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

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Abstract

Four commercial scale field studies were conducted in 1991 and 1992 to further evaluate Upland cotton yield and development responses to PIX application timing as a function of cotton growth stage. Treatments imposed in both years 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 four 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. Upon clarification, usage guidelines may be standardized for producer usage.

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.

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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 four field studies conducted in 1991 and 1992 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

Four replicated field studies were conducted in 1991 and 1992 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. Crop and relevant study information is listed in Tables 2, 3, 4 and 5. All tests consisted of eighteen, eighteen 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. Refer to Tables 7, 8, 9 and 10 for growth and development measurement summaries.

Results and Discussion

Two of the four studies (1991 and 1992) resulted in significant lint yield increases of approximately one hundred pounds per acre in all PIX treatments in contrast to the untreated check (table 6). The results are interesting since measured growth and development parameters which account for the yield increase were observed. These measured differences assist with potential standardization of recommendations and guidelines for product usage. The measurements which best serves as a reliable indicator of the vegetative nature and potential for positive PIX response is the plant height:number of mainstem node ratio and fruit retention. Several years worth of observations where optimal yields occurred across Arizona resulted in a graphical depiction of optimal height:node ratios and fruit retention as a function of time or heat unit accumulation since planting (Figure 1).

When comparing measured height:node ratios over the test period in the two studies where a positive PIX response was measured against the recommended guideline as depicted in Figure 1, 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, two 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 study and the 1992 Buckeye studies, height:node ratios were in the recommended range and plant height reduction would be unnecessary and undesirable. In other words, it can be concluded that when commercial PIX applications are considered, this crop should not be treated. 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. Note the measured height:node ratios across treated plots compared against the general optimum curve 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 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 optimum plant growth and development depiction in figure 1 based on growth stage, a producer can readily determine the actual crop development status over time and informed decisions regarding PIX applications. 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 ratios are essential to consistently optimize cotton lint yields.

References

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Table 1. PIX 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. 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 (86/155) 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. Crop and Application Information for PIX Study, Maricopa Agriculture Center, 1992

Planting Date	April 17, 1992
Variety	D & PL 5415
Application 1	June 26 (1503 HUAP)
Application 2	July 17 (1952 HUAP)
Application 3	July 29 (2314 HUAP)
Application 4	August 17 (2825 HUAP)
Irrigation Termination	August 26
Harvest	October 21
Carrier	27 gpa

Table 5. Crop and Application Information For PIX Study, P & L Farms, Buckeye, AZ, 1992

Planting Date	May 1, 1992
Variety	D & PL 5415
Application 1	June 29 (1321 HUAP)
Application 2	July 17 (1770 HUAP)
Application 3	July 28 (2107 HUAP)
Application 4	August 19 (2652 HUAP)
Irrigation Termination	August 29
Harvest	October 20
Carrier	10 gpa

Table 6. Lint Yield Means For 1991 and 1992 PIX Studies

Treatment	Waddell 1991	Maricopa 1991	Maricopa 1992	Buckeye 1992
1	1093	1268 c	969 c	1204 b
2	1099	1381 a	1190 a, b	1318 a
3	1106	1375 a	1241 a	1198 b
4	1008	1316 a, b, c	1178 a, b	1173 b
5	1113	1280 b, c	1185 a, b	1243 a, b
6	1073	1349 a, b	1114 b	1244 a, b

* Means Followed by The Same Are Not Significantly Different

Table 7. Plant Height, Height: Node Ratio, and % Fruit Retention, Waddell, Arizona, 1991

Date (Heat Units)	Treatments	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 8. 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

Table 9.   Plant Height, Height: Node Ratio, and % Fruit Retention, Buckeye Arizona, 1992

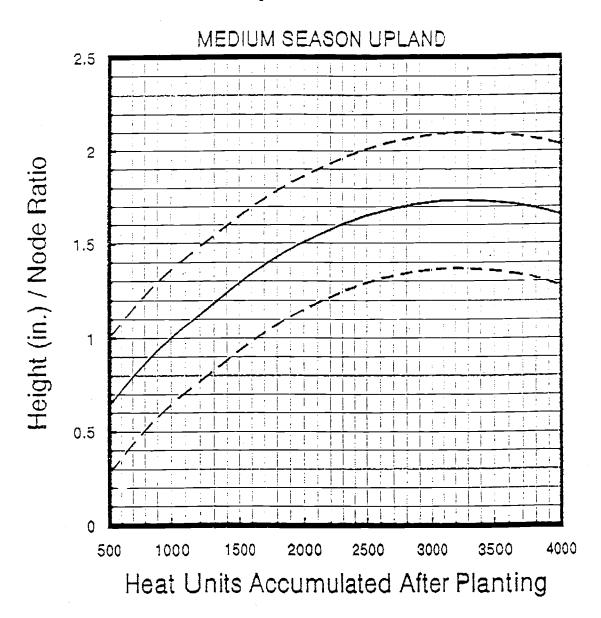| Date (Heat Units)	Treatment	Height (in)	Height:Node Ratio	Fruit Retention (%)
July 4 (1510)	1	22	1.38	94
	2	24	1.60	94
	3	21	1.50	87
	4	23	1.53	88
	5	22	1.50	85
	6	23	1.53	93
July 16 (1845)	1	29	1.61	90
	2	29	1.53	91
	3	26	1.53	87
	4	30	1.58	90
	5	31	1.72	92
	6	29	1.61	93
July 30 (2249)	1	32	1.60	77
	2	36	1.71	79
	3	32	1.52	80
	4	42	1.83	81
	5	32	1.52	81
	6	38	1.73	87
Aug 11 (2591)	1	41	1.71	73
	2	39	1.70	73
	3	34	1.48	74
	4	41	1.71	73
	5	37	1.61	73
	6	38	1.58	75
Aug 19 (3603)	1	39	1.50	53
	2	41	1.52	55
	3	35	1.40	49
	4	39	1.50	56
	5	39	1.50	50
	6	40	1.60	53

Table 10. Plant Height, Height: Node Ratio, and % Fruit Retention, Maricopa, Arizona, 1992

Date (Heat Units)	Treatment	Height (in)	Height:Node Ratio	Fruit Retention (%)
July 9 (1862)	1	32	1.52	71
	2	32	1.52	73
	3	29	1.38	73
	4	29	1.38	71
	5	32	1.60	71
	6	29	1.38	71
July 27 (2354)	1	47	1.88	59
	2	42	1.62	63
	3	40	1.60	62
	4	42	1.60	72
	5	45	1.80	64
	6	39	1.62	66
Aug 5 (2606)	1	56	2.00	54
	2	44	1.69	56
	3	40	1.60	58
	4	48	1.71	55
	5	46	1.59	54
	6	43	1.59	55
Aug 19 (3015)	1	65	1.91	51
	2	51	1.70	51
	3	49	1.69	55
	4	51	1.70	55
	5	54	1.80	55
	6	51	1.70	57
Sept 10 (3523)	1	69	1.92	50
	2	58	1.71	49
	3	51	1.59	49
	4	54	1.69	50
	5	56	1.70	43
	6	58	1.81	49

Figure 1. Relationship of Height: Node Ratio With Growth
            and Development

MEDIUM SEASON UPLAND

Height (in.) / Node Ratio

Heat Units Accumulated After Planting

Upland Cotton

1988-1991