Utility of Plant Growth Regulation in Cotton Production

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Plant Growth Regulation in Cotton

Plant growth regulators (PGRs) are commonly used to manage vegetative growth in cotton. The PGR most often used in cotton, mepiquat chloride, (MC), (1,1 dimethylpiperidinium chloride), was marketed by a single manufacturer, BASF Corporation, from 1984 until 1998. Upon patent expiration, several generic MC products were commercialized and the price of MC dropped significantly. Shortly thereafter, several new products that featured MC as their principal ingredient were introduced. Most of these products were new formulations or salts of MC, or combinations of MC with synthetic plant hormones. These new products are typically offered at prices higher than that of generic MC products, and they promised benefits beyond those the sellers claimed could be achieved with the old formulation of MC. Cotton growers want to know if there are any additional benefits to the higher priced MC products.

Physiologically, cotton is an indeterminate perennial grown commercially as an annual crop. When fruit are not set, the plant will continue or resume vigorous vegetative growth. The best way to prevent excessive vegetative growth is to manage for early and high fruit set. If early fruit are not set, the crop may compensate by setting fruit at higher nodes and at outer fruiting positions; however, crop maturity generally will be delayed. If few bolls are set, rank growth will likely occur under high moisture conditions, and the bolls may be difficult to harvest. Also, a dense canopy will make insect scouting more difficult and favor development of boll rot. A standard recommendation for the use of MC has been to apply the PGR if the internode length of the five uppermost nodes average more than two inches. However, many growers feel that if they wait to see the onset of rapid growth, either they have already experienced yield loss or would not be able to treat quickly enough to prevent excess growth. Hence the preventive use of PGRs is often practiced especially in irrigated fields.

The great majority of cotton growers and crop consultants feel that PGRs are used in cotton to control crop height. The perceived benefits of height control include: facilitation of scouting for insects, enhanced spray penetration into the canopy, reduced boll rot, increased defoliation efficiency, and harvest speed (field capacity). Additional claims of enhanced 'earliness' or accelerated crop maturity are often made. Typically, field managers try to defoliate or desiccate cotton for picking or stripping, respectively, when further additional boll opening is judged to be of minimal value (i.e., the last harvestable boll opens), and further delay will result in loss of lower bolls and fiber quality. Another benefit that is sometimes claimed for PGR use is translation of early boll set into yield increases, although the latter claim is tempered by the caveat that many factors affect final yields. Certain products claim positive effects on fiber properties that may benefit grade and increase lint value.

Table 1. Plant Growth Regulator (PGR) Treatments

	------------------ Time of Applications ------------------			
Plant Growth Regulator Treatment	Match Head Square	Match Head + 2 Weeks	5 Nodes Above White Flower	Cost of Treatment*
	---------- ounce formulated product/acre ----------			product/acre
Mepex®	8	10	0	$5.22
Mepex® Gin Out™	8	10	0	$4.86
Pentia™	8	10	0	$5.05
Stance™	1.5	2	0	$3.85
Stance™	2	3	0	$5.50
Stance™	2	3	3	$8.80

* Mississippi State University Crop Production Budgets, Appendix Table 4. Operating Inputs – Estimated Prices 2010.

Experimental Program

In 2007, Extension Cotton Specialists from across the Cotton Belt in partnership with Cotton Incorporated began a Beltwide project to determine the benefits of PGR treatments on cotton and the relative utility of using several different widely marketed cotton PGRs. Experiments were conducted at 22 locations in 11 states in 2007 and 2008. The objective was to determine the effect of several commercial PGR treatments on cotton growth, development, yield, and fiber quality.

All management practices were performed according to the respective state's cooperative extension service recommendations. The experimental design was a randomized complete block with treatments replicated three or four times at each location. Plant growth regulators evaluated in this study included: 1) mepiquat chloride (Mepex®, NuFarm); 2) mepiquat chloride + kinetin (Mepex® Gin Out™, NuFarm); 3) mepiquat chloride + cyclanilide (Stance™ Plant Regulator, Bayer CropScience); and 4) mepiquat pentaborate (Pentia™ Plant Regulator, BASF). PGR application timings, rates, and treatment costs are given in Table 1. and are representative of early-low multiple rate strategies for preventive plant growth regulation. A non-ionic surfactant was included with all treatments at 0.25% v/v. A non-treated check was also included for comparison. All PGR treatments were applied either with a tractor-mounted, compressed air sprayer or a CO_2-pressurized backpack sprayer.

Plant height data from five to ten plants per plot were collected before the first and second applications, two weeks after the second application, and at the end of the growing season. Total nodes and nodes above cracked boll (NACB) data were collected from five to ten plants per plot prior to defoliation. Defoliation was initiated when cotton bolls were 60% open. Seed cotton was harvested using a cotton picker modified to harvest small plots at all locations except Halfway and Lamesa, TX, and Altus, OK, where a cotton stripper was used. Seed cotton from each plot was ginned with a 10-saw laboratory gin and percent gin turnout (lint percent) was determined. Fiber properties were measured using a High Volume Instrument (HVI) at United States Department of Agriculture (USDA) classing offices or independent laboratories. All data were subjected to analysis of variance (ANOVA) using appropriate statistical techniques (Dodds et al. 2010).

Citation

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Table 2. PGR Effects on Cotton Yields, Earliness, and End of Season Height

Year	State	Cultivar	Yield	Earliness	Height
			------------Response------------		
2007	AZ	DP 164 B2RF	ns	No data	(-)
2007	West TX	FM 9063 B2RF	(-)	No data	(-)
2007	East TX	DP 555 BR	ns	ns	ns
2007	OK	PHY 485 WRF	ns	(-)	No data
2007	AR	PHY 485 WRF	ns	ns	(-)
2007	LA	PHY 485 WRF	ns	ns	ns
2007	TN	DP 143 B2RF	(+)	(-)	(-)
2007	AL	DP 555 BR	ns	No data	(-)
2007	GA	DP 555 BR	ns	(+)	(-)
2007	SC	DP 555 BR	ns	No data	ns
2007	NC	DP 117 B2RF	ns	ns	(-)
2007	VA	DP 117 B2RF	ns	(-)	(-)
2008	AZ	DP 164 B2RF	(-)	No data	(-)
2008	West TX	ST 5458 B2RF	ns	No data	(-)
2008	OK	PHY 485 WRF	ns	No data	ns
2008	East TX	FM 9063 B2RF	ns	(-)	ns
2008	AR	PHY 485 WRF	ns	ns	(-)
2008	MS	PHY 485 WRF	ns	ns	ns
2008	TN	DP 143 B2RF	(-)	ns	(-)
2008	AL	DP 555 BR	(+)	No data	(-)
2008	SC	DP 555 BR	ns	ns	ns
2008	NC	DP 117 B2RF	ns	(+)	No data

ns – no statistical differences among treatments; the PGRs had no economic effect.
(+) – at least one PGR treatment had a higher yield than the non-treated.
(-) – at least one PGR treatment had a lower yield than the non-treated.
(-) – at least one PGR treatment reduced nodes above cracked boll, i.e., accelerated earliness, and/or reduced crop height at the end of the season.
(+) – at least one PGR treatment delayed maturity.

Table 3. Effects of PGR Treatment on Yields in the 5 of 22 Experiments Where Significant Differences Were Found

Treatment	TN 2007	West TX 2007	AL 2008	AZ 2008	TN 2008
Ozs./Acre	------------------------ Lbs. Lint/Acre ------------------------				
Untreated (0)	738c	889a	1210c	1690a	1687abc
Mepex® (8/10)	867b	838ab	1246c	1690a	1480d
Mepex® GO (8/10)	934ab	823ab	1332ab	1693a	1754ab
Pentia™ (8/10)	975a	870a	1352a	1682a	1606bcd
Stance™ (1.5/2)	751c	841ab	1260bc	1689a	1783a
Stance™ (2/3)	988a	841ab	1250c	1521b	1585cd
Stance™ (2/3/3)	894b	768b	1250c	1620ab	1728abc

Means followed by the same letters within columns (site-years) did not differ ($P > 0.05$).
Green and red highlight significant positive and negative differences from the untreated, respectively.

Results and Discussion

All treatments reduced plant height within the two-week period following treatment. There were no large or consistent differences among treatments (Dodds et al. 2010 – data not shown). Potential economic responses to treatment would be increased yield, accelerated maturity, and shortened end-of-season height that would reduce overall plant biomass, and thereby speed harvest, and reduce trash in the lint. Other advantages might be improved fiber properties that might increase grade. In-season management of the canopy can make crop scouting and spraying, and between row placement of fertilizer and other products easier, but could make weed management more difficult.

Yields: The most common effect on yield was <u>none</u> (Table 2.). In 5 of 22 experiments, statistically significant effects were found. In three cases, the responses were negative and in two, positive (Table 3.). In the five cases of positive or negative response, no environmental factor was identified consistently that differentiated the response at the responding locations from those of others where no response was observed.

Earliness: In 6 of 14 cases, the maturity of treated cotton differed from the untreated (Table 4.). In four instances there were positive effects, and in two the effects were negative. In North Carolina in 2008, the crop was rated at a later than optimum date which may have obscured the results; in the other cases, no factor was identified that differentiated the positively or negatively responding sites from the others.

Height of the Crop at the End of the Season: The main benefit of in-season height control is stimulating early fruit set and thus accelerating maturity. Such benefits should have appeared as increased yield or earliness, but generally were not found (Tables 2., 3., and 4.). In-season height control can make field operations, such as insect scouting and spraying, easier and more effective. End-of-season height was reduced in 65% of the tests (Table 2.). Mean reduction in height was 16% (Table 5.). In general, the absolute amount of height reduction was proportional to the height of the untreated cotton. Growers must decide how much growth management is necessary for their harvesting system. In 46% of the cases where height response was observed, the untreated crop was 38 inches or less when the defoliation treatment was applied.

Fiber Quality: Assessment of fiber quality was a major objective of this effort. Effects on fiber properties were small and inconsistent; greater detail is provided in the full report (Dodds et al. 2010). The best overall summary of the effects on fiber quality is that no consistent, economic effects on fiber quality were observed.

Table 4. Nodes Above Cracked Boll in the 6 of 14 Experiments Where Significant Differences Were Found

Treatment	OK 2007	VA 2007	East TX 2008	GA 2007	NC 2008	TN 2007
Ozs./Acre	-------------- Nodes above cracked boll at 60% open boll ---------------					
Untreated (0)	3.1a	4.1ab	3.9a	3.3c	1.7bc	5.2a
Mepex® (8/10)	1.8abc	2.2c	3.7a	4.0bc	3.0a	3.7b
Mepex® GO (8/10)	1.4bc	2.3c	2.0d	5.3ab	2.1ab	4.7ab
Pentia™ (8/10)	1.9abc	4.7a	2.4cd	5.0ab	1.5bc	4.0b
Stance™ (1.5/2)	1.2c	3.7b	2.3cd	4.3bc	2.4ab	4.7ab
Stance™ (2/3)	1.9abc	4.7a	3.3bcd	3.0c	1.5bc	3.8b
Stance™ (2/3/3)	1.1c	3.8ab	2.7bcd	5.9a	0.9c	4.1b

Means followed by the same letters within columns (site-years) did not differ ($P > 0.05$).
Green and red highlight significant positive and negative differences from the untreated, respectively.

Table 5. Mean Effects of PGR Treatments in the 13 of 20 Experiments where Differences Were Found

Locations	Untreated	Mean of Treated	Mean Difference	Percent Difference
	End of Season Height --------------- inches ---------------			
GA 2007	53	41	12	22
AR 2007	51	41	10	19
TN 2008	48	39	9	18
AR 2008	42	37	5	12
AL 2008	42	35	7	17
AZ 2007	40	38	2	5
AZ 2008	40	37	4	9
AL 2007	38	28	10	26
TN 2007	37	30	7	19
West TX 2007	30	26	4	13
VA 2007	29	24	5	17
NC 2007	28	24	4	14
West TX 2008	25	22	3	12
U. S. Mean (n=13)	39	32	7	16

Conclusions

All the PGRs and treatment regimes tested were effective for controlling plant height. Consistent benefits in acceleration of maturity, increased yields, or improvement in fiber quality were not found. High fruit retention is important for cotton growth management. In situations where fruit shed or insect-induced fruit losses occur, or if excessive plant canopy is likely to increase boll rot, PGR application may be necessary to manage plant size. Preventative treatment of cotton with PGRs when the crop is successfully managed for high retention can then only be economically justified as a means to facilitate in-season operations or to manage the risk of excess growth. Application of PGRs to stressed cotton, or when there is risk of drought, should be avoided.

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