

# Evaluation of a Feedback Approach to Nitrogen and Pix Applications, 1998

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## Abstract

A single field experiment was conducted in 1998 at Marana, AZ to evaluate a scheduled (based upon stage of growth) versus a feedback approach (based upon growth parameters and crop conditions) to nitrogen (N) and mepiquat chloride (Pix<sub>TM</sub>) applications on upland cotton (*Gossypium hirsutum* L.). The parameters used in evaluating feedback applications for both N and Pix included fruit retention (FR) levels and height to node ratios (HNRs) with respect to established baselines for cotton grown in the desert Southwest. Scheduled and feedback Pix applications were made for a total of 1.5 and 2.5 pint Pix/acre, respectively, with the feedback treatments receiving a late season application at approximately 3100 heat units after planting (HUAP 86/55<sup>0</sup> F threshold). Scheduled Pix treatments received a single 1.5 pint Pix/acre application prior to peak bloom (approximately 2000 HUAP). Scheduled applications of fertilizer N totaled 205 lbs. N/acre from three applications. Feedback applications of N received a total of 100 lbs. N/acre from two applications. Treatments consisted of all combinations of feedback and scheduled applications of both N and Pix. The highest lint yields occurred in the treatment consisting of Pix feedback and N feedback (treatment two), however, there were no significant differences ( $P \geq 0.05$ ) among any of the treatments with respect to yield.

## Introduction

Much of the dynamic nature of the cotton (*Gossypium* spp.) plant stems 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 structures. 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 is a subject of some debate and considerable research. Many processes have been 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 and 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 and York, 1983b). Environmental and cultural stresses can also exacerbate these problems. The most likely culprit is not one single event, however, but combinations of these factors and 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.

Mepiquat chloride, or Pix<sub>TM</sub>, is a plant growth regulator that has been used in cotton production for several decades as a management tool in controlling vegetative growth. Pix 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 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 and Boman and Westerman, 1994). However, application strategies that result in consistent significant increases in lint yield from Pix have yet to be identified or demonstrated.

Many studies have been conducted in the past several years in Arizona (Silvertooth et al., 1989, 1990, 1991c, 1992a, 1993b, and Fletcher et al., 1994) to determine optimal rates and application regimes of multiple Pix applications for Upland (*G. hirsutum* L.) and Pima (*G. barbadense* L.) cotton. The results from these studies have been used to develop a feedback type approach to Pix applications based upon actual crop conditions and measured growth parameters in-season. Naturally, this type of feedback approach with respect to inputs such as Pix 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 been developed and tested along the same line in a feedback versus scheduled type approach (Silvertooth et al., 1991b, 1992b, 1993a, 1994, 1995a; and Silvertooth and Norton, 1996a, 1997a, and 1998a).

In 1998 a field experiment was conducted with the objective of evaluating the effects of scheduled and feedback applications of both Pix and N. The present study is a continuation of a long-term project in Arizona.

## Methods and Materials

A field study was conducted in 1998 at the University of Arizona Marana Agricultural Center at Marana, AZ (1,972 ft.) on a Pima clay loam soil (Typic Torrifuvent). Upland cotton (var. DP NuCotn 33b) was planted on 17 April into moisture (Table 1). Treatments were arranged in a randomized complete block design with four replications. Treatments consisted of all combinations of N and Pix feedback and scheduled applications (Table 2). Fertilizer N application dates and rates are shown in Table 3 and Pix application dates and rates are shown in Table 4. Plots consisted of 8, 40 in. rows that extended the full length of the irrigation run (600 ft.). Pix 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 167 ft.<sup>2</sup>, nodes above top white flower (NAWF), percent fruit retention, and percent canopy closure) were taken on approximately 14 day intervals from each plot. Nitrogen fertility levels were also monitored throughout the course of the season by sampling petioles and analyzing their NO<sub>3</sub><sup>-</sup>-N concentrations on approximately 14 day intervals. Management of the study with respect to irrigation and pest control was carried out in a uniform and optimal manner among all treatments. Final irrigations were made on 5 September in order to provide a sufficient amount of water to carry-out full development of the fruit set established up to cut-out. Defoliant was applied by a ground rig application on 28 October. A mechanical picker was used to harvest the center four rows of each plot on 17 November to obtain yield results. Data was analyzed in accordance with procedures outlined by Steele and Torrie (1980) and the SAS Institute (1988).

## Results

Figure 1 summarizes the FR and HNRs of all treatments over the course of the season. Significant fruit loss occurred early in the season due to insect damage and terminal loss (due in part to wind), resulting in increasing HNRs. As HNRs continued to increase, the first application of 1.5 pint Pix/acre was made to all treatments at approximately 1900 HUAP (near peak bloom). Effective control of vegetative growth was accomplished. As HNRs slowly increased again, a late season application of 1.0 pint Pix/acre was applied to the feedback treatments at approximately 3100 HUAP. From plant measurement information taken late in the season, the late application of Pix appeared to have little affect on the vegetative growth (HNR) of the plants. The control plot (treatment one) exhibited extreme vigor with high HNRs as would be expected with low FR and no Pix application.

Fertilizer N was applied in split applications to feedback treatments so as to provide a total of 100 lbs. N/acre. This approach was based in part on a projected yield goal of three bales per acre, assuming a requirement of 60 lbs. N/bale and attributing approximately 70 lbs. N/acre to a 18 ppm  $\text{NO}_3^-$ -N residual pre-season soil level test. Applications of fertilizer N were split from pinhead square to peak bloom (Table 3). Fertility status of the crop with respect to N is summarized in Fig. 2 with petiole  $\text{NO}_3^-$ -N concentrations shown over time. The N fertility level of the crop remained well above the baseline throughout the season, with treatments four and five showing substantial increase toward the end of the season. This coincides with the extra fertilizer N application given to the scheduled N treatments at approximately 1700 HUAP (prior to peak bloom).

Yield results are displayed in Table 5. Means are also separated according to single degree of freedom orthogonal contrasts (Table 6). No significant differences occurred among any of the treatments ( $P \geq 0.05$ ). Highest lint yields (arithmetically) were realized from treatment two, which utilized a feedback approach to the applications and management of Pix and N.

## Summary and Conclusions

The utilization of a feedback approach to N and Pix management offers many positive opportunities. The ability to improve upon efficiencies associated with crop inputs such as N and Pix is the most significant of these. However, it is also important to realize that use of a feedback approach requires site-specific management, regular and timely field evaluation, and well-established references or baselines. The use of a feedback approach allows the grower to respond to in-season changes in crop conditions. For example, it is unlikely that cotton crops would respond similarly every season to scheduled Pix applications. Therefore, the use of a feedback approach provides flexibility and improves the ability of the grower to better determine when a positive yield response to Pix can be realized.

## Acknowledgements

The support provided by the Marana Agricultural Center staff is gratefully acknowledged. Also, the authors appreciate the technical assistance provided by the crew of the University of Arizona Cotton Agronomy Program.

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Table 1. General experimental description, Nitrogen x Pix experiment, Marana, AZ, 1998.

Planted:	17 April (391 HU/Jan 1)
Variety:	DP NuCotn 33B
Harvested:	17 November

Table 2. Nitrogen x Pix experiment, Marana, AZ. 1998.

<u>Treatment</u>	<u>N Strategy</u>	<u>Pix Strategy</u>
1	Feedback	---
2	Feedback	Feedback
3	Feedback	Scheduled
4	Scheduled	Feedback
5	Scheduled	Scheduled

Table 3. Nitrogen applications for each treatment, Nitrogen x Pix experiment, Marana, AZ, 1998.

Date	Form	Method	Nitrogen Treatments				
			1	2	3	4	5
			lbs. N/acre				
5 June HUAP 790	21-0-0	SD	50	50	50	50	50
23 June HUAP 1192	21-0-0	SD	50	50	50	100	100
15 July HUAP 1779	21-0-0	SD	0	0	0	55	55
Total			100	100	100	205	205

Table 4. Pix applications for each treatment, Nitrogen x Pix experiment, Marana, AZ, 1998.

Date	Pix Treatments				
	1	2	3	4	5
20 July HUAP 1914	0	1.5	1.5	1.5	1.5
3 September HUAP 3117	0	1.0	0	1.0	0
Total	0	2.5	1.5	2.5	1.5

Table 5. Lint yield results, Nitrogen x Pix experiment, Marana, AZ, 1998.

Treatment	Lint Yield lbs. lint/acre
1, NF	997 a*
2, NF+PF	1009 a
3, NF+PS	989 a
4, NS+PF	952 a
5, NS+PS	936 a
OSL	0.3661
CV%	5.87

\*Means followed by the same letter are not significantly different according to the single degree of freedom orthogonal contrasts.

Table 6. Single degree of freedom orthogonal contrast results, Nitrogen x Pix experiment, Marana, AZ, 1998.

Contrast	OSL
2 vs. 5, NF+PF vs. NS+PS	0.0946
2 vs. 4, NF+PF vs. NS+PF	0.1852
2 vs. 3, NF+PF vs. NF+PS	0.6237
1 vs. 2 & 3, NF vs. (NF+PF, NF+PS)	0.9527
1 vs. 2, NF vs. NF+PF	0.7622
1 vs. 3, NF vs. NF+PF	0.8453
4 vs. 5, NS+PF vs. NS+PS	0.6896

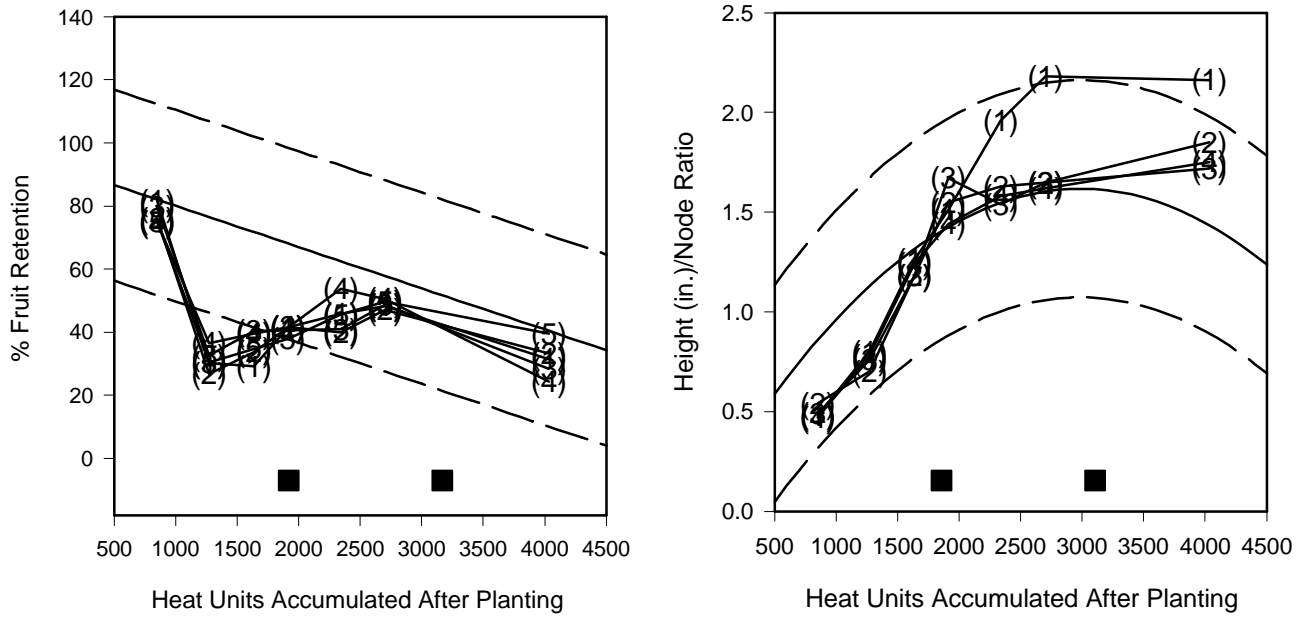


Fig 1. Summary of fruit retention and height to node ratios for Nitrogen x Pix study, Marana, AZ, 1998  
 ■ = Pix application

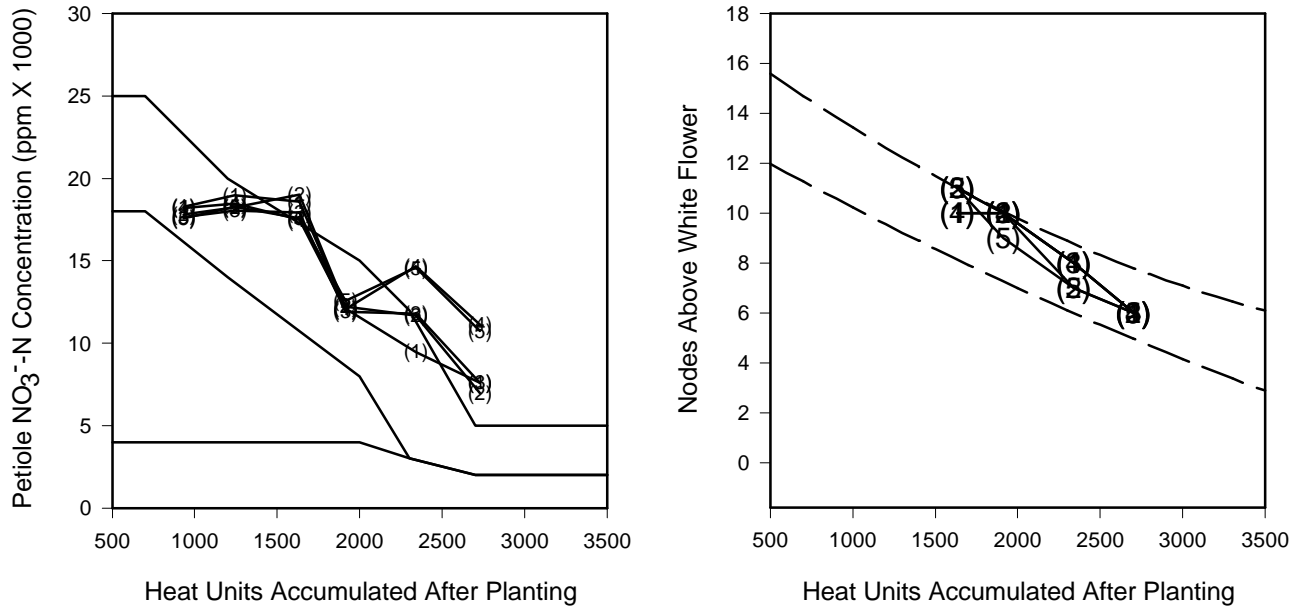


Fig. 2 Summary of petiole NO<sub>3</sub><sup>-</sup> N and nodes above white flower for Nitrogen x Pix study, Marana, AZ, 1998