The Effects of PIX Application Timing on Upland Cotton Lint Yield and Growth and Development Parameters

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Abstract

Six commercial scale field studies were conducted from 1991-1993 to further evaluate and predict Upland cotton yield and development responses to PIX application timing as a function of cotton growth and condition. Treatments imposed intended to further clarify some response trends observed in previous years of field studies. Treatments were all at the maximum label rate of one and one half pints with application timing the main variable. Timing was based on heat unit accumulation and resultant growth stage since date of planting. Two of the six studies resulted in significant lint yield increase of roughly one hundred pounds across all PIX treatments in contrast to the untreated check. The two studies which resulted in lint yield increases both had height:node ratio measurements in excess (vegetative) of previously defined guidelines.

Introduction

PIX (mepiquat chloride) is a widely used compound in commercial cotton production. PIX is a compound which is used as a plant height control tool by suppressing giberellic acid production which results in a reduction of cell elongation. PIX is commercially used to control excessive vegetative growth whereby theoretically plant energy expended in vegetative production can be reallocated to formation and retention of fruiting forms such as squares, flowers and bolls.

PIX is widely utilized in many commercial cotton operations. In general, yield response has been variable and inconsistent. Numerous field studies have been conducted over many years which have basically verified the inconsistent and variable cotton response to PIX applications that producers experience. Field studies conducted by Silvertooth, et al. since 1988 in Arizona have resulted in interesting results and observed trends in studies where positive yield responses have been measured. The purpose of field study continuation is to further clarify crop conditions that may result in an increased yield response to PIX applications. As a result of these plus other studies, usage guidelines have been developed for Upland cotton production.

A brief review of the above described work follows. In 1988 and 1989, several field studies were initiated which investigated the effects of low rate multiple applications at initiation of match head square, early bloom and 14 days post bloom. It was found that the treatments successfully controlled plant height for roughly two weeks after application. Due to the rapid rate of growth experienced in low desert cotton production, the crop rapidly outgrew the PIX applications when produced under full season conditions and no lint yield differences were experienced with the exception of one case.

The exception was a study where a severe wind and rain storm prematurely terminated the crop thereby eliminating potential for extended or late season fruiting potential. Significant lint yield increases were observed when the crop was produced under reduced season conditions. These results concurred with previous studies conducted by Kerby, Hake and Keeley. It was reported that when PIX was applied at early bloom, boll

retention was significantly enhanced at the lower nodes. Middle crop retention was unchanged while fruit retention decreased in the top crop.
The positive yield response in this single experiment was possibly due to the decreased time for compensation in terms of vegetative production following the final PIX applications and a resultant positive yield response.

From these results, the 1990 field studies conducted by Silvertooth et. al. employed an extended PIX application period in addition to increasing the rates. The strategy was to extend applications from early bloom through peak bloom and into the latter periods of fruit initiation within the first fruiting cycle. Interestingly, one study in 1990 resulted in significant lint yield increases. This was a study that exhibited definite vegetative tendencies with height:node ratio measurements as verification.

The six field studies described herein from 1991-1993 further tweaked application rates and timing as a function of plant growth and development measurements with applications based on heat unit accumulations since planting. All total application rates were at the maximum label allowance of one and one half pints over a maximum of four split application multiples.

Materials and Methods

Six replicated field studies were conducted from 1991-1993 to evaluate PIX applications as a function of timing based on heat unit accumulation since planting. Treatments were initiated at early bloom and extended up to the measured cut-out growth stage. The treatments used are listed in Table 1 and Table 2. Crop and relevant study information is listed in Tables 3. All tests consisted of eighteen, twelve row plots running the entire field length. There were six treatments with three replicates randomized into a randomized complete block design. Applications were made with ground rigs with carrier rates ranging from 10 to 25 gallons per acre. Four center rows from each plot were machine picked and weighed. Each treatment received an independent lint turnout from a commercial gin.

Plant growth and development measurements were made every two weeks. These measurements consisted of fruit retention, plant height, number of nodes above top white fresh bloom, number of blooms per 25 feet row length, number of mainstem nodes and the calculated height:node ratio. Although a complete set of plant growth and development data was collected, it has been found that the height:node ratio measurements represent the most accurate indicator of expected PIX response. Therefore, Figures 1-6 summarize the measured height:node ratios across all six treatments overlaid on the developed height:node ratio guideline curve.

Results and Discussion

Two of the six studies resulted in significant lint yield increases of approximately one hundred pounds per acre in all PIX treatments in contrast to the untreated check. The results are interesting since measured growth and development parameters which account for the yield increase were observed. The measured plant growth and development difference between results with a positive PIX response versus those without a response was the height:node ratio measurement. As a result a general curve has been developed depicting the lower, optimum and upper range of height:node ratios as a function of growth stage. Recommendations and usage guidelines have been developed for Arizona as a result of multiple year studies including these.

When comparing measured height:node ratios over the test period in the two studies where a positive PIX response was measured, it is noted that actual measurements exceed (vegetative) recommended standards over the season. As a result, PIX applications resulted in a reduction in the vegetative tendency and encouraged energy transfer into a reproductive or fruiting mode.

Conversely, four of the studies resulted in no PIX response. In these cases, measured plant height:node ratios did not exceed optimum growth and development standards and lack of yield response was predictable. Growth and development characteristics were already at an optimum and necessitated no growth regulator manipulation. In the 1991 Waddell, 1992 Buckeye, and both 1993 studies, height:node ratios were in the recommended range and plant height reduction would be unnecessary and undesirable. The lack of differences in lint yields verified this conclusion. No yield loss was experienced, but knowing the ideal and actual development status, a producer can make an informed decision as to PIX input.

Both the 1991 and 1992 studies at the Maricopa Agricultural Center demonstrated a positive PIX response from a lint yield standpoint and reduction in height:node ratio following applications. Height:node ratios exceeded the optimum standard from the beginning. The untreated check continued to develop vegetatively at the expense of energy allocation to fruiting forms. The final height:node ratio exceeded 2 in the untreated check and a resultant yield decrease. The PIX treatments all resulted in reduced height:node ratios ultimately resulting in a plant energy reallocation from the vegetative component to the reproductive component. The PIX treated plots, even at the high rates were remaining on the high side of the desirable height:node ratio. Also note that in agreement with previous studies, after roughly two weeks, the PIX effect on plant height suppression was negated. This suggests that a rapidly growing crop that is being pushed hard would potentially benefit from multiple applications at the maximum label rate throughout the entire fruiting cycle.

in the 1991 and 1992 Maricopa Agricultural Center studies all PIX treatments produced significant yield increases in contrast to the untreated checks. Treatment 2 and treatment 3 consistently resulted in the highest yields within the PIX treatments. However, treatment 3 received two high rate applications versus three applications in treatment 2. From a management and cost effective position, treatment 3 is the better alternative. Minimize applications but use the high rates under these field conditions. Treatment 2 utilized a 0.75 pt. application at both early and peak bloom.

Summary

These studies were exciting from the standpoint since progress was made to further clarify crop conditions whereby lint yield increases are predictable as a result of PIX application. When simple in field crop measurements determine that a cotton crop is moving towards vegetative production at the expense of fruiting and fruit retention, PIX represents a viable management tool to maximize fruit set and desirable reproductive conditions. Using the developed recommendations and guidelines, a producer can readily determine the actual crop development status over time and informed decisions regarding PIX applications. An optimum balance of vegetative to reproductive ratios are essential to consistently optimize cotton lint yields. For a copy of the University of Arizona Cooperative Extension usage guidelines, contact your local Extension Office or your BASF representative.

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References

Husman, S.H., J.C. Silvertooth, and C. Ramsey. Effects of PIX Application Timing on Lint Yield and Growth and Development Parameters, 1992. 1992 Cotton Report. Series P-91, pp. 25-32. College of Agriculture, University of Arizona.

Silvertooth, J.C., J.E. Malcuit, S.H. Husman, W.S. Winans, and L. Hood. 1990. Cotton Response to

Multiple Applications of PIX, 1990. 1991 Cotton Report. Series P-87, pp. 55-58. College of Agriculture, University of Arizona.

Silvertooth, J.C., J.E. Malcuit, D. R. Howell, and C.R. Farr. 1990. PIX multiple application evaluations in Arizona on Upland and Pima cotton. Cotton, A College of Agriculture Report, University of Arizona. Series P-81:50-56.

Silvertooth, J.C., D.R. Howell, C.R. Farr, and J.E. Malcuit. 1989. Evaluation of PIX multiple application treatments on Upland and Pima cotton in Arizona, 1988. Cotton, A College of Agriculture Report. University of Arizona, Series P-77:104-109.

SAS User's Guide: Statistics, 5th Edition. Cary, NC: SAS Institute Inc., 1985.956 pp.

Guinn, G. 1982. Causes of square and boll shedding in cotton. USDA Tech. Bulletin No. 1672, 12pp.

Table 1. PIX Treatment Application Schedule 1991 and 1992

Treatment	1200 HUAP	1600 HUAP	2000 HUAP	2400 HUAP
1	-	-	-	-
2	1/4	1/2	-	3/4
3	3/4	-	3/4	-
4	1/2	-	1/2	1/2
5	-	1/2	1/2	1/2
6	1	-	-	1/2

*** HUAP = Heat Units After Planting**
*** Rates are in Pints Per Acre**

Table 2. PIX Treatment Application Schedule - 1993

Treatment	1200 HUAP	1600 HUAP	2000 HUAP	2400 HUAP
1	-	-	-	-
2	1	-	1/2	-
3	3/4	-	3/4	-
4	1/2	-	1/2	-
5	-	1/2	1/2	1/2
6	1	-	-	1/2

*** HUAP = Heat Units After Planting**
*** Rates are in Pints Per Acre**

Table 3. Crop Management Records **1991 - 1993**

	MAC '91	Waddell '91	MAC '92	Buckeye '92	MAC '93	Buckeye '93
Variety	D+PL 90	SureGro C-40	D&PL 5415	D&PL 5415	D&PL 5415	D&PL 5415
Plant Date	4/20 (554 HU)*	4/8 (577 HU)*	4/17	5/1	4/3	3/29
Appl 1	6/27 (1294 HUAP)**	6/21 (1249 HUAP)**	6/26 (1503 HUAP)	6/29 (1321 HUAP)	6/14 (1244 HUAP)	6/2 (1168 HUAP)
Appl 2	7/15 (1762 HUAP)	7/8 (1700 HUAP)	7/17 (1952 HUAP)	7/17 (1770 HUAP)	6/29 (1633 HUAP)	6/17 (1494 HUAP)
Appl 3	8/2 (2249 HUAP)	7/19 (2019 HUAP)	7/29 (2314 HUAP)	7/28 (2107 HUAP)	7/21 (2226 HUAP)	7/6 (1996 HUAP)
Appl 4	8/23 (2731 HUAP)	8/1 (2375 HUAP)	8/17 (2825 HUAP)	8/19 (2652 HUAP)	8/9 (2741 HUAP)	7/19 (2291 HUAP)
Irr. Term	9/6 (3151 HUAP)	8/3	8/26	8/29	8/27	8/22
Harvest	11/5	9/16	10/21	10/20	10/4	9/21
Carrier	-	-	27 gpa	10 gpa	18.5 gpa	18.5 gpa

MAC = (Maricopa Ag Center)
*** HU = Heat Units (86/155) Accumulated Since January 1**
**** HUAP = Heat Units Accumulated Since Planting**

Table 4. PIX Effects on Lint Yield

Treatment	Maricopa 1991	Waddell 1991	Maricopa 1992	Buckeye 1992	Maricopa 1993	Buckeye 1993
1	1268c	1093a	969c	1204b	1866a	1873a
2	1381a	1099a	1190ab	1318a	1827ab	1770b
3	1375a	1106a	1185ab	1198b	1846ab	1774b
4	1316abc	1008a	1241a	1173b	1838ab	1758b
5	1280bc	1113a	1178ab	1243ab	1796ab	1835a
6	1349ab	1073a	1114b	1244ab	1777b	1719b

* Means followed by the same letter are not significantly different (Fisher's LSD $\alpha = 0.05$)
* Values are expressed in lint (lbs/acre)

Figure 1

Height:Node Ratio vs. Heat Units

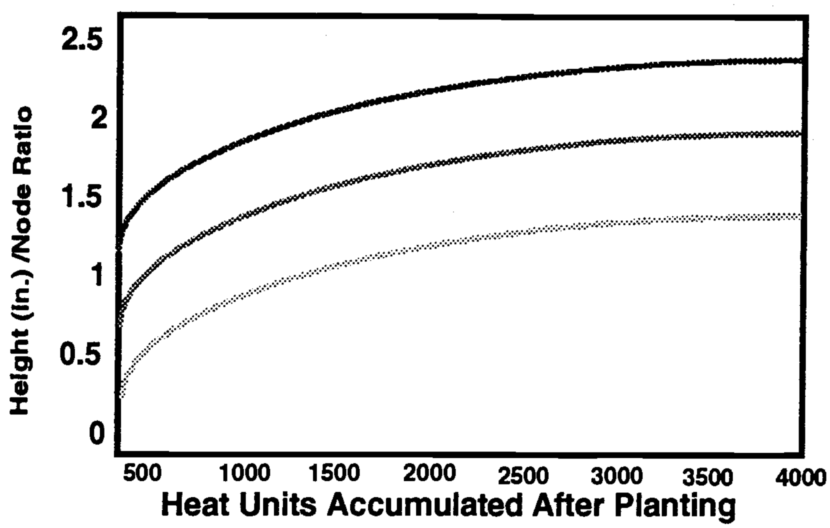


Figure 2

Pix Experiment 1991
Maricopa Ag Center

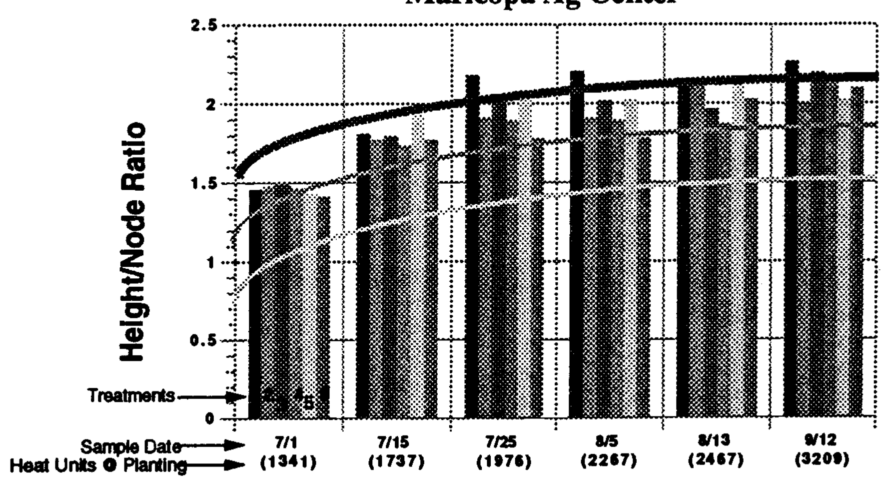


Figure 3

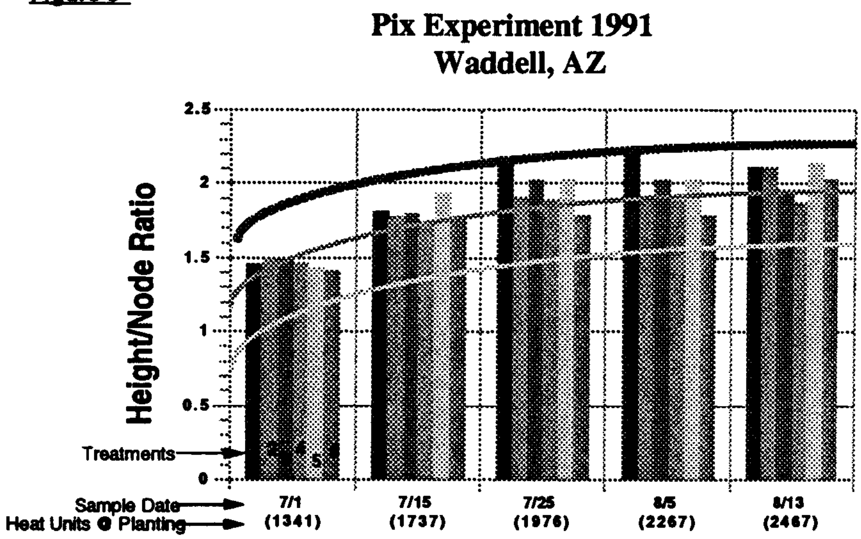


Figure 4

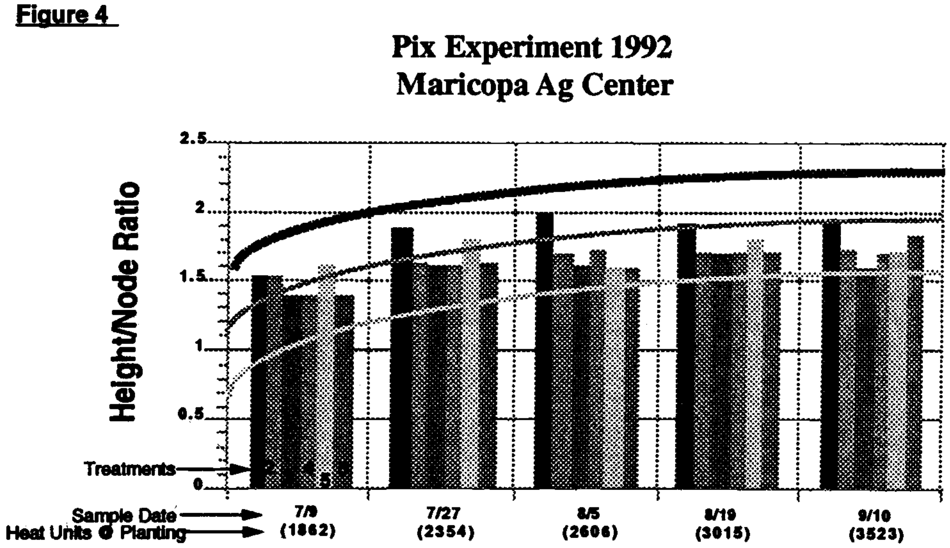


Figure 5

Pix Experiment 1992
Buckeye, AZ

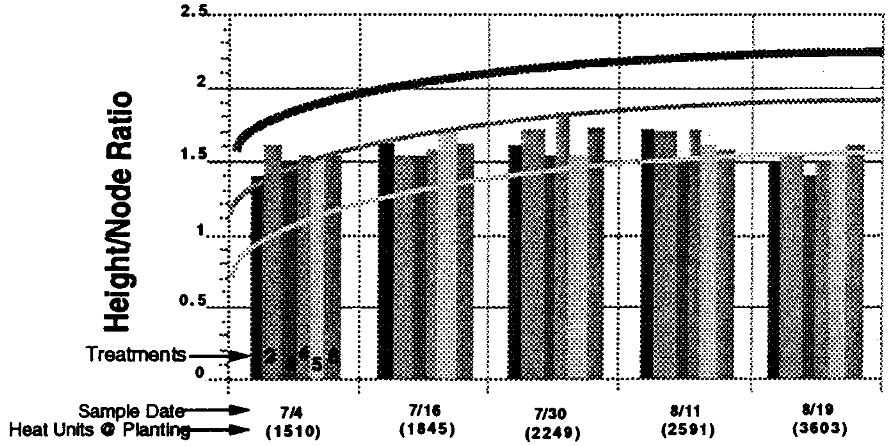


Figure 6

PIX Experiment 1993
Maricopa Ag Center

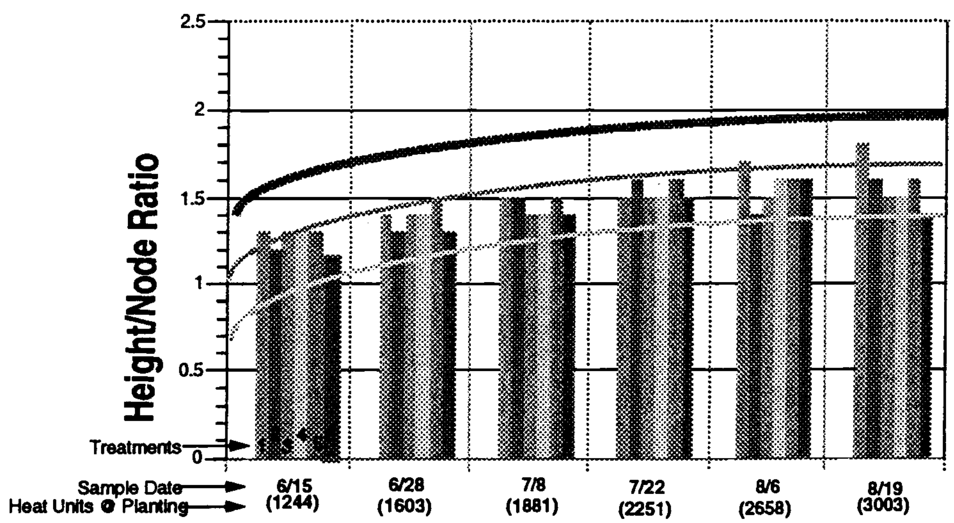
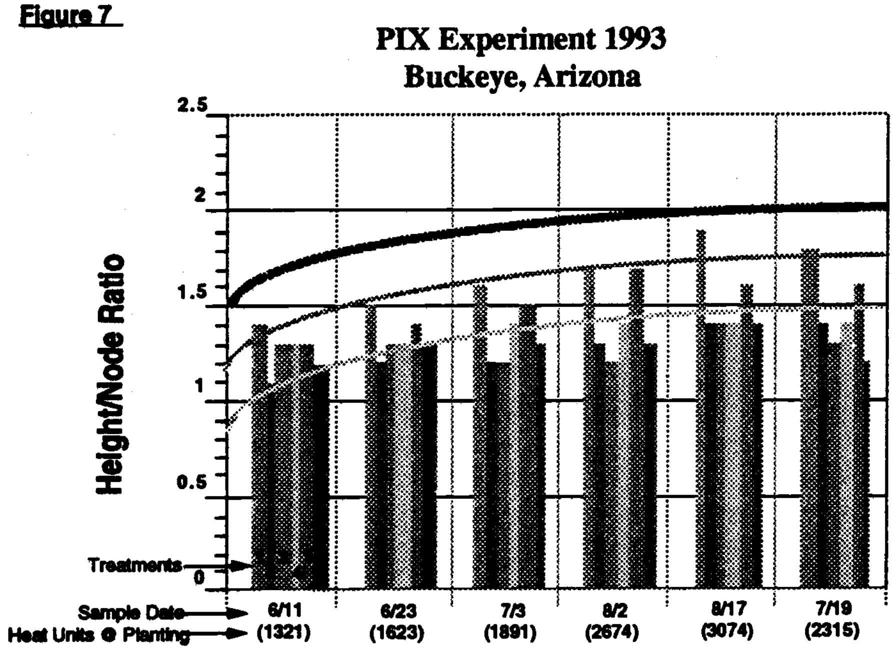


Figure 7


PIX Experiment 1993
Buckeye, Arizona
Height/Node Ratio
2.5
2
1.5
1
0.5
0
Treatments
Sample Date
Heat Units @ Planting
6/11
(1321)
6/23
(1623)
7/3
(1891)
8/2
(2674)
8/17
(3074)
7/19
(2315)