Scheduling Techniques for the Use of Pentia Plant Growth Regulator

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Abstract

A single field study was conducted at the University of Arizona Safford Agricultural Center during the 2004 season to evaluate the utilization of a feedback technique that is based upon plant growth and development to schedule applications of the new plant growth regulator (PGR) from BASF, Pentia. A simple three treatment study was constructed consisting of a control treatment (no Pentia application), a scheduled treatment (application of 16 oz/acre at first bloom regardless of plant growth), and a feedback treatment (applications based upon plant growth and development). Application decisions on the feedback treatment were made using height to node ratios (HNR) as a measure of plant vigor. Treatment applications were made on the scheduled regime on 14 July with a one time 16 oz/acre application. The feedback regime received an application (16 oz/acre) of Pentia five days later on 19 July. An additional application (16 oz/acre) was made on the feedback treatment on 3 August due to continued high HNR levels. Significant differences in plant vigor were observed post application among the three treatments as measured by end of season HNR ratios. Yield results indicated positive lint yield response to Pentia application with both the scheduled and feedback treatment producing statistically higher yields than the control. Differences between the feedback and scheduled treatments were not statistically different however a slight yield increase was observed in the scheduled treatment. The second Pentia application made to the feedback treatment was not necessary. End of season HNR measurements indicate that the additional 16 oz/acre application suppressed growth to below the average baseline for HNR. These results indicate that potential positive response to PGR applications, specifically Pentia, under conditions of high vigor.

Introduction

Cotton grown in the deserts of the southwestern cotton belt are intensively managed crops with high levels of input and high yields. Among those inputs are both water and fertilizer nitrogen (N) which are two of the most well recognized growth stimulants for any crop. With high levels of both water and N, maintaining a proper balance between the reproductive and vegetative components of the crop is sometimes difficult to accomplish. Increased production of vegetative components (stems and leaves) at the expensive of the reproductive component (squares, flowers, and bolls) can lead to decreased yield. Maintenance of a proper vegetative to reproductive ratio is often difficult due to the dynamic nature of the cotton plant. The tendency of the cotton plant to abort fruiting forms in response to environmental cues may result in the disruption of a vegetative/reproductive balance that is favorable to high yields. The loss of these carbohydrate sinks (fruiting forms) results in rapid proliferation of the mainstem (Mauney, 1986) and other vegetative components of the crop. However, the cotton plant also has the ability to compensate for that loss under favorable environmental conditions through rapid initiation and retention of new fruiting forms. This ability of the cotton plant to shed fruit and then also to compensate based upon environmental cues necessitates crop monitoring to properly manage the vegetative/reproductive ratio of the crop.

Indices have been developed and validated that can help to track crop progression and the vegetative reproductive balance over the course of the growing season. Baseline levels for both height (inches) to node ratios (HNR) and fruit retention (FR) levels have been developed for cotton grown in Arizona (Silvertooth et. al., 1993; Silvertooth, 1994; Silvertooth et. al., 1996; Silvertooth and Norton, 1998). These baselines have been developed from over 14 years of data collected from around the state of Arizona and provide a good indication of what is 'normal' for a crop produced in this region. All indices are developed as a function of heat units accumulated after planting (HUAP) which provides a measure of time that is very well correlated to crop growth and development.

There are several tools that can be used to aid in maintaining proper vegetative/reproductive balance in the crop. Optimum planting date will aid in maintaining a proper balance. Research has indicated that delayed planting will result in increased vegetative growth and decreased yields (Silvertooth and Norton, 2000). Proper management of water and fertilizer N will also have an influence on the vegetative/reproductive balance (Silvertooth et. al., 2001). Plant growth regulators such as mepiquat chloride (Pix – manufactured by BASF) have been used in cotton production for many years as a tool for controlling vegetative growth in cotton thus helping to maintain a proper ratio of reproductive to vegetative growth. Mepiquat chloride suppresses the production of the plant hormone gibberellic acid (GA) which is a growth stimulant that induces cell elongation. Suppression of GA production results in decreased cell elongation and overall decrease in the vertical and horizontal elongation of stems and branches (York, 1983; Kerby, 1985).

There has been a considerable amount of research conducted throughout the state of Arizona on the effects of PGR applications on crop growth, development, and yield. A summary of over ten years (31 site-years) of these projects indicated that increases in lint yields with the application of Pix was most commonly observed when crop growth trends indicated an increasing vegetative state of the crop. Using a feedback approach involving crop monitoring of HNR trends and FR levels for scheduling PGR applications demonstrated the highest potential for increased lint yield (Norton and Silvertooth, 2000).

The objectives of the current studies were two-fold. The first objective was to evaluate the effects of the new formulation of mepiquat pentaborate (Pentia) from BASF on cotton growth development and yield. The second objective was to evaluate a feedback versus a scheduled approach with the new mepiquat formulation.

Materials and Methods

A single field experiment was established during the 2004 growing season at the Safford Agricultural Center in order to accomplish the objectives in this study. The field was planted to Fiber Max FM991BR variety on 28 April. A simple three treatment study was constructed consisting of a control, a scheduled, and a feedback treatment regime. The scheduled application regime consisted of an application of Pentia at first bloom regardless of crop vigor and fruit load. The feedback application regime consisted of applications of Pentia based upon increased vegetative growth as measured by height to node ratios. Plant measurements were collected from each experimental unit on a regular interval to track plant growth and development. These measurements included plant height, number of mainstem nodes, position of the first fruiting branch, and the number of aborted or missing fruiting sites on the first two positions of each fruiting branch. This data was summarized and plotted against average baseline values. These plant growth and development indices were used to make treatment decisions for the feedback application regime. Lint yield estimates were made at the end of the season by harvesting the entire four row plot from each experimental unit and weighing the seedcotton with a cotton weigh wagon equipped with load cells. Sub samples were also collected from each experimental unit for fiber quality analysis. All data was subjected to analysis of variance and means separation according to procedures outlined by the SAS Institute (2002) and Gomez and Gomez (1985).

Results

Treatment applications made in both the feedback and scheduled regimes are outlined in Table 1. The scheduled treatments received an application of Pentia 16 oz/acre on 14 July. The feedback regime was treated with 16 oz/acre Pentia five days later on 19 July. Due to the high vegetative growth rate of the crop an additional application of 16 oz/acre was applied on the feedback regime on 3 August for a total of 32 oz/acre (Table 1). Plant growth and development measurements revealed high levels of vegetative growth and fruit load. Figure 1 show fruit retention (FR) levels remaining high the entire season with final FR levels near 65%. Height to node ratios (HNR) also revealed a high level of plant vigor. Figure 2 shows HNR levels for all three treatments with vertical lines indicating the timing of the Pentia applications. Decisions for the feedback Pentia applications were made based on the HNR levels observed in the field. After the first Feedback application was made an additional set of measurements indicated a sustained level of high plant vigor (Figure 2) so an additional Pentia application was made on 3 August. A clear separation of HNR levels were observed among the three treatments toward the latter part of the sason. The control treatment remained well above the baseline late into the season. The scheduled treatment, receiving 16 oz/acre Pentia application tracked very near the baseline throughout remainder of the season while in the feedback treatment, receiving 32 oz/acre, was slightly below the baseline near the end of the season.

Lint yield differences among the treatments were statistically significant with both the scheduled and feedback treatments producing significantly higher yield than the control (Table 2). Differences between the feedback and scheduled regimes were not significant but the one time application (scheduled) treatment produced a slightly higher yield. This result is an indication that the additional Pentia application on 3 August was not needed. Levels of plant vigor (HNR) towards the end of the season (Figure 2) would also support that fact that the second Pentia application was not needed. Fiber quality results were not significantly different among the three treatments for any of the parameters measured except for fiber strength. A slight increase in fiber strength was observed with the Pentia applications that was statistically significant at the 0.1 level (Table 2).

The results of this study further validate the University of Arizona recommendations with respect to plant growth regulator applications. The most effective use of the product is when applications are based upon plant growth and development in some type of a feedback approach to PGR management. Research conducted in 2003 indicate the effects of applications of Pentia made when crop vigor is at a minimum. A decline in yield was oserved with Pentia applications made under these circumstances (Norton and Clark, 2004).

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Table 1. Treatment applications and rates for each of the three treatments in the Pentia scheduling evaluation conducted at Safford Agricultural Center, 2004.

Application Date	Feedback	Treatment Scheduled Rate (oz/acre)	Control
14 July	---	16	---
19 July	16	---	---
3 August	16	---	---
Total	32	16	---

Table 2. Lint yield estimates and fiber quality data for each of the three treatments in the Pentia scheduling evaluation conducted at Safford Agricultural Center, 2004.

Treatment	Yield lbs. lint/acre	Micronaire	Fiber Length (100ths)	Staple Length (32nds)	Fiber Strength (g/tex)	Uniformity Index	Leaf Grade
Control	1792 b*	38.5 a	115 a	36.8 a	28.5 b	80.8 a	3.0 a
Feedback	2089 a	39.8 a	117 a	37.5 a	32.9 a	81.5 a	2.3 a
Scheduled	2121 a	37.3 a	112 a	36.0 a	30.2 ab	81.0 a	2.8 a
§LSD	222	NS	NS	NS	NS	NS	NS
†CV	6.4	8.3	3.1	3.0	7.9	1.4	18.8
‡OSL	0.0206	0.5708	0.2376	0.2441	0.0993	0.6481	0.1780

*Means followed by the same letter are not statistically different according to a Fisher's LSD means separation test.
§Least Significant Difference
†Coefficient of Variation
‡Observed Significance Level

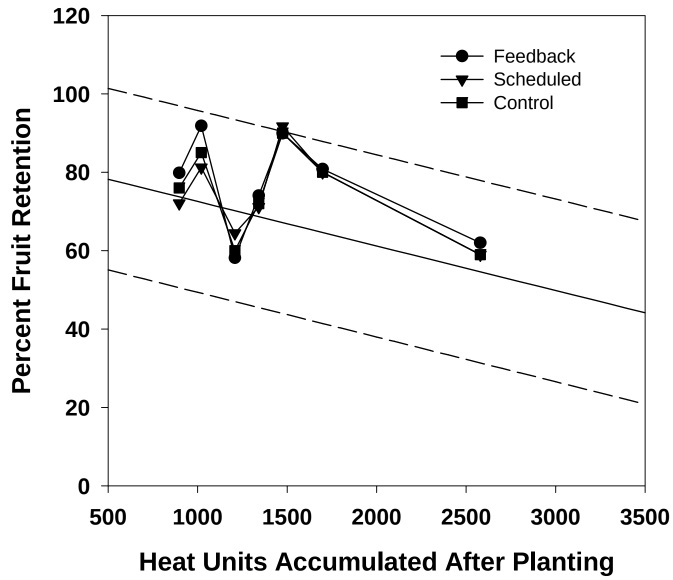

Figure 1. Percent fruit retention trends for each of the three treatments in the Pentia scheduling evaluation conducted at Safford Agricultural Center, 2004.

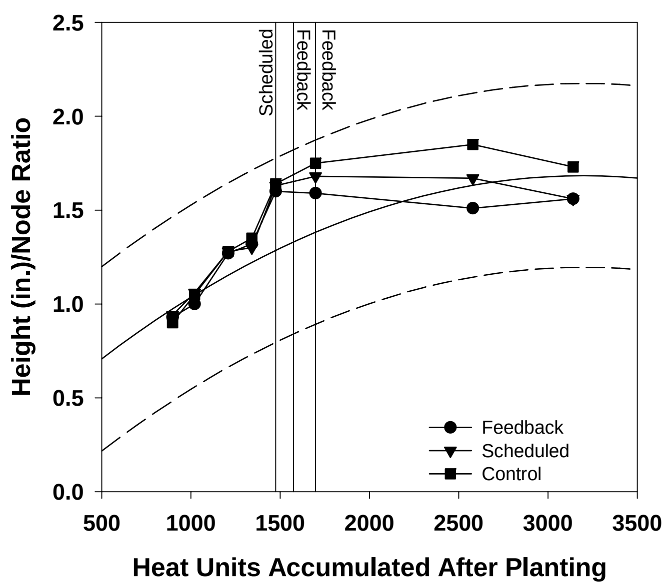

Figure 2. Height to node ratio trends for each of the three treatments in the Pentia scheduling evaluation conducted at Safford Agricultural Center, 2004. Vertical lines indicate Pentia application events for for both the scheduled and feedback regimes.l