

Table 4. Selected plant growth characteristics, PIX application recommendations by MID and Univ. of CA Acala Guidelines methods for cotton at high early fruit retention sites (West Side REC) in 2000.

				Recommended PIX application rate at specific # of nodes by MID method (in oz PIX/acre with 4.2% formulation)			Univ. of CA Acala Guidelines – with measurements at 14-15 nodes	
Fld #	Variety	Ht. to node ratio @ 15 nodes	Bot-5 fruit retention (%)	@ 10 nodes	@ 15 nodes	@ 20 nodes	Estim lbs/ac yield response to PIX	Rec. PIX application rate in oz/ac
26	Pima S-7	1.50	67	0	0	6	11	12
26	Pima Phy-57	1.80	59	0	0	6	33	12
16	Max-xa	1.81	73	0	6	8	7	8
16	Phy-33	1.97	80	0	8	12	22	8
16	Nucot-33B	1.39	64	0	0	8	5	8

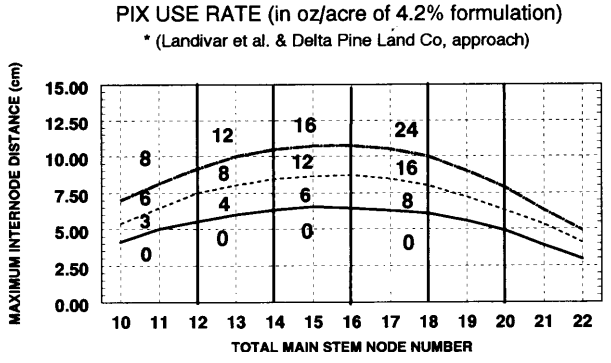

Figure 1. Mepiquat chloride (PIX) applications as a function of maximum internode distance (MID) and total main stem node number (from Delta and Pine Land Company, 1999)-values shown within figure area recommended rates of PIX (4.2% formulation) application (in oz PIX/acre) for the particular MID and node number combination.

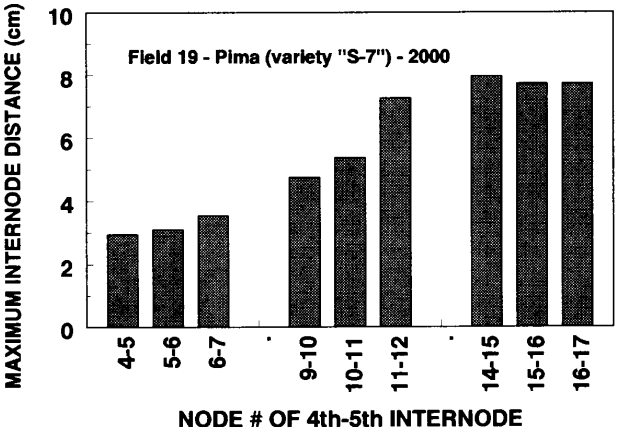

Figure 2. Growth stage (node of internode) impacts on maximum internode distace in Field 19 for the Pima variety “S-7" in 2000. Values shown are the mean across 7 plants per field replication in 3 field blocks.

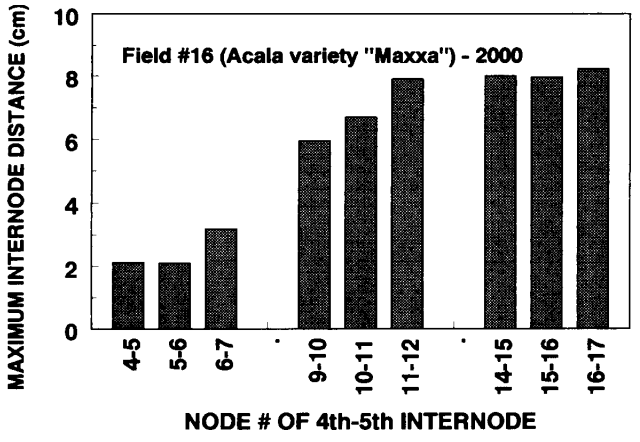

Figure 3. Growth stage (node of internode) impacts on maximum internode distace in Field 19 for the Acala variety “Maxxa” in 2000. Values shown are the mean across 7 plants per field replication in 3 field blocks.

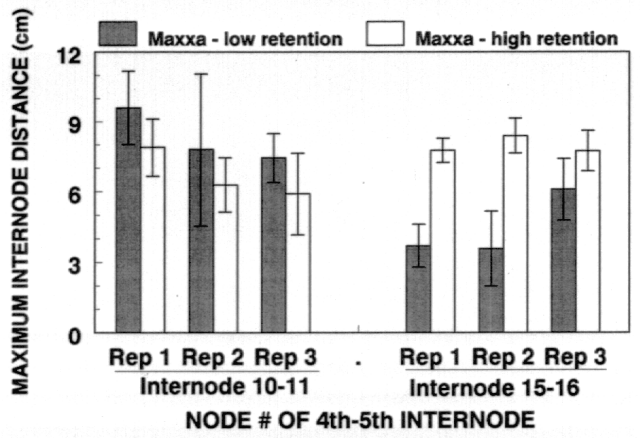

Figure 4. Variation in average internode distance (cm) with field replication and with growth stage (10`-11th internode versus 15-16th internode) for the variety “Maxxa” in a high fruit retention field and a low fruit retention field in 2000. Variation among plants within a field replication is indicated by the vertical standard error bars shown here.