Heat Units as a Method for Timing Pix® Applications

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Heat units provide a method of studying the relationships of plant development with temperature. This is done by measuring the accumulation of daily temperature above a certain base and below an upper threshold value, for a determined period of time.

This approach is based on the fact that plants and other organisms, contrary to human beings, are "cold blooded". They are unable to maintain a constant temperature thus, their metabolic activities are directly related to changes in ambient temperature. Measuring amounts of accumulated "effective" temperature or heat units is nothing more than an attempt to measure and quantify development of cold blooded organisms by morphological, biochemical and physiological changes. In this sense, the heat unit system can be thought of as a way to quantify development in a physiological time that differs from calendar time because of changes in weather pattern from year to year.

In a strict sense the heat unit system assumes a perfectly linear relationship between plant development and temperature. However, this relationship is better represented by a sigmoid curve, with departures from linearity around the lower and upper thresholds.

The most common formula for daily accumulation of heat units is:

$$\text{Heat units} = \frac{\text{maximum} + \text{minimum}}{2} - \text{base temperature}$$

Although easily calculated, this method presents certain weakness. For example, in cases where the mean temperature is at or below the base temperature an accumulation of heat units would not be possible. Yet, it is common knowledge that heat units accumulate for any time period when the temperature exceeds the base.

The most accurate method of calculating heat units above a certain base temperature is by measuring units of temperature above the base. Since this method is very time consuming, several formulas have been proposed to estimate this area by using maximum and minimum temperature values only. The best approximation has been obtained by the use of a sine wave method. In this method, a chart is developed with specific heat unit values for each combination of maximum and minimum temperatures.

The usefulness of the heat unit system is that plant development can be followed and predicted without constant field observations. For example, the amount of heat units required for seed to emerge, flowers to appear, bolls to mature or insects to develop remains quite constant. In cotton, it is known that it takes around 150 heat units for seed to emerge and 1300 for flowers to appear.

The responses of a cotton plant to Pix (mepiquat chloride) are discussed elsewhere in this paper. Timing of application is a very important factor for the successful use of Pix. The label recommends that Pix should be applied when the physiological state corresponding to 5-6 white blooms/25' row appear. The problems of using a visual field observation to time an application are quite obvious. This is impractical because it requires constant and careful field observation for an extended period. To be valid, it requires counts from several 25 feet plots randomly picked across the field. Also, insect damage may cause squares to shed before the flowers open even though the physiological state corresponding to 5-6 white blooms/25' has been reached.

Growers would definitely prefer methods of timing Pix application which is not dependent on field examination and predicts optimum time of application in advance. This method reduces the time required for checking fields.

The objective of this work was to evaluate advantages of using heat units as a tool for timing Pix application.

Materials and Methods

Fifteen field trials in 1979, 44 in 1980 and 12 in 1981 from several locations in Arizona were used to estimate relationships between heat units, application time and yields. Accumulated heat units were calculated in two ways: 1) The standard formula and 2) By estimating the time period that temperature is greater than a base of 55F. This computer program was developed by Dr. R. Huber, Entomology Department, at the University of Arizona, which gives a distinct heat units value for every combination of maximum and minimum temperatures.

Results and Observations

Based on observations for three years the optimum timing for an application time of Pix is hard to determine. In most of the 71 cases studied we found that applications made were later than suggested on the label.

We believe that heat units provide greater accuracy in determining proper application date and require much less effort than field observation of bloom occurrence.

We did find a yield increase in 50% of the fields receiving Pix when the compound was applied at an average of 8 to 20 white blooms per 25 feet of rows. This coincides with a heat unit range of 1200-2000.

In the other 50% of the fields there was either no change in yield or a yield decrease.

We determined the success rate was similar when applications were made at an average bloom count of 8 or at an average of 20 blooms. These values correspond to about 1400 and 1800 heat units, respectively.

Thus, it appeared that heat units would be a more reliable method than bloom counts to determine application timing.

Also, our data supports our belief that we do not fully understand the response of cotton to Pix and thus, we feel a more in depth evaluation must be done before Pix can be universally used as a management tool.

The Effect of Pix® Applications on Cotton Treated with Four Levels of Nitrogen

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During 1980 we monitored petiole nitrate levels of five varieties of cotton treated with Pix. Our data suggested that Pix treated plots maintained higher petiole nitrate levels during each of the four weeks the nitrate level was monitored. The level was an average of 10% greater in the Pix treated plots at each sampling date. These results suggested that the successful use of Pix may depend on the relative availability of nitrogen and the nitrogen status of the plant.

In 1981 we applied 20 grams of Pix per acre to cotton fertilized with four nitrogen levels. The test was conducted at two locations in cooperation with cotton farmers and agricultural industry representatives. The tests were six rows wide and replicated four or eight times. The fertilizer rates selected included 100, 200, 300 and 400 pounds nitrogen per acre.

Each field received 100 pounds of nitrogen preplant and the remainder in two or three applications side dressed at two week intervals preceeding the Pix application. The Pix application was timed to approximate 5 or 40 white blooms per 25 feet of row. Twenty-five to thirty petioles were collected from each plot the day the Pix was applied and one, three and five weeks later.

The initial petiole nitrate level averaged 15,000 and 18,500 for the two tests, respectively. Five weeks later, approximately August 1, the petiole level had decreased to an average of 5,000 and 11,000 for the two tests, respectively. No differences in nitrate nitrogen petiole levels were observed on a sampling date (Table 1).

The petiole nitrate level from the plots receiving the lowest rate of nitrogen per acre were as high as plots receiving the highest rate of nitrogen per acre. Data we collected do not explain this result. Yield differences were not observed between nitrogen treatments, yields were greater in seven of eight plots receiving an application of Pix (Table 2).