

GROWTH AND YIELD RESPONSES TO MEPIQUAT-TYPE PGRs IN TENNESSEE

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Abstract

Mepiquat chloride is widely used in cotton production in Tennessee, but producers lack clear information about crop responses to newer mepiquat-type plant growth regulators (PGRs). Field studies were conducted at Jackson TN in 1998, 1999, and 2003 to evaluate cotton responses to newer mepiquat-type products (Pix Plus, BAS 130, Pentia) relative to traditional mepiquat chloride formulations (Pix, Mepex) and untreated cotton. Growth responses to the newer products were generally similar to those of mepiquat chloride regardless of rate of application, cultivar or year. All the products promoted earliness during flowering by 5-10 days relative to untreated check. All products reduced final plant height similarly, by 4-14 inches relative to untreated cotton. Multiple applications starting at matchhead square controlled growth more than a single application at early bloom. Reduction in plant height was accompanied by production of 1-4 fewer fruiting branches. Boll retention at first and second position sites and total lint yield were not significantly affected by treatment in any test. Application of Mepex or Pentia increased percent of total yield picked at first harvest in DP 555 BR, relative to untreated check. Results provided no evidence that any of the newer mepiquat-type PGRs evaluated here are more effective than mepiquat chloride for growth control, or that any of these PGRs affect boll retention or total lint yield. Use of a mepiquat-type PGR is essential for controlling rank growth and promoting earliness in Tennessee cotton.

Introduction

Several newer mepiquat-type PGRs have recently become commercially available, including Mepex (0.35 lb/gal mepiquat chloride); Pix Plus (0.35 lb/gal mepiquat chloride + 3.1×10^8 colony units/oz *Bacillus cereus*); and Pentia, tested as BAS 130 (0.82 lb/gal mepiquat pentaborate). Mepex is a trademark of Griffin LLC, Valdosta GA, and Pix Plus and Pentia are trademarks of BASF Corp., Research Triangle Park NC.

Boron is an essential micronutrient especially important in pollination processes. Severe B deficiency may reduce fruit set, boll retention, and yield in cotton (Miley et al., 1969). It has been hypothesized that boron supplied by the pentaborate in Pentia or BAS 130 may increase boll retention by improving pollination and fruit set. It has been reported that Pentia application increased boll retention and yield relative to cotton treated with mepiquat chloride (Stapleton and Via, 2003).

Objectives of these studies to determine (1) if newer mepiquat-type PGRs differ from mepiquat chloride in their growth, earliness and yield effects under Tennessee field conditions, and (2) if boron supplied as pentaborate in Pentia affects boll retention and yield under Tennessee field conditions.

Materials and Methods

Four PGR studies were conducted on different sites at the West Tennessee Experiment Station from 1998 through 2003. In all studies, cotton was planted in 38-inch rows and managed according to Tennessee Agricultural Extension guidelines. Except as noted below, PGR treatments were applied by high-clearance sprayer to plots arranged in a randomized complete block design with 4 replications. The two center rows of each plot were spindle picked twice to measure earliness as percent of total yield picked at first harvest. Seedcotton of each plot was weighed, and a sub-sample from each plot was ginned to calculate lint yields.

Data collected from all tests were analyzed by SAS GLM procedures. Least-square means were separated by pairwise T-tests using the 'pdiff' option in Proc GLM, with a significance level of $p=0.05$.

1998-99 Field Study

The cultivar 'Stoneville 474' was planted on 14 May 1998 and 11 May 1999 in a Calloway silt loam. The N rate was 80 lb/ac, broadcast at planting each year. Supplemental irrigation was applied by traveling sprinkler boom to reduce moisture stress during periods of prolonged drought. Treatments listed in Table 1 were applied in two stages to 6-row plots in 1998, and to 4-row plots in 1999. In both years, rates of application listed in Table 1 were determined by SysCot (BASF Corp., Research Triangle Park NC), a Pix rate calculator based on research by Landivar (1998). To measure earliness during flowering, nodes above white flower (NAWF) were counted on 10 plants per plot at 7- to 10-day intervals. Earliness was expressed as days from planting to NAWF=5 in 1998, and days to NAWF=4 in 1999. Prior to harvest, final plant height was measured and fruiting branches were counted. Plots were spindle picked 131 and 129 days after planting (DAP) in 1998 and 1999, respectively, and again 17 days later.

2003 Study with ST 4892 BR

The cultivar 'Stoneville 4892 BR' was planted on 12 May 2003 in a Dexter loam. The N rate was 80 lb/ac, broadcast at planting. Supplemental irrigation was applied by traveling sprinkler boom to reduce moisture stress during periods of prolonged drought. PGR treatments listed in Table 1 were applied to 4-row plots in three stages starting at matchhead square (44 DAP) and continuing at 56 and 72 DAP. Two of the Mepex treatments were mixtures with Solubor DF (U.S. Borax Inc., Valencia CA) containing 17.5% B, applied at equivalent B rates to the boron supplied as pentaborate in Pentia. To compare earliness during flowering, nodes above white flower were counted on 5 plants per plot at 80 DAP. Prior to harvest, final plant height was measured and fruiting branches and harvestable bolls at first- and second-position sites were counted. These data were used to calculate percent boll retention. Plots were spindle picked 150 and 162 DAP.

2003 Study with DP 555 BR

The cultivar 'Deltapine DP 555 BR' was planted on 13 May 2003 in a Memphis silt loam. The N rate was 100 lb/ac, broadcast at planting. This trial received no supplemental irrigation. Four of the PGR treatments listed in Table 1 were applied to 4-row plots in three stages starting at matchhead square (45 DAP) and continuing at 55 and 66 DAP. Two treatments were applied at early bloom (66 DAP) only. To measure earliness during flowering, nodes above white flower were counted on 10 plants per plot at 7- to 14-day intervals. Prior to harvest, final plant height was measured, and fruiting branches and harvestable bolls at first- and second-position sites were counted. These data were used to calculate percent boll retention. Plots were spindle picked 155 and 171 DAP.

Results

Combined analysis of variance of 1998 and 1999 data showed no significant treatment-by-year interactions for response variables measured here. Therefore data were combined across these two years for mean separation. Data from the 2003 experiments were analyzed separately.

Earliness During Flowering

In 1998-99, all PGRs hastened flowering progress similarly, relative to untreated ST 474 (Table 2). The gain in earliness averaged 5.5 days. In 2003, NAWF of ST 4892 BR at 80 DAP was reduced by all PGRs except for the 24 oz/ac Mepex treatments, relative to untreated (Table 3). In 2003, PGRs applied to DP 555 BR starting at matchhead square hastened flowering progress by about 10 days to NAWF=5, relative to untreated (Table 4). Flowering progress was not significantly affected by PGRs applied to DP 555 BR only at early bloom. In all studies and rates, Pentia, Pix or Mepex had similar effects on earliness during flowering.

Plant Height

In 1998-99, PGR application reduced the final plant height of ST 474 by 8 to 10 inches relative to the untreated check (Table 2). BAS130 reduced height slightly more than Pix Plus. In 2003, PGR application reduced plant height of ST 4892 BR by 11 to 15 inches, relative to untreated (Table 3). The higher rate of Mepex reduced height more than the lower rate. Higher rates of Pentia and Mepex also reduced height of DP 555 BR more than lower rates (Table 4).

Fruiting Branches

In 1998-99, PGR application reduced the number of fruiting branches by one or two, relative to untreated ST 474 (Table 2). In 2003, Pentia or Mepex similarly reduced fruiting branch number of ST 4892 BR by about two, relative to untreated (Table 3). Rate of application or the addition of boron to Mepex did not significantly alter response of ST 4892 BR. However, the 60 oz rate of Mepex reduced fruiting branch number more than the 28 oz rate applied to DP 555 BR (Table 4). The 60 oz rate of Pentia or Mepex reduced the number of fruiting branches of DP 555 BR by about four, relative the untreated check.

Boll Retention

PGR treatments had relatively few effects on boll retention at first and second position sites in 2003. The 48 oz Mepex treatment, with or without boron, increased boll retention of ST 4892 BR relative to the untreated check (Table 3). The addition of boron to Mepex, at rates equivalent to Pentia, did not alter boll retention relative to Pentia or Mepex alone. Mepex and Pentia had similar effects on boll retention at equivalent rates. Treatments did not significantly affect boll retention of DP 555 BR in the 2003 study (Table 4).

Lint Yields

Total lint yields were not significantly affected by treatment in any of these PGR studies, with one exception. Model F-tests in GLM showed no significant treatment effects, but contrast arguments (not shown) indicated that in DP 555 BR, the 16 oz treatments at first bloom resulted in slightly lower yields than the 28 or 60 oz treatments that began at matchhead square. Pentia did not differ from Mepex in yield effects in any test.

Percent First Harvest

In 1998-99, model F-tests in GLM showed no significant treatment effects on earliness at harvest of ST 474 ($p=0.09$). However, contrast arguments indicated that all PGRs as a group increased percent first harvest relative to untreated ST 474 (Table 2). In 2003, first harvest percentage of ST 4892 BR was not significantly affected, but first harvest of DP 555 BR was significantly increased by all PGRs similarly (Table 4). Rate of Pentia or Mepex application did not alter this earliness response.

Discussion

These results support earlier findings (Livingston et al., 1999; Prince et al., 2000) that cotton responses to Pentia or BAS 130 are generally similar to mepiquat chloride. Flowering progress was hastened and plant growth was controlled effectively by multiple applications of mepiquat-type PGRs that begin at matchhead square. Moderate rates (totaling 24 to 28 oz product/acre) were adequate for control with either Mepex or Pentia under these conditions.

The addition of boron to mepiquat chloride, at rates equivalent to Pentia, did not alter boll retention or lint yield relative to Mepex alone in 2003. Neither Pentia nor Mepex altered boll retention percentage relative to untreated cotton in the 2003 studies.

These results do not support assertions that Pentia increases boll retention or lint yield relative to mepiquat chloride under Tennessee growing conditions. If control of vegetative growth is the main objective in using a PGR, then mepiquat chloride appears to be as effective as the newer mepiquat-type products tested. Regardless of formulation, use of a mepiquat-type PGR is essential for controlling rank growth and promoting earliness in Tennessee cotton.

Acknowledgments

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Table 1. PGR treatments applied in 1998, 1999, and 2003, Jackson TN.

Year	Cultivar	PGR Product	Total Season Rate oz prod./acre	Timing oz prod./acre at days after planting (DAP).
1998	ST 474	(untreated check)	--	
		Pix	17.7	7.4 oz 48 DAP, 10.3 oz 64 DAP. [‡]
		Pix Plus	17.7	7.4 oz 48 DAP, 10.3 oz 64 DAP.
		BAS130 01W	17.7	7.4 oz 48 DAP, 10.3 oz 64 DAP.
1999	ST 474	(untreated check)	--	
		Pix	12.9	5.4 oz 52 DAP, 7.5 oz 70 DAP. [‡]
		Pix Plus	12.9	5.4 oz 52 DAP, 7.5 oz 70 DAP.
		BAS130 01W	12.9	5.4 oz 52 DAP, 7.5 oz 70 DAP.
2003	ST 4892 BR	(untreated check)	--	
		Pentia	24	4 oz 44 DAP, 8 oz 56 DAP, 12 oz 72 DAP.
		Pentia	48	8 oz 44 DAP, 16 oz 56 DAP, 24 oz 72 DAP.
		Mepex	24	4 oz 44 DAP, 8 oz 56 DAP, 12 oz 72 DAP.
		Mepex	48	8 oz 44 DAP, 16 oz 56 DAP, 24 oz 72 DAP.
		Mepex and Solubor DF	24 [§]	4 oz 44 DAP, 8 oz 56 DAP, 12 oz 72 DAP.
		Mepex and Solubor DF	48 [§]	8 oz 44 DAP, 16 oz 56 DAP, 24 oz 72 DAP.
		Mepex and Solubor DF	4.8 [§]	0.8 oz 44 DAP, 1.6 oz 56 DAP, 2.4 oz 72 DAP.
2003	DP 555 BR	(untreated check)	--	
		Pentia	16	16 oz 66 DAP.
		Mepex	16	16 oz 66 DAP.
		Pentia	28	4 oz 45 DAP, 8 oz 55 DAP, 16 oz 66 DAP.
		Mepex	28	4 oz 45 DAP, 8 oz 55 DAP, 16 oz 66 DAP.
		Pentia	60	12 oz 45 DAP, 24 oz 55 DAP, 24 oz 66 DAP.
		Mepex	60	12 oz 45 DAP, 24 oz 55 DAP, 24 oz 66 DAP.

[‡] Rates determined by SysCot Pix rate calculator.[§] Boron rates equivalent to boron from corresponding Pentia treatments.

Table 2. Effects of PGR treatments on ST 474 cotton at Jackson TN, 1998-99.

Treatment	Days to NAWF # (d.)		Plant Height (in.)		Fruiting Branches (no.)		Total Lint (lb/ac)	First Harvest (%)		
Means:										
Untreated check	80.0	a	43.5	a	12.9	a	1014	78.1	b	
Pix	73.1	b	34.5	bc	11.0	c	1033	81.3	a	
Pix Plus	75.5	b	35.0	b	11.6	b	1064	80.0	ab	
BAS 130 01W	74.7	b	33.1	c	10.9	c	1039	81.9	a	
Statistics:		Pr > F	Pr > F		Pr > F		Pr > F		Pr > F	
Treatment effects	<.0001		<.0001		<.0001		0.526	ns	0.089	ns
<u>Contrast</u>										
Check vs PGRs	<.0001		<.0001		<.0001		0.261	ns	0.025	
	R ²		R ²		R ²		R ²		R ²	
Model R-square	0.827		0.904		0.794		0.919		0.787	

[#] days from planting to five nodes above white flower (NAWF=5) in 1998; to NAWF=4 in 1999.

Letters separate means at p=0.05. ns = no significant differences (p>0.05).

Table 3. Effects of PGR treatments and boron on ST 4892 BR cotton at Jackson TN, 2003.

Treatment (product rate/acre)	NAWF at 80 DAP (nodes)		Plant Height (in.)		Fruiting Branches (no./plant)		Boll Retention (%)		Total Lint (lb/ac)		First Harvest (%)	
Means:												
Untreated check	4.9	a	39.1	a	13.3	a	36.8	c	1300		78.1	
Mepex (24 oz)	4.1	ab	27.8	b	11.5	b	38.9	abc	1469		81.0	
Pentia (24 oz)	3.9	b	27.8	b	11.0	b	36.5	c	1377		78.8	
Mepex (48 oz)	3.4	b	24.4	c	10.7	b	42.3	a	1338		81.3	
Pentia (48 oz)	3.7	b	25.3	bc	10.9	b	39.2	abc	1339		79.6	
Mepex (24 oz) + 0.026 lb B	4.2	ab	27.7	b	10.7	b	36.2	c	1317		78.7	
Mepex (48 oz) + 0.052 lb B	3.8	b	25.1	bc	10.7	b	40.9	ab	1273		83.7	
Statistics:	Pr > F		Pr > F		Pr > F		Pr > F		Pr > F		Pr > F	
Treatment effects	0.043		<.0001		0.006		0.032		0.057 ns		0.3558 ns	
Contrast												
Check vs PGRs	0.002		<.0001		<.0001		0.150 ns		0.183 ns		0.220 ns	
	R ²		R ²		R ²		R ²		R ²		R ²	
Model R-square	0.683		0.919		0.741		0.635		0.582		0.799	

Letters separate means at p=0.05. ns = no significant differences (p>0.05).

Table 4. Effects of PGR treatments on DP 555 BG/RR cotton at Jackson TN, 2003.

Treatment (product rate/acre)	Days to NAWF=5 (d.)		Plant Height (in.)		Fruiting Branches (no./plant)		Boll Retention (%)		Total Lint (lb/ac)		First Harvest (%)	
Means:												
Untreated check	79.8	a	38.4	a	12.7	a	33.5		1819		83.1	b
Mepex (16 oz)	77.5	a	34.2	b	10.8	b	35.8		1618		88.2	a
Pentia (16 oz)	76.7	a	34.1	b	10.7	b	33.5		1648		88.4	a
Mepex (28 oz)	70.8	b	29.6	c	11.1	b	38.3		1831		90.0	a
Pentia (28 oz)	70.8	b	27.3	cd	10.0	bc	39.3		1760		90.4	a
Mepex (60 oz)	69.5	b	25.7	de	8.9	c	39.0		1935		90.1	a
Pentia (60 oz)	68.0	b	23.7	e	8.9	c	37.5		1724		88.1	a
Statistics:												
Treatment effects	Pr > F		Pr > F		Pr > F		Pr > F		Pr > F		Pr > F	
	<.0001		<.0001		<.0001		0.445 ns		0.081 ns		0.010	
Contrast:												
Check vs PGRs	<.0001		<.0001		<.0001		0.179 ns		0.409 ns		<.0001	
	R ²		R ²		R ²		R ²		R ²		R ²	
Model R-square	0.827		0.937		0.764		0.296		0.533		0.685	

Letters separate means at p=0.05. ns = no significant differences (p>0.05).