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PIX APPLICATION STRATEGIES

Dave Guthrie, Juan Landivar, Doug Munier, Charles Stichler, Bill Weir

Pix plant regulator has been used by cotton growers for more than 10 years. Although the benefits of Pix use are well documented in the scientific literature, there has been a gradual evolution on how best to use the product in specific field situations. We are learning that there is no <u>one</u> best way to use this plant regulator, but rather a series of options that fit various environmental and developmental circumstances. This newsletter will review some basic principles underlying the use of Pix on cotton and approaches that have been developed to realize the most benefits in these varying situations.

The physiology of Pix was the subject of an earlier Physiology Today newsletter (May 1991, Vol 2, #6). The reader is referred to that issue for more complete discussion of the basic physiology of the product. This newsletter will highlight several points made in that issue.

Plants, like animals, have a number of hormones that direct their growth and development. One of these plant hormones is called gibberellic acid (GA). Gibberellic acid, alone or in combination with other plant hormones, impacts plant growth in many ways. This hormone helps maintain the selective permeability of membranes so vital to orderly cell functioning. Research has found that GA treatment can cause dormant buds to break and stimulate terminal growth in cotton during cutout. GA also promotes cell elongation, including fiber elongation, during the first stages of boll development.

Pix alters the concentration of GA in cells by partially inhibiting the formation of GA in the plant. Cell expansion is reduced when GA levels are lower. This explains why Pix applications cause new internodes to be shorter and leaves to be smaller. The cells are smaller and more dense, which also concentrates chlorophyll molecules in the leaves and produces the darker green leaf color. Although Pix is distributed throughout the plant, it only limits cell expansion in new cells. The size of previously formed cells remains unaffected. Pix concentration is diluted as growth continues. With this dilution, GA synthesis and cell expansion rebound at the growing point.

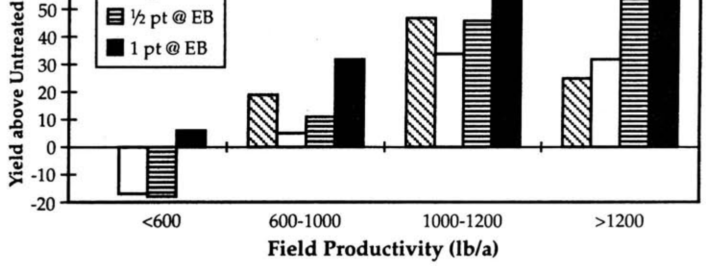
Cell expansion is driven by a number of factors in addition to GA. The plant's moisture status and the temperature exert a powerful influence on the cells. When moisture is abundant in the presence of warm temperatures and high relative humidity, cell expansion can produce the "elephant ear leaves" common during rainy seasons in the Southeast and Mid-South. The absence of any one of these environmental factors will reduce cell expansion, leaf size and internode elongation. Cooler temperatures during the early season limit the metabolic rate at the growing point. Cell expansion at that time is temperature dependent, even though moisture may be abundant. Once temperatures warm, the plant's transpiration of water increases. In the arid West, where relative humidity is lower, hot temperatures may create a very high heat load, with correspondingly high transpiration rates. This too will limit internode elongation and leaf expansion due to reduced moisture in the expanding cells at the growing point. At the other extreme, you may find "elephant ear leaves" and 6+ inches-long internodes in humid regions across the Southeast and Mid-South. The combination of moisture, humidity, heat and GA can produce truly impressive plant specimens.

Pix distribution and its consequence on cell expansion is at the heart of determining when and how much product should be applied. Much confusion and resulting misapplication of the product could be avoided with a better understanding of this dynamic interaction between the environment, cell expansion and Pix.

Response to Pix in Different Environments

A Pix treatment exerts indirect effects on cotton apart from its action on GA synthesis. These responses (vegetative control, early maturity, fruit retention and yield) to the plant regulant are strongly influenced by environmental conditions and the grower's management philosophy. The most consistent response to Pix is reduced plant size, a consequence of suppressed cell expansion. Pix treatment also stimulates crop maturity. Treated plants may mature 7 to 14 days earlier than untreated plants. This response results from increased boll retention produced on the first 5-10 fruiting branches. Research is underway to determine whether this increased retention is due to improved light conditions in the canopy and/or altered hormone balances. Yield responses to Pix are less consistent. Research conducted across the Belt has demonstrated that yield response to Pix increases with field productivity and management intensity. Yield responses also increase as planting is

Response to Pix as Affected by Yield Potential North Carolina



delayed (Kerby 1985, Cathy and Meredith 1988). One consistent trend found throughout these varied trials is this: A positive yield response to Pix is most likely when the benefits of rapid boll loading are highest.

Regional Approaches

An application strategy must be consistent with the environmental conditions and a grower's management philosophy to optimize the benefits of Pix use. Researchers have developed several methods to assist growers in their region use Pix to its best affect. These regional approaches are all based on assessing crop status in a specific field rather than making blanket recommendations. This can best be determined through the use of plant monitoring. However, there are regional production challenges and constraints which producers in those areas routinely confront. Several of these regional challenges and responses are reviewed below.

Southeast

Southeast production on coarse-textured soils is determined primarily by moisture availability. Growth responses to rainfall are rapid, but potentially short-lived. Moisture availability ranges from 1-2" in the rooting zones. A fully-charged soil profile may be depleted of available moisture within 5 to 7 days during bloom. Internode elongation and leaf expansion can seesaw in this transient system. Yearly and local variations in rainfall distribution may support lush growth at one extreme and premature cutout at the other. Although irrigation can lessen these fluctuations, long-range predictions of crop growth potential are uncertain. A cautious approach to plant regulation is warranted, at least in dryland production.

Plant monitoring data from across the Belt documents the importance of high plant vigor at early bloom to final field productivity. Southeast dryland producers must contend with the perennial possibility of prebloom drought and resulting decreases in height, nodes, height-to-node ratios (HNR) and nodes above white flower (NAWF) at early bloom. Once boll loading begins, plants with low vigor are predestined to lower yields.

A review of plant monitoring data obtained from the Southeast and Mid-South during 1993 and 1994 (Table 1) illustrates the impact that prebloom environmental conditions can have on plant stature and potential response to Pix. HNR is a useful measure of prebloom crop vigor in many production regions. HNR due to drought was only 1.65" at early bloom in Southeast fields that were monitored in 1993. In 1994, early bloom HNR values increased 0.2" in response to adequate June moisture. When combined with increased nodes, the resulting plant height increased 6 inches. The dramatic increase in NAWF from 1993 to 1994 (6.7 vs. 8.7) also demonstrates the importance of prebloom moisture to plant growth. Low vigor at early bloom can be particularly damaging to yield prospects when square retention is high. It is ironic that good-to-excellent first position square retention commonly encountered in Southeast cotton at early bloom can magnify the potential for premature cutout as rapid loading overwhelms the plant's capacity to supply carbohydrates.

Table 1

Plant Monitoring at Early Bloom
1993 vs 1994

	SOUTHEAST		MID-SOUTH	
	1993	**1994**	**1993**	**1994**
HNR	1.65	1.85	1.73	2.05
NODES	13.6	15.1	13.8	15.1
PLANT HT	22	28	24	31
NAWF	6.7	8.7	7.4	8.7
1st SQ RET (%)	85	90	82	86

In contrast, July rainfall in the Southeast can stimulate lush growth during bloom. Plant size may increase 12" or more per week following July rains, turning small-statured plants into vigorous growing trees. Premature cutout was prevalent in many drought affected Southeast production fields in 1993. July rains that might have rescued the 1993 crop never arrived. With timely rainfall, record-breaking yields were produced throughout this same region in 1994.

An application strategy for the Southeast must allow producers to optimize boll retention without risking premature cutout. Research in North Carolina indicates the most consistent yield response to Pix is obtained when ½ pt/A applications are made at early bloom. Additional applications are made if conditions remain favorable for vegetative growth. This approach has also proved effective in other regions along the northern tier of the Cotton Belt. These regions rely on early maturity but do not normally experience vigorous growth prior to bloom. This can be traced back to limited moisture and/or heat required for full cell expansion. On those occasions when prebloom conditions do favor vigorous growth, earlier applications are suggested. Treatment thresholds suggest Pix applications when new internode lengths exceed 2" at matchhead square up to 3-3½" at early bloom or later. Subsequent applications up to the labeled maximum are made whenever internodes exceed this 3-inch threshold.

Mid-South

Soils of the Mid-South tend to be finer textured with consequent increases in moisture availability — reaching 2-4" or more in the rooting zone. Rainfall distribution patterns differ from the Southeast. The Mid-South routinely has adequate moisture in the spring (1993 excepted) with an increased likelihood of persistent drought in late July and August.

Mid-South prebloom square retention varies widely from the South to the North area. Plant height at early bloom tends to be higher in the Mid-South than the Southeast. In part, this reflects the increased moisture availability and higher accumulated heat units. These environmental differences between the two regions are illustrated in Table 1. Again, it should be stressed that these generalizations do not hold for every field or every year.

Plant height may exceed 30" at early bloom in fields left untreated with Pix. It is vital to manage stalk development and retain first position squares under this scenario common to many Mid-South fields. This region has enjoyed the greatest successes with multiple applications. This is due in part to the presence of the environmental factors contributing to vigorous prebloom growth. Early season Pix application when internode lengths exceed the 2-inch threshold at early square, 3-inch threshold at early bloom, enables producers to create an early bloom plant stature that will support early boll retention. A refinement on this approach following early bloom suggests measuring the top 5 internodes. Treat with Pix when the average length of these internodes exceeds 1.8 - 2.0 inches.

Southwest and West Texas — Charles Stichler

Determining when to use mepiquat chloride (common name for active ingredient in Pix) and the application rate for each field has often been a "best guesstimate." Often, the growing conditions following the application will determine if it was "right or wrong." An irrigation followed by additional rains may mean not enough product was applied. Square set, boll load, insect damage, rainfall and potential of irrigation are factors used to determine the Pix rate.

The cotton plant will literally show a producer how it is doing. Plant mapping and noting a limited number of growth criteria take out much of the guess work.

The cold, windy, dry spring weather in west and southwest Texas often will keep plants small "naturally." Because adequate early plant development is so critical for maximum yield, growth regulator applications on stressed or slowly growing cotton will generally cause a yield decrease. If cotton is growing too rapidly, mepiquat chloride (MC) usage generally will produce a profitable yield increase. Trials conducted over many years in west Texas indicate that the average internode length (plant height/number of nodes) at first bloom, shows a strong relationship between MC usage and yield response. When the average internode length at first bloom was more than 1.1 - 1.2" in length, the plants responded with a yield increase when 8 ounces of MC was applied. When the average internode length was less than 1" at first bloom, application generally resulted in a yield decrease. In southwest Texas where growing conditions in the spring are better, MC applications of 8 to 12 ounces or more should be made at first bloom when the average internode length is more than 1.5 inches. Since plant development is somewhat variety dependent, short season, smaller varieties will need less MC, while taller full season varieties will need more to slow cell expansion.

Once the node with 1st position white flower (WFN) is 3-4 nodes above the first fruiting branch, another measurement can be taken to determine if more MC is needed. If the average internode length of the NAWF (between the WFN and the terminal) is more than 2" and growing conditions are good, another MC application may be needed if a grower wants to hold plant height below 42 inches.

For example, in Southwest Texas at first bloom, most plants should be fruiting by the 6th node with 8 NAWF. On such plants there will be 14 nodes. Fourteen nodes times 1.5" (Southwest cotton) means the plant will be 21" tall. Most cotton (with good growing conditions) will put on an additional 9 fruiting branches (nodes) prior to cutout, when growth almost stops. Nine additional nodes times 2 is 18 more inches. That would make the cotton about 39" tall at harvest.

In west Texas, the measurements are slightly shorter. Cotton should have 1.1" (at first bloom) average internode length, times 14 nodes (8 NAWF) resulting in 15½" tall cotton at first bloom. With an additional 7 fruiting branches by cutout, at 1.75 average internode length, there is an additional 12¼" in height; 15½" plus 12¼" is about 28" tall cotton.

Using Pix Concentration in the Plant to Estimate the Rate and Time of Application — Juan Landivar

Research and Extension workers at Texas A&M University Research and Extension Center in Corpus Christi are developing and evaluating a technique based on an estimated plant concentration of MC to determine the rate and time of application. The plant concentration of MC is simply calculated by dividing the amount of MC applied per acre (plus any MC already in the plant system) into the current plant weight. The concentration is expressed in parts of MC in the plant per million parts of plant biomass (ppm). The technique is used to calculate the amount of MC required to increase concentration of MC in plants of certain size (biomass) to a target level. As the plant grows after the application, the concentration declines because of dilution. Subsequent applications are made when the concentration drops below a predetermined level. At that point, the producer needs to apply enough MC to increase the concentration back up again to the target level. This process is repeated until the desired vegetative control is achieved.

Field research demonstrated that increasing the concentration to 10 to 12 ppm produced favorable results in terms of plant height control and lint yield for dryland production systems (Landivar et. al., 1992). Subsequent applications are recommended when the concentration drops below 5 ppm. At this time, the producer needs to apply enough MC to return the concentration to 10 to 12 ppm.

In order to facilitate the use of the technique, a computer program named MEPRT (for Mepiquat Chloride Rate and Time) has been developed (Landivar et. al., 1995). Data required to execute MEPRT are row spacing, plant population, plant height, number of main stem nodes and amount of MC applied. MEPRT uses plant height, number of mainstem nodes and plant population to estimate plant weight. The program then estimates the amount of formulated product (4.2% a.i.) to increase the concentration by dividing the amount of MC per unit of plant biomass. Further growth will reduce the Pix concentration at the growth points. As the concentration declines, plants outgrow the effect of MC and growth rate approaches the rate of untreated plants.

Field verification of MEPRT (Landivar et. al., 1992) showed that the timing and amount of MC application can be determined by monitoring an estimated MC concentration within the plant. The technique recommended reasonable amount and frequencies of application. The research demonstrated that this technique can be used to schedule MC applications for dryland crops which often experience post-application stress, minimizing the risk of reduced yields.

Far West — Bill Weir and Doug Munier

The typical hot, dry summers of the Far West are a distinct advantage in predicting yield responses to Pix applications. Good irrigation management, both early and mid-season, allows us to make the best possible use of Pix. Even with the benefit of dry weather and irrigation, each field must be evaluated independently due to differences in plant vigor and early crop fruit retention.

Many years of extensive field experiments with Pix and plant monitoring data have been used to develop an estimated Pix response equation. This equation uses row spacing (30" to 40"), planting date (March 20 to June 10), plant vigor (height-to-node ratio) and early crop fruit retention (bottom five first position retention) to estimate a Pix response in pounds of lint per acre.

The required plant monitoring measurements are: plant height, total nodes and bottom five first position fruit retention. These calculations can be done manually, but are simpler and faster if a University of California plant mapping program is used to do the mapping. This program runs on an inexpensive Hewlett Packard palmtop or a desktop computer. Pix rates from ½ to 1 pt/A are suggested by the plant mapping program depending on plant vigor and early crop fruit retention.

Wrap Up

There are several Pix application strategies that have been used successfully. Your choice of a specific approach should be guided by locally-developed recommendations that are based on your region's environmental conditions and your management objectives. In all cases, your best strategy is one based on the crop's status in each field. Plant monitoring can give you the data you need to make informed Pix decisions.

For additional reading on other mid-season management topics, refer to the following issues of Cotton Physiology Today:

- Negotiating the Path to Peak Bloom, June 1994, Vol. 5, #5
- Monitoring Plant Vigor, June 1993, Vol. 4, #5
- Cotton Irrigation Scheduling, August 1992, Vol. 3, #8

To obtain copies of these issues, call or write Pat Yearwood at the National Cotton Council, Box 12285, Memphis, TN 38182-0285, phone: 901/274-9030.

About the Authors

Doug Munier and Bill Weir are Farm Advisors with the University of California Cooperative Extension Service in Bakersfield and Merced, respectively. Charles Stichler is Extension Agronomist with Texas A&M Agricultural Extension Service in Uvalde, and Juan Landivar is Associate Professor at the Texas A&M Research Center in Corpus Christi.

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