# TWO-YEAR STUDY ON THE EFFICACY OF PIX<sup>™</sup> WHEN FOLIAR APPLICATION IS FOLLOWED BY PRECIPITATION D. Zhao, D. M. Oosterhuis and T. Daniel Department of Crop, Soil, and Environmental Sciences University of Arkansas Fayetteville, AR

### Abstract

Rainfall is a frequent event where Mepiquat Chloride (Pix<sup>TM</sup>) is used in the Mid-South. However, uncertainty exists about the minimum time needed after foliar Pix application for effective absorption of Pix. Field studies were conducted in 1998 and 1999 to determine the efficacy of Pix in controlling plant growth after simulated rain had washed Pix off the plants at different time intervals after spraying. A rain simulator was used to wash off the Pix at select intervals after foliar application. In 1998 the six treatments consisted of an untreated control. Pix not washed off, and Pix washed off 1. 2, 4 and 8 h after spraying. In 1999 the five treatments, repeated under well-watered (WW) and water deficit stressed (WS) conditions, consisted of an untreated control, Pix not washed off, and Pix washed off starting 8, 12 and 24 h after spraying. In all cases Pix was applied with a backpack sprayer at 6 oz/acre in 10 gallons of water. In 1998, rain within 8 hours significantly reduced the efficacy of Pix for controlling vegetative growth, indicating that more than 8 hours were needed for adequate Pix absorption. In 1999, foliar application of Pix significantly controlled plant height and leaf growth. Simulated rain washing eight hours after Pix application significantly reduced the efficacy of Pix, whereas 12 and 24 hours allowed adequate time for Pix absorption and control of vegetative growth. The minimum critical time period between foliar application of Pix and rain was 12 hours after which respraying Pix would not be necessary. Water deficit stress during the vegetative phase did not affect the time needed for leaf absorption of Pix in this study.

# **Introduction**

Mepiquat Chloride has been widely used to control vegetative growth and to improve lint yield of cotton (*Gossypium hirsutum* L.). However, rainfall is a frequent event in the Mid-South region when Pix is foliarly applied, and this would result in rain washing off some of the Pix from the leaf surface. It is believed that it probably takes several hours for the leaves to absorb the Pix after foliar application, however, there is no published data to support this. Questions have arisen about how long it takes for leaves to absorb Pix under field conditions? What is a critical time period after foliar application of Pix for rain not to affect Pix efficacy? Does drought during the early growing season change the critical uptake time period? Studies were conducted at the Arkansas Agricultural Research and Extension Center, University of Arkansas, Fayetteville, AR. in 1998 and 1999 to answer these questions. The objectives of our study were: (1) to determine the effect of rain washing Pix off plants, at different time intervals after spraying Pix on the efficacy of Pix in controlling growth, and (2) to investigate the response of water-stressed cotton plants to the time period of Pix absorption after foliar application.

### **Materials and Methods**

Cotton (cv. Suregrow 125) seeds were planted in 4-gallon pots on 18 June 1998 and 28 May 1999. The pots were buried in a cotton field in rows one meter apart to provide representative cotton plants that could be transported to a rainfall simulator. The surface of each pot was level with the surrounding field during growth to maintain soil temperatures in the pots similar to the surrounding field. Water, fertilizer, and the control of weeds and insects were applied as needed.

In 1998, when plants reached the early squaring stage (23 July 1998), all pots were separated into six identical groups of 6 pots each (one group was a treatment). The six Pix treatments were: (1) a control without Pix application; (2) Pix not washed off; (3) Pix washed off starting 1 h after spraying; (4) Pix washed off starting 2 h after spraying; (5) Pix washed off starting 4 h after spraying; and (6) Pix washed off starting 8 h after spraying.

In 1999, 60 pots were split into 2 identical groups 3 weeks after planting. The first group was well-watered (WW) and the second group received 3 periods (wilt-rewater) of water deficit stress (WS) before Pix application. All plants in both treatments were well-watered after the Pix application. The five treatments within each water regime were: (1) a control without Pix application; (2) Pix not washed off; (3) Pix washed off starting 8 h after spraying; (4) Pix washed off starting 12 h after spraying; and (5) Pix washed off starting 24 h after spraying.

All Pix treatments received the same amount of Pix equivalent to 6 oz. per acre in 10 gallons of water. According to the treatments above, the plants were moved into a simulated rainfall shelter at 1, 2, 4 or 8 hours in 1998 and 8, 12 or 24 hours in 1999 after Pix application, respectively. All rain washing-off treatments were "rained on" for 30 minutes with a one-inch simulated rain. During rain washing, the pot surface was covered using plastic bags. Plants were moved back to the original locations in the field after the simulated rain washing.

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The effect of Pix on growth was determined by measuring the elongation of the uppermost unfolded main-stem leaves daily,

and plant height and nodal development at 2-day intervals for two weeks. Finally, plants were harvested 2 weeks after Pix application, and leaf area, the number of fruiting sites, and the number of squares were recorded. Dry matters of leaves, stems and squares were also determined. A randomized complete block (1998) or split block (1999) design with 6 replications was used to evaluate each treatment. Differences among treatments were compared by the LSD test. Mean differences were significant when  $P \le 0.05$ .

## **Results and Discussion**

## <u>Plant Height</u>

In 1998, plants receiving Pix without simulated rain washing were significantly shorter than the no-Pix control plants from 6 days after application of Pix (Fig. 1A). Fourteen days after Pix application, plant height of plants treated with Pix without simulated rain washing was reduced 22% compared to the control. However, all three simulated-rain-washing-Pix-off treatments did not differ from the control (Fig. 1A, B). This indicated that an 8-hour period after foliar applying Pix was still not sufficient for leaves of field-grown cotton to completely absorb Pix.

In 1999, results of Pix controlling plant height were similar to those in 1998 (Fig. 2). Both WW- and WS-treated plants with Pix washed off 8 hours after spraying did not differ from the control in plant height at 14 days after simulated rain washing. Washing Pix off at 12 and 24 hours after spraying resulted in significantly shorter plants than the control, indicating that sufficient Pix has been absorbed and rain did not affect Pix efficacy 12 hours after spraying Pix.

#### Main-Stem Nodes

The number of main-stem nodes was not significantly different among all treatments in 1998 (Fig. 3A) and among the 5 washing-Pix-off treatments within WW group in 1999 (Fig. 3B). In 1999 WS-treated plants, the plants receiving Pix with and without washing off at 24 hours after spraying had significantly less main-stem nodes than the control plants.

### Leaf Elongation

In 1998, leaf length of cotton plants receiving Pix without washing was significantly smaller than the control from 4 days after Pix application (Fig. 4). All four washing-off treatments did not differ from the control in leaf length at all measuring times.

In 1999, control plants had a greater increase in leaf length than all other Pix treatments, but leaf length did not differ among the four Pix treatments within the WW plants (Fig. 5A, B). Within water-stressed plants, the plants receiving Pix with and without washing off at 12 and 24 hours after spraying Pix had significantly shorter leaf length than the control plants (Fig. 5D).

## Leaf Area and Number of Fruits

In 1998, the number of fruits per plant was not different among treatments at 14 days after spraying Pix. The treatment receiving Pix with no washing had significantly smaller leaf area (LA) than the control; the LA did not differ among the other treatments (data not shown). In 1999, the LA of all Pix treatments was decreased significantly compared to the control except for the treatment consisting of WW plants with Pix washed off 8 hours after application. Pix and water treatments did not affect the number of fruits (Table 1).

### **Dry Matter Accumulation**

At 14 days after applying Pix, no significant differences were observed in dry weights of leaves and fruits among Pixwashing-off treatments for both WW and WS plants (Table 2). The Pix application significantly decreased stem dry weight. This indicated that stem growth was the most sensitive plant tissue to Pix application.

### **Conclusions**

Foliar application of Pix significantly controlled plant height and leaf growth. Simulated rain washing within eight hours after Pix application significantly reduced the efficacy of Pix controlling plant vegetative growth. Cotton leaves need about 12 hours to effectively absorb foliar applied Pix. The minimum critical time period between foliar application of Pix and raining was 12 hours after which respraying Pix would not be necessary. However, if it rains within 12 hours of a Pix application, respraying needs to be considered. The drought during early growing season did not affect the time needed for leaf absorption of Pix in this study.



Figure 1. Effect of washing Pix off at different time intervals plant hight in 1998. (A) changes in plant height during growth. (B) increases in plant height within 14 days.



Figure 2. Effect of washing Pix off at different time periods on plant height for wee-watered (WW) and water-stressed (WS) plants in 1999. Line graphs (Top) show plant height. Bar graphs (Bottom) show increases in plant height within 14 days after washing off. The means with same letter within a graph are not significant (P > 0.05).



Figure 3. Incrases in number of main-stem nodes in 14 days after washing Pix off at different time intervals in 1998.and 1999. Bars with the same letter within a graph are not significant (P > 0.05).



Figure 4. Effect of washing Pix off at different time intervals on leaf length in 1998. Bar with the same letter are not significant (P > 0.05).



Figure 5. Effect of washing Pix off at different time intervals on leaf length for well-watered (WW) and water-stressed (WS) plants in 1999. Line graphs (Top) show changes in leaf length. Bar graphs (Bottom) show increases in leaf length within 14 days after washin. Means with the same letter within a graph are not sinificant (P > 0.05).

Table 1. LA, bolls and squares of different treatments at 14 days after application of pix in 1999.

Treatment	WW			WS			
	LA	Bolls	Square	LA	Bolls	Square	
	cm <sup>2</sup> /pl.	No./pl.	No./pl.	cm <sup>2</sup> /pl.	No./pl.	No./pl.	
Control	2052	1.2	36.2	2156	0.2	27.0	
Pix	1916*	1.0	36.5	1637*	0.5	18.5*	
Pix(8h)	2043	2.0	36.0	1656*	0.2	26.8	
Pix(12h)	1856*	2.0	34.8	1766*	0.7	29.5	
Pix(24h)	1701*	2.0	29.0	1654*	0.3	24.3	

\*Significantly different (P<0.05)

Table 2. Dry weight of different plant parts at 14 days after application of pix in 1999.

	WW				WS						
Treatment	Leaves	Fruits	Stems	Total	Leaves	Fruits	Stems	Total			
	g/plant										
Control	15.93	3.13	18.06	37.11	15.71	1.69	15.49	32.89			
Pix	16.01	3.14	15.70	34.85	13.81	1.51	10.00*	25.32*			
Pix (8h)	16.37	3.52	16.28	36.17	12.90*	1.36	10.57*	24.82*			
Pix (12h)	15.05	3.50	13.72*	32.27	13.83	1.76	11.16*	26.75*			
Pix (24h)	15.91	3.40	14.21*	33.52	13.40	1.93	9.86*	25.19*			

\*Significantly different (P<0.05).