EVALUATION OF PLANT GROWTH REGULATORS WITH VARYING NITROGEN MANAGEMENT

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Abstract

Various plant growth regulators have been studied and used for many years around the country to reduce or stimulate all aspects of plant development. They have been proposed to interact with higher N rates to produce higher lint yields. A 3-year study was established at the Delta Research and Extension Center, Stoneville, MS to evaluate the interaction of nitrogen (N) management and plant growth regulator (PGR) systems. A factorial arrangement of N management systems (120 and 160 lb N/A applied 100% preplant (PP) or 50% PP plus 50% sidedressed) and PGR systems (mepiquat chloride [Pix] and PGR-IV) were included in a randomized complete block design with five replications. The PGR systems included 1) an untreated control (UTC; 2) Pix applied at a rate of 4 oz/A/ applicationfor a total of 16 oz/A (applied bi-weekly) ; 3) PGR-IV applied at the 3-4 leaf stage (1 oz/A), at pin-head square (2 oz/A), and at first bloom (4 oz/A): and 4) Pix plus PGR-IV at the above rates and timing. There was no significant lint yield response to N rates or to split applications throughout the study nor when averaged across years. Pix applications increased lint yield increases in two of the three years and when averaged across years. There was no lint yield increase associated with the application of PGR-IV when averaged across N management systems. When both Pix and PGR-IV were used in combination, the lint yield increase was lower than with Pix alone.

Introduction

Plant growth regulators have been evaluated for many years, in many regions, and for many crops. They have been proposed for utilization in cotton production for controlling plant growth while increasing N rates above normal levels. Increased N rates in combination with plant growth regulators have been proposed and evaluated for several years (1, 2, 3, 4, 5, 8, 9, 10, 13). Studies across the country during the 1970's and 1980's examined the use of mepiquat chloride (Pix) for decreasing vegetative growth and shortening plants while increasing lint yields. Early work in the Rio Grande Valley (8, 9, 13) found reduced height, shorter internodes, and reduced leaf area where Pix was used. The results also showed no significant effect on yield, earliness, boll size, seed weight, and lint quality. In Mississippi, yields have ranged from a decrease of 4.5% to an increase of 12.7% when Pix was used (12).

Another plant growth regulator, PGR-IV, was introduced to the market place in 1990 and has been included in research studies across the Cotton Belt since the mid-1980's. The product has been promoted to accelerate the plant's reproductive physiology by changing the ratio of internal plant regulants (1, 6, 7). This should enhance the plant's ability to initiate, set, and retain more fruit. Early use of PGR-IV was reported by industry to increase the production of root mass and leaf area. In theory, greater early leaf area should expand the plant's ability to manufacture photosynthates for plant growth and for the production of more fruiting positions (1). Favorable results have been presented by industry representatives and other researchers (1, 6, 7, 11). They have reported consistently increased cotton yields and increased boll retention, increased root mass, early maturity, and yield.

Little information is available to describe the interaction of Pix and PGR-IV with respect to N management. As with many growth regulators, it is difficult to show the consistent response that is reported by the industry. The objective of this research was to determine the interactive effects of Pix and PGR-IV with respect to N management.

Materials and Methods

A 3-year study was initiated in 1993 at the Delta Research and Extension Center, Stoneville, MS on a Bosket very fine sandy loam (Mollic Hapludalfs). The study consisted of a 2x2x4 factorial arrangement of nitrogen (N) rates (120 and 160 lb N/A), N application systems (100% preplant [PP100] and 50% preplant plus 50% of the total N applied as a sidedress between pin-head square and early bloom [PP50-SD50]), and plant growth regulator (PGR) systems. The PGR systems included a) and untreated control,(UTC), b) Pix applied at a rate of 4 oz/A with 4 applications applied bi-weekly (16 oz/A total) beginning at pin-head square; c) PGR-IV applied 1 oz/A at the 3-4 leaf stage plus 2 oz/A applied at pin-head square plus 4 oz/A at first bloom (total of 7 oz/A); and d) both Pix and PGR-IV. The 16 treatments were arranged in a randomized complete block design (RCB) with five replications. Cotton ('DES-119') was planted 17 May 1993, 22 April 1994, and 5 May 1995 with emergence in 5 to 7 days. The 1993 planting date was actually a replant based on very poor emergence following heavy rainfall. Nitrogen was applied as urea-ammonium nitrate solution (UAN, 32% N) between 10 April and 27 April. Sidedress N was applied at early- to mid-bloom. All N was 'knifed' 10 inches to both sides of the drill with a 'John Blue' liquid applicator. The growth regulators were applied as band applications when the plants were small and with a 3-nozzle per row boom as the plants got larger. Pix and PGR-IV were applied separately in plots receiving both materials. All cultural practices including weed

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control, insecticide applications, cultivation, and defoliation were held constant across all treatments. The crop was grown without supplemental irrigation. After defoliation in mid- to late-September, the two center rows of each 4-row plot were harvested with a mechanical spindle picker adapted for plot harvest. The plots were harvested once in late September followed by a second harvest in late October.

Lint yields were calculated for individual plots using lint percents which were determined by ginning 1-2 lb grab samples taken at the time of harvest. Samples were ginned through a 10-saw laboratory gin without seedcotton or lint cleaning. All yield data and components including seed-cotton and lint yield from each harvest and the lint percent, were analyzed statistically using the Statistical Analysis System (SAS) with Fisher's protected LSD's for mean separations. Main effects were evaluated where appropriate (averaged across other main effects). A combined analysis over years was also completed following the last year of the study in order to determine the overall effect from the applied treatments.

Results and Discussion

There was no significant interaction between N management and growth regulator systems so the discussion will center on main effects. The main effects for 1993, 1994, and 1995 are summarized in Tables 1 through 3, respectively. In 1993, there was no difference between the 120 and 160 lb N/A rates nor between the two application systems when averaged across PGR systems (Table 1). The recommended N level for this area is 100-120 lb N/A and one should not normally expect a yield increase with an additional 40 lb N/A. There were significant differences between the PGR systems when averaged across N management for second harvest lint yield and total lint yield. There was a 58 lb lint/A response (8.7% increase)with Pix compared to the untreated control (UTC). There was no response to PGR-IV (1.8% decrease) compared to the UTC. When both products were used together, the total lint yield was intermediate to the UTC and the Pix-only system (Table 1).

Like 1993, there was no response to N management in 1994 even though average lint yields were 40% higher than 1993 (681 vs 958 lb lint/A) (Table 2). Drought conditions in 1994 were not as severe as those experienced in 1993. The was no significant difference between N rates nor between N application systems when averaged across PGR systems. When averaged across N management systems, there was a significant lint response to PGR system for both first harvest and total lint. Total lint yields were increased by 6.3% (59 lb lint/A) when Pix was used compared to the UTC. However, there was no significant difference between the UTC and the PGR-IV system alone. When both Pix and PGR-IV were used in combination, there was a 4.8% increase in lint compared to the UTC.

In 1995, there was no significant response to N rates or N application systems (Table 3). Average lint yields were 23% lower than the previous year which reflects the adverse effects of excess heat and deficit moisture in July, August, and September. There was a similar trend with respect to PGR systems to results obtained in previous years. However, there was no significant difference between the PGR systems at either first or second harvest. Pix treatment means were 4.7% higher than the UTC means.

A summary of the combined analysis across years has been inclued in Table 4 (interaction effects) and Table 5 (main effects). The range in first harvest lint yields for the 16 treatments was 695 to 765 lb/A while second harvest yields ranged from 60 to 69 lb lint/A. Total lint yields ranged from 755 to 830 lb/A. There was no significant N management system by PGR system interaction so main effects were also summarized and included in Table 6. There was no lint yield increase when the N rate was increased from 120 lb/A to 160 lb /A. There was also no yield response to split applications of N which is related to the lower yields associated with the drought stress in 1993 and 1995. When averaged across years and N management systems, there were significant difference between the PGR systems (Table 5). Average first harvest lint yields were increased by 6.3% (45 lb lint/A) with Pix, 3.5% (25 lb lint/A) with Pix plus PGR-IV, and not affected by PGR-IV alone as compared to the UTC. Second harvest lint yields were also increased slightly with Pix with no response to PGR-IV. Total lint yields were increased by 6.6% (51 lb lint/A) with Pix, 3.9% (30 lb lint/A) with Pix plus PGR-IV, and not affected by PGR-IV alone.

These data have not supported industry reports of significant yield response to applications of PGR-IV. However, the treatments used were not the same as reported in earlier literature (1, 6, 7) but were the treatments designated by the protocol for PGR-IV. Under higher yielding environments (adequate rainfall or irrigation) there may be possible response to PGR-IV with replicated field trials. In this study yield response was measured when Pix (16 oz/A) was used. However, an economic evaluation of the results should be included to determine whether the costs of material plus application will be less than the return from additional lint produced. Especially, since significant responses were measured in only two of the three years of this study.

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Table 1. Main effect of plant growth regulators with different nitrogen management. 1993. MAFES - DREC

Main Effect	First Harvest	Second Harvest	Total Harvest
	- - - - - - - - - - (lb lint/A) - - - - - - - - - -		
N Management (PP/SD), lb/A [1]			
120/0	602	91	694
60/60	601	83	685
160/0	591	89	680
80/80	575	90	664
LSD(0.05)	---ns	---ns	---ns
Plant Regulator Systems (Pix/PGR-IV), oz/A [2]			
0/0	582	82b	663b
16/0	627	95a	721a
0/7	568	83b	651b
16/7	593	94a	687ab
LSD(0.05)	---ns	7**	49*
N Rate, lb/A [3]			
120	602	87	689
160	583	89	672
LSD(0.05)	---ns	---ns	---ns
N Application System [4]			
PP100	597	90	687
PP50-SD50	588	87	674
LSD(0.05)	---ns	---ns	---ns

LSD's are also provided for mean comparisons at the 5% level (** = <0.01, * = 0.01 - 0.05, ns = not significant).
[1] Means 5 reps across 4 PGR systems (N=20).
[2] Means 5 reps across 4 N management (N=20).
[3] Means 5 reps across 4 PGR systems and 2 N application system (N=40).
[4] Means 5 reps across 4 PGR systems and 2 N rates (N=40).

Table 2. Main effect of plant growth regulators with different nitrogen management. 1994. MAFES - DREC

Main Effect	First Harvest	Second Harvest	Total Harvest
	- - - - - - - - - - (lb lint/A) - - - - - - - - - -		
N Management (PP/SD), lb/A [1]			
120/0	904	49	953
60/60	927	50	978
160/0	896	53	949
80/80	899	53	952
LSD(0.05)	---ns	---ns	---ns
Plant Regulator Systems (Pix/PGR-IV), oz/A [2]			
0/0	884bc	50	934b
16/0	942a	51	993a
0/7	874c	52	926b
16/7	927ab	53	979a
LSD(0.05)	44**	---ns	45**
N Rate, lb/A [3]			
120	916	50	965
160	898	53	951
LSD(0.05)	---ns	---ns	---ns
N Application System [4]			
PP100	900	51	951
PP50-SD50	913	52	965
LSD(0.05)	---ns	---ns	---ns

LSD's are also provided for mean comparisons at the 5% level (** = <0.01, * = 0.01 - 0.05, ns = not significant).
[1] Means 5 reps across 4 PGR systems (N=20).
[2] Means 5 reps across 4 N management (N=20).
[3] Means 5 reps across 4 PGR systems and 2 N application system (N=40).
[4] Means 5 reps across 4 PGR systems and 2 N rates (N=40).

Table 3. Main effect of plant growth regulators with different nitrogen management. 1995. MAFES - DREC

Main Effect	First Harvest	Second Harvest	Total Harvest
	- - - - - - - - - - (lb lint/A) - - - - - - - - - -		
N Management (PP/SD), lb/A [1]			
120/0	684	55	740
60/60	688	54	741
160/0	678	54	733
80/80	686	54	740
LSD(0.05)	---ns	---ns	---ns
Plant Regulator Systems (Pix/PGR-IV), oz/A [2]			
0/0	671	55	726
16/0	703	57	760
0/7	673	51	724
16/7	690	54	745
LSD(0.05)	---ns	---ns	---ns
N Rate, lb/A [3]			
120	686	54	741
160	682	54	736
LSD(0.05)	---ns	---ns	---ns
N Application System [4]			
PP100	681	55	736
PP50-SD50	687	54	741
LSD(0.05)	---ns	---ns	---ns

LSD's are also provided for mean comparisons at the 5% level (** = <0.01, * = 0.01 - 0.05, ns = not significant).
[1] Means 5 reps across 4 PGR systems (N=20).
[2] Means 5 reps across 4 N management (N=20).
[3] Means 5 reps across 4 PGR systems and 2 N application system (N=40).
[4] Means 5 reps across 4 PGR systems and 2 N rates (N=40).

Table 4. Lint yield from plant growth regulators with different nitrogen management. 1993-1995. MAFES - DREC

PGR System	Nitrogen Management (PP/SD), lb N/A			
	120/0	60/60	160/0	80/80
	- - - - - - - - - - (lb lint/A) - - - - - - - - - -			
First Harvest				
0/0	709c	730abc	715bc	695c
16/0	755a	765a	762a	747ab
0/7	699c	714bc	700c	707c
16/7	758a	747ab	710bc	732abc
LSD(0.05)		37 **		
Second Harvest				
0/0	62	62	64	60
16/0	66	63	69	72
0/7	64	60	62	63
16/7	69	64	67	68
LSD(0.05)		--- ns		
Total Harvest				
0/0	771de	792b-e	779cde	755e
16/0	822ab	828ab	830a	818ab
0/7	762de	774cde	762de	769de
16/7	827ab	811abc	769cde	799a-e
LSD(0.05)		39 **		

LSD's are also provided for mean comparisons at the 5% level (** = <0.01, * = 0.01 - 0.05, ns = not significant).

Table 5. Main effect of plant growth regulators with different nitrogen management. 1993 - 1995. MAFES - DREC

Main Effect	First Harvest	Second Harvest	Total Harvest
	- - - - - - - - - - (lb lint/A) - - - - - - - - - -		
N Management (PP/SD), lb/A [1]			
120/0	730	65	796
60/60	739	62	802
160/0	722	66	787
80/80	720	66	786
LSD(0.05)	---ns	---ns	---ns
Plant Regulator Systems (Pix/PGR-IV), oz/A [2]			
0/0	712c	62b	774c
16/0	757a	68a	825a
0/7	705c	62b	767c
16/7	737b	67a	804b
LSD(0.05)	19**	4*	19**
N Rate, lb/A [3]			
120	735a	64	798
160	721b	66	786
LSD(0.05)	13*	---ns	---ns
N Application System [4]			
PP100	726	65	791
PP50-SD50	729	64	793
LSD(0.05)	---ns	---ns	---ns

LSD's are also provided for mean comparisons at the 5% level (** = <0.01, * = 0.01 - 0.05, ns = not significant).
[1] Means 5 reps across 4 PGR systems and 3 years (N=60).
[2] Means 5 reps across 4 N management and 3 years (N=60).
[3] Means 5 reps across 4 PGR systems,2 N application system, and 3 years (N=120).
[4] Means 5 reps across 4 PGR systems 2 N rates and 3 years (N=120).