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

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## *Abstract*

*Two field studies were conducted in 1991 to further evaluate Upland cotton yield and development responses to PIX application timing as a function cotton growth stage. Treatments imposed in 1991 were intended to further clarify some response trends observed in previous field studies. Treatments in 1991 were all at the maximum label rate of 1.5 pt./acre with application timing the main variable. Timing was based on growth stage and heat unit accumulation since date of planting. The study in Waddell, Az. resulted in no significant yield differences across all treatments. In contrast, the study at the Maricopa Agricultural Center resulted in a statistically significant yield response by approximately 100 lbs. lint/acre for all PIX treatments compared to the untreated check plots. Plant growth and development measurements indicated the height:node ratio counts to be a good reflection of vegetative tendancies under field conditions in the two studies.*

## 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 then results in a reduction of cell elongation. PIX is commercially used to control excessive vegetative growth where theoretically plant energy expended in vegetative production can be reallocated to the formation and retention of fruiting forms such as squares, flowers and bolls.

In general, yield response to PIX has been variable and inconsistent. Numerous field studies have been conducted which have documented the inconsistent and variable cotton response to PIX applications that producers experience. Field studies conducted by Silvertooth, et al. since 1988 in Arizona have produced results where positive and negative yield responses have been measured. The purpose of continuing field experiments is to identify crop conditions that may result in positive response to PIX applications. Upon clarification, guidelines may be standardized for producer usage.

In 1988 and 1989, several field studies were initiated which investigated the effects of early low rate multiple applications at initiation of match head square, early bloom and 14 days post early bloom treatments. It was found that several PIX 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 affects, 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 in the Yuma Valley prematurely terminated the crop on 27 July 1989 thereby eliminating late season fruiting potential. Significant lint yield increases were observed when the crop was produced under these imposed reduced season conditions. These results concurred with previous studies conducted by Kerby, Hake and Keeley, who 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 (Silvertooth et al., 1990) 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 the results, the 1990 field studies conducted by Silvertooth et al. (1991) 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 later periods of the first fruiting cycle. One study in 1990 resulted in significant lint yield increases. This was a study that exhibited definite vegetative tendencies with excessive height:node ratio measurements (⟩1.5) and low fruit retention as general indicators.

The two field studies conducted in 1991 were intended to further refine application rates and timing as a function of plant growth and development measurements in combination with heat unit accumulations since planting. All total application rates were at the maximum label allowance of 1.5 pt. PIX/acre over a maximum of four applications.

## Materials and Methods

Two replicated field studies were conducted to evaluate PIX applications as a function of timing based on growth stage and heat unit accumulation since planting (HUAP). Treatments were initiated at early bloom and some extended up to the measured cut-out stage. The treatments used are listed in Table 1. Relevant crop information is listed in Tables 2 and 3 for each experiment. Both tests consisted of 18, 18 row plots running the entire field length. There were six treatments with three replicates in a randomized complete block design. Eight 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 bloom (NAWB), number of blooms per 25 feet row length, number of mainstem nodes and the calculated height:node ratio. Refer to Tables 6 and 7 for growth and development measurement summaries.

## Results and Discussion

Waddell

The study in Waddell, Az. resulted in no significant yield differences among treatments. In contrast, the identical study conducted at the Maricopa Agricultural Center resulted in an approximate lint yield increase of 100 lbs. lint/acre across all PIX treatments when compared to the untreated check.

These results are particularly interesting since measured growth and development parameters could account for these results. The plant parameters measured assist with standardization of recommendations and guidelines for product usage. The parameter that is the best indicator of the vegetative nature is the plant height:number of mainstem node ratio. Several years of observations where optimal yields occurred across Arizona resulted in a graphical depiction of a generally desirable height:node ratio as a function of time or heat unit accumulation since planting (Figure 1)(Silvertooth et al.,1992).

When comparing measured height:node ratios in the two studies against this recommended guideline as depicted in Figure 1, it is noted that actual measurements fall below the recommended standard from the very beginning in the Waddell study. This would indicate that the vegetative growth (structure) was not excessive. This crop may have actually benefitted from a greater plant height and more mainstem nodes to result in increased lint yields.

In other words, it can be concluded that this crop would not necessarily be a candidate for PIX application based upon lack of vegetative tendancies. No differences in lint yields verified this conclusion. Yield reductions were not experienced due to the PIX treatments used. Referring to guidelines, such as height: node ratios (Figure 1), a producer can make an informed decision as to PIX input based upon actual field conditions.

Maricopa

Height:node ratios exceeded the optimum standard from the beginning at MAC. The height:node ratios for the PIX treatments (Table 7) compared against the general optimum curve are depicted in Figure 1. The untreated check continued to develop vegetatively at the expense of energy allocation to fruiting forms. The final height:node ratio exceeded 2.0 in the untreated check and a resultant yield decrease compared to PIX treatments. The PIX treatments all resulted in reduced height:node ratios compared to the check, apparently resulting in a plant energy reallocation from the vegetative component to the reproductive component. The PIX treated plots, even at the high rates remained 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 would potentially benefit from multiple applications at relatively high rates throughout the entire fruiting cycle. In addition, it is possible to speculate that crops which are extended later in the season may benefit from higher than labeled rates in the low desert valleys. This is a consideration currently under review by BASF.

No significant yield differences were measured among all the PIX treatments MAC. There were differences between the untreated check and various PIX treatments. Treatment 2 and treatment 3 resulted in the highest yield within the PIX treatments. Treatment 3 received two high rate applications over the three applications used in treatment 2. From a management standpoint, treatment 3 perhaps offers a better alternative with fewer applications and higher rates, under field conditions similar to those experienced at MAC in 1991.

## Summary

These studies support and clarify recommendations and conditions where PIX usage will be of benefit in terms of increased lint yields. When a cotton crop is moving towards vegetative production at the expense of reproduction, PIX may be a viable tool to control this tendency. These studies will be repeated in 1992 to further clarify recommendations and usage guidelines.

Simple, in-field measurements can be made when PIX applications are being considered. A combination of height, number of mainstem nodes and general fruit retention patterns over time can be utilized for decision making purposes. An optimum balance of vegetative to reproductive components are essential to consistently optimize cotton lint yields.

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**Table 1. PIX APPLICATION SCHEDULE, 1991**

| 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 | /2 | 1/2 |
| 6 | 1 | - | - | 1/2 |

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

**Table 2. Crop and Application Information for Pix Study, Moore Ranches, Waddell, Arizona 1991**

| | |
|---|---|
| Planting Date | April 8 (577 HU)* |
| Variety | Sure-Gro C-40 |
| Application 1 | June 21 (1249 HUAP)** |
| Application 2 | July 8 (1700 HUAP) |
| Application 3 | July 19 (2019 HUAP) |
| Application 4 | August 1 (2375 HUAP) |
| Irrigation Termination | August 3 |
| Harvest | September 16 |

*** HU = Heat Units (86/of thresholds) Accumulated Since January 1**
*** HUAP = Heat Units Accumulated Since Planting**

**Table 3. Crop and Application Information for Pix Study, Maricopa Agriculture Center, 1991**

| | |
|---|---|
| Planting Date | April 20 (554 HU)* |
| Variety | D + PL 90 |
| Application 1 | June 27 (1294 HUAP)** |
| Application 2 | July 15 (1762 HUAP) |
| Application 3 | August 2 (2249 HUAP) |
| Application 4 | August 23 (2731 HUAP) |
| Irrigation Termination | September 6 (3151 HUAP) |
| Harvest | November 5 |

*** HU = Heat Units (86/55F) Accumulated Since January 1**
**** HUAP = Heat Units Accumulated Since Planting**

**Table 4. Lint Yield Means for Pix Study, Waddell, Arizona, 1991**

| Treatment | Yield (lbs./Acre) |
|---|---|
| 1 | 1093 a |
| 2 | 1099 a |
| 3 | 1106 a |
| 4 | 1008 a |
| 5 | 1113 a |
| 6 | 1073 a |

* Means Followed by the Same Letter are not Significantly Different (PLO.05) According to Pairwise Comparisons Using a Fisher's LSD.

**Table 5. Lint Yield Means for Pix Study, Maricopa Agricultural Center, 1991**

| Treatment | Yield (lbs./Acre) |
|---|---|
| 1 | 1268 c |
| 2 | 1381 a |
| 3 | 1375 a |
| 4 | 1316 a,b,c |
| 5 | 1280 b,c |
| 6 | 1349 a,b |

* Means Followed by the Same Letter Are Not Significantly Different (PLO.05) According to Pairwise Comparisons Using a Fisher's LSD.

**Table 6. Plant Height, Height: Node Ratio, and % Fruit Retention, Waddell, Arizona, 1991**

| Date (Heat Units) | Treatment | Height (in) | Height: Node Ratio | Fruit Retention (%) |
|---|---|---|---|---|
| July 1 (1559) | 1 | 17 | 1.17 | 97 |
| | 2 | 17 | 1.06 | 98 |
| | 3 | 17 | 1.09 | 98 |
| | 4 | 22 | 1.18 | 95 |
| | 5 | 17 | 1.11 | 93 |
| | 6 | 19 | 1.23 | 97 |
| July 23 (2175) | 1 | 33 | 1.35 | 68 |
| | 2 | 30 | 1.40 | 66 |
| | 3 | 31 | 1.48 | 70 |
| | 4 | 31 | 1.40 | 69 |
| | 5 | 31 | 1.40 | 67 |
| | 6 | 31 | 1.40 | 74 |
| August 1 (2462) | 1 | 35 | 1.46 | 64 |
| | 2 | 31 | 1.30 | 64 |
| | 3 | 35 | 1.47 | 70 |
| | 4 | 34 | 1.33 | 63 |
| | 5 | 34 | 1.40 | 67 |
| | 6 | 34 | 1.42 | 69 |
| August 12 (2740) | 1 | 36 | 1.35 | 58 |
| | 2 | 33 | 1.36 | 54 |
| | 3 | 38 | 1.40 | 55 |
| | 4 | 37 | 1.44 | 60 |
| | 5 | 36 | 1.33 | 61 |
| | 6 | 39 | 1.56 | 63 |
| August 23 (3060) | 1 | 35 | 1.40 | 62 |
| | 2 | 33 | 1.38 | 59 |
| | 3 | 39 | 1.54 | 58 |
| | 4 | 36 | 1.46 | 60 |
| | 5 | 36 | 1.40 | 60 |
| | 6 | 39 | 1.56 | 65 |

Table 7. Plant Height, Height: Node Ratio, and % Fruit Retention, Maricopa Ag Center, 1991

| Date (Heat Units) | Treatment | Height (in) | Height: Node Ratio | Fruit Retention (%) |
|---|---|---|---|---|
| July 1 (1341) | 1 | 25 | 1.45 | 94 |
| | 2 | 25 | 1.48 | 95 |
| | 3 | 25 | 1.49 | 95 |
| | 4 | 25 | 1.46 | 95 |
| | 5 | 24 | 1.43 | 88 |
| | 6 | 24 | 1.41 | 87 |
| July 15 (1737) | 1 | 39 | 1.81 | 70 |
| | 2 | 39 | 1.77 | 67 |
| | 3 | 38 | 1.79 | 66 |
| | 4 | 39 | 1.74 | 65 |
| | 5 | 42 | 1.93 | 63 |
| | 6 | 38 | 1.77 | 69 |
| July 25 (1976) | 1 | 55 | 2.18 | 64 |
| | 2 | 46 | 1.91 | 59 |
| | 3 | 45 | 2.02 | 66 |
| | 4 | 46 | 1.89 | 67 |
| | 5 | 47 | 2.03 | 61 |
| | 6 | 42 | 1.78 | 68 |
| August 5 (2267) | 1 | 57 | 2.20 | 65 |
| | 2 | 48 | 2.05 | 59 |
| | 3 | 46 | 1.86 | 64 |
| | 4 | 47 | 1.88 | 66 |
| | 5 | 49 | 1.94 | 67 |
| | 6 | 44 | 1.74 | 68 |
| August 13 (2467) | 1 | 57 | 2.11 | 65 |
| | 2 | 49 | 2.11 | 62 |
| | 3 | 46 | 1.96 | 59 |
| | 4 | 48 | 1.87 | 70 |
| | 5 | 50 | 2.14 | 53 |
| | 6 | 49 | 2.03 | 58 |
| September 12 (3209) | 1 | 57 | 2.26 | 38 |
| | 2 | 53 | 1.99 | 43 |
| | 3 | 60 | 2.19 | 41 |
| | 4 | 55 | 2.14 | 40 |
| | 5 | 50 | 2.02 | 42 |
| | 6 | 54 | 2.09 | 51 |