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AGRONOMY AND SOILS

Determining Optimum Plant Growth Regulator Application Rates in Response to Fruiting Structure and Flower Bud Removal

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ABSTRACT

Cotton (*Gossypium hirsutum* [L.]) yield is dependent on retention of first position bolls on lower sympodial branches; however, fruiting forms can abscise due to a multitude of physiological stresses or insect feeding. Fruit loss results in taller plants as energy devoted to fruit production is redirected to vegetative growth. Plant growth regulator (PGR) use has become common in cotton production systems in the U.S. PGR applications have been shown to reduce plant height; however, yield responses due to PGR application are variable. Due to insect pressure associated with the mid-southern growing region, a better understanding of PGR management is needed in the presence of fruit loss during the floral period of cotton. Field research was conducted in 2012 and 2013 at four locations in Mississippi. Flower bud and fruiting structures were hand removed at first bloom at the following rates: 0, 50 and 100%. Mepiquat pentaborate was applied immediately after flower bud or fruiting structure removal at the following application rates: 0.06, 0.11, 0.17, and 0.23 kg ai ha^{-1}. An untreated check was included for comparison purposes. As the level of flower bud and fruiting structure removal increased, plant height, number of mainstem nodes, and nodes above the cracked boll also increased. Lint yield was similar when comparing the untreated and the 50% removal rate; with both yielding significantly greater than the 100% removal rate. Generally, as PGR application rate increased, plant height, number of mainstem nodes, and nodes above cracked boll decreased.

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Cotton (*Gossypium hirsutum* [L.]) yield is heavily dependent on retention of first position bolls on lower sympodial branches (Jenkins et al., 1990; Mauney, 1984). Regardless of practice used to protect fruiting forms on these positions, they can abscise due to a multitude of physiological stresses or insect feeding (Guinn, 1982). Stress induced losses can be attributed to reduced carbohydrate supply (Guinn, 1974). However, some fruit loss early in the season is acceptable as long as it does not exceed the economic injury level (Parker et al., 1991; Ring and Benedict, 1993). The current economic injury level for cotton in Mississippi is 20% square loss at first bloom (Catchot, 2013). However, cotton with fruit retention of 70 to 85% will often produce higher yields than cotton with a greater fruit retention (Catchot, 2013). Cotton has an indeterminate growth habit and thus can compensate for fruit lost early in the year; however, the level of compensation depends on agronomic practices and environmental conditions (Carroll et al., 2012; Cook and Kennedy, 2000; Dale, 1959; Kletter and Wallack, 1982; Mann et al., 1997; Ungar et al., 1989).

Four separate cotton plant responses to loss of flower buds were described by Hearn and Room (1979), Kletter and Wallach (1982), and Brook et al. (1992) and further modified by Sadras (1995). The first response is passive and instantaneous. Damaged reproductive structures are shed but no change in fruiting pattern is found due to the potential for this fruit to have been shed physiologically. The second response is passive and time dependent. The plant responds by retaining fruiting structures that would have been shed physiologically to replace damaged structures. The third response is active and instantaneous. Nutrients that would have been partitioned to damaged structures are partitioned into undamaged structures, thus increasing boll weight in the undamaged structures. The fourth response is active and time dependent. Resources that would have partitioned to damaged sites are partitioned into the production of additional fruiting sites, thus delaying crop maturity.

Fruit loss can result in increased plant height as carbohydrates and nutrients are directed to vegetative growth due to loss of growing fruiting structures.

Excessive plant height can be problematic for pest management, defoliation, and harvest. In addition, it is difficult to manage height of cotton with reduced fruit retention (Hake et al., 1990). PGR use has become common in cotton production systems in the U.S. as a method of managing excessive vegetative growth, with the most commonly used plant growth regulator being mepiquat chloride. However, other mepiquat products such as mepiquat pentaborate also are commonly utilized. Mepiquat pentaborate contains the same molar concentration of mepiquat as mepiquat chloride (Gwathmey and Craig, 2003; Jost et al., 2006). Applications of mepiquat products reduce internode elongation and plant height by reducing gibberellic acid in plant tissues (Nuti et al.; 2006; Reddy et al., 1990; Zhao and Oosterhuis, 2000). Reduced gibberellic acid causes stiffened cell walls and reduced elongation and division of cells (Behringer et al., 1990; Biles and Cothren, 2001; Yang et al., 1996). Gwathmey and Craig (2003) observed similar suppression of vegetative growth between mepiquat chloride and mepiquat pentaborate. However, mepiquat pentaborate has been shown to be absorbed by cotton faster than mepiquat chloride (Stapleton and Via, 2003).

Yield response due to application of mepiquat chloride and mepiquat pentaborate has been variable. Some studies have noted yield increases following mepiquat application (Asher et al. 2005; Cathey and Meredith Jr., 1988; Cook and Kennedy, 2000; Johnson and Pettigrew 2006; Kerby, 1985; Kerby et al., 1998; York, 1983a). Increased yields can result from redistribution of photoassimilates between vegetative and reproductive growth (Nuti et al., 2006). Yield reductions due to mepiquat chloride and mepiquat pentaborate applications also have been observed (Cathey and Meredith Jr., 1988; O'Berry et al., 2009; York, 1983a,b; Zhao and Oosterhuis, 2000). Decreased yields can be the result of restricted development of nodes and fruiting sites (Kerby, 1985). Additionally, some have found that PGR applications had no effect on lint yield (Dodds et al., 2010; Gwathmey and Craig, 2003).

Cook and Kennedy (2000) observed that PGR applications had a positive effect on yield following early bud loss at, or greater than, that of the economic injury level. Where 20% of the flower buds were removed 10 to 14 d after buds were easily visible followed by four weekly applications of mepiquat chloride at 12 g ha^{-1}, cotton yielded significantly greater than instances where 20% of flower buds were removed but no PGR was applied or where two applications of mepiquat chloride were made two weeks apart at 25 g ha^{-1}. Cotton with 40% flower bud loss 10 to 14 d after buds were easily visible that received two applications of mepiquat chloride two weeks apart at 25 g ha^{-1} yielded greater than cotton with similar flower bud removal rates that received no PGR application or cotton that received four weekly applications of mepiquat chloride at 12 g ha^{-1}. Generally, in the presence of fruit loss, mepiquat application can have a positive effect on yield.

Enhanced earliness has been a claimed benefit from mepiquat chloride application; however, as with yield response to PGR application, contradictory data exists with respect to PGR effect on maturity. Several studies concluded there is no benefit with respect to enhanced earliness following mepiquat chloride application (Crawford, 1981; Stewart et al., 2000; Yeates et al., 2002). However, Kerby et al. (1982) observed increased earliness under conditions favorable for excessive growth or in short-season production systems. In addition, Johnson and Pettigrew (2006) and O'Berry et al. (2008, 2009) observed increased earliness following mepiquat pentaborate application. Wilde et al. (1988) and Kerby et al. (1986) both observed enhanced earliness of the crop due to greater retention of early flower buds and bolls following application of mepiquat chloride. Due to the level of variability of cotton response to mepiquat chloride and mepiquat pentaborate application as well as the lack of data regarding PGR use rates in the presence of flower bud loss and fruit loss exceeding the economic injury level, a more defined strategy is needed for proper PGR application where fruit loss has occurred.

MATERIALS AND METHODS

Studies were conducted in 2012 and 2013 at the R. R. Foil Plant Science Research Center near Starkville, MS and at the Black Belt Branch Experiment Station near Brooksville, MS. Cotton was planted on conventionally tilled beds on 18 May 2012 and 15 May 2013 at Starkville and 19 May 2013 and 20 May 2013 at Brooksville. Plots consisted of four 97-cm rows that were 12.2 m in length. At harvest, plots were trimmed to a length of 6.1 m. In 2012, experiments at both locations were conducted under dryland conditions. The Starkville location received abundant rainfall throughout the growing season; therefore, supplemental irrigation was not needed. In 2013, the Starkville location was irrigated and the Brooksville location was dryland. Treatments were arranged in a two-factor factorial arrangement in a randomized complete block design.

Factor A consisted of level of flower bud and fruiting structure removal at rates of 0, 50, and 100%. Flower bud and fruiting structure removal was conducted by hand on the center two rows of each four row plot at first bloom. The 100% removal pattern was achieved by hand removing every fruiting structure and flower bud on the plant at first bloom (Fig. 1). The 50% removal pattern was achieved by hand removing flower buds and fruiting structures in an alternating pattern at first bloom (Fig. 1). An untreated check, from which no flower buds or fruiting structures were hand removed, was included for comparison purposes (Fig. 1). Factor B consisted of PGR application rate. Mepiquat pentaborate (Pentia, BASF Ag Products, Research Triangle Park, NC) was utilized in this experiment at the following application rates (kg ai ha^{-1}): untreated, 0.06, 0.11, 0.17, and 0.23. All PGR applications were made immediately after flower bud and fruiting structure removal. Applications were made with a CO_2-powered backpack sprayer using XR 110015 tips (Teejet Technologies, Glendale Heights, IL). Application pressure was 290 kPa and application speed was 4.8 kph. The variety used at both locations in both years was DP 1034 B2RF (Monsanto Company, St. Louis, MO) that was seeded at 13.1 seeds per meter of row. Cotton seed treatment consisted of Acceleron N (thiamethoxam + pyraclostrobin + ipconazole + abamectin) (Monsanto Company, St. Louis, MO).

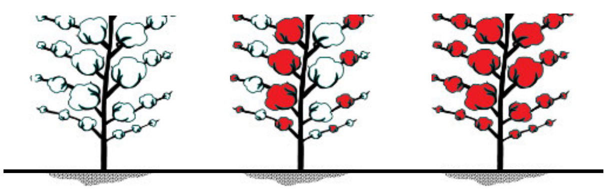

Figure 1. Fruiting structure and flower bud removal patterns at first bloom in 2012 and 2013. Bolls red in color indicate a structure that was removed.

Nitrogen (32% UAN) was injected into the soil in a split application at all locations in both years, with the first application consisting of 56 kg N ha^{-1} at planting and the second application consisting of 78 kg N ha^{-1} at the fourth week of squaring. Applications were made using a ground driven knife applicator. Fertilizer in the form of P_2O_5 and K_2O were applied at each location based on soil test recommendations. Plots were scouted weekly using appropriate methodology for weed and insect pests with all pesticide and harvest aid applications applied based on Mississippi State University Extension service recommendations (Anonymous, 2015; Catchot, 2013).

Data collection included: stand counts 30 d after planting, plant height, total nodes, and nodes above white flower prior to fruit removal. In addition, plant height, total nodes, and nodes above cracked boll data were collected prior to harvest aid application. Nodes above cracked boll were determined by selecting the uppermost first position cracked boll, then counting the number of mainstem nodes between the uppermost first-position cracked boll and the uppermost harvestable boll. With the exception of stand count data, all data were collected from five plants $plot^{-1}$. Harvest aid applications were initiated when plots that had 100% of flower bud and fruiting structures removed at first bloom had 60% open bolls. Yield data were collected from the center two rows of each plot using a cotton picker equipped with load cells that recorded yield data for each row. Plots were harvested at Starkville on 28 October 2012 and 18 October 2013, and at Brooksville on 31 October 2012 and 07 November 2013. Gin turnout and fiber quality was determined from 25 boll samples that were hand harvested from each plot. Each sample was ginned using a 10-saw Continental Eagle (Continental Eagle Corp., Prattville, AL) laboratory gin. Gin turnout was determined by dividing the mass of lint after ginning by the mass of seed cotton prior to ginning and multiplying by 100. Ten grams of lint were sent to the Louisiana State University Fiber Quality Laboratory where fiber quality was determined using high volume instrumentation (HVI). All data were subjected to analysis of variance using the PROC GLIMMIX procedure of the Statistical Analysis System (SAS version 9.3; SAS Institute Inc.; Cary, NC). No significant effects due to environment, year, or environment*year were observed; therefore, data were pooled over year and environment. Means were separated using Fisher's protected LSD ($\alpha \leq 0.05$). Degrees of freedom were calculated using the Kenward-Roger method.

RESULTS AND DISCUSSION

Prior to flower bud and fruiting structure removal there were no significant differences in cotton height, total nodes, and nodes above white flower (data not shown). Cotton height averaged 74 cm and 13 nodes prior to fruit removal. In addition, cotton averaged seven nodes above white flower at the time of flower bud and fruiting structure removal.

Fruiting structure and flower bud removal rate and PGR application rate individually had a significant effect on cotton height at the end of the season (Table 1). As fruiting structure and flower bud removal rate increased, final cotton height significantly increased (Table 2). Cotton was significantly taller at the end of the season compared to all other treatments when 100% of fruiting structures and flower buds were hand removed at first bloom. Additionally, cotton with 50% of all fruiting structures and flower buds removed at first bloom was significantly taller at the end of the season compared to cotton from which no fruiting structures or flower buds were hand removed (Table 2). Cotton height at the end of the season following 0, 50, and 100% fruiting structure and flower bud removal rate was 112, 117, and 127 cm, respectively. Results are similar to those of Cook and Kennedy (2000), who observed up to a 12% increase in cotton height when averaging across all mepiquat chloride treatments when 40% of flower buds were removed 10 to 14 d after the first square emerged. Similarly, Pettigrew et al. (1992) observed increased plant height to be the most apparent visual response to fruit removal.

PGR application rate significantly affected plant height at the end of the season (Table 1). Cotton that received no PGR was significantly taller than cotton that received a PGR application at any rate (Table 3). No significant differences in cotton height were present following PGR application at 0.17 and 0.23 kg ai ha^{-1}; however, cotton that received PGR applications at 0.17 and 0.23 kg ai ha^{-1} was significantly shorter compared to cotton height following PGR application at all other rates. Mepiquat pentaborate applications of 0.06 and 0.11 kg ai ha^{-1} resulted in cotton that was significantly shorter than cotton that recieved no PGR application (Table 3). Plant height at the end of the season following PGR application rates of 0, 0.06, 0.11, 0.17, and 0.23 kg ai ha^{-1} was 136, 119, 117, 112, and 109-cm tall, respectively. These results are similar to those of Johnson and Pettigrew (2006) who also observed a significant decrease in final plant height following mepiquat pentaborate application compared to the untreated check. Application of mepiquat pentaborate at 0.12 and 0.23 kg ai ha^{-1} resulted in a significant cotton height reduction compared to the untreated check. These data are in agreement with Dodds et al. (2010) in that regardless of PGR application rate, significant cotton height reductions were observed following PGR application.

Table 1. Analysis of variance and associated *p* values for fruiting structure and flower bud removal rate and mepiquat pentaborate application rate on cotton growth, development, lint yield, and fiber quality in 2012 and 2013^{z}

Effect	D.F.^{y}	EOS^{x} Height	EOS Nodes	NACB^{w}	Lint Yield	Fiber Length	Fiber Strength	Fiber Uniformity	Micronaire
		P Values							
Removal Rate	2	<0.0001	<0.0001	<0.0001	0.04	0.0002	<0.0001	0.0001	0.016
PGR^{v} Rate	4	<0.0001	<0.0001	0.0008	0.18	<0.0001	<0.0001	<0.0001	0.74
Removal Rate *PGR Rate	8	0.61	0.45	0.78	0.37	0.64	0.41	0.7688	0.75

^{z} Data were pooled over environment and year as none of these effects were significant.

^{y} Degrees of freedom.

^{x} End of season.

^{w} Nodes above cracked boll.

Table 2. Effect of fruiting structure and flower bud removal rate on cotton growth and development at the end of the season^{z,y}

Fruit Removed at 1st bloom	Final Height	Final Nodes	NACB^{x}	Lint Yield
%	cm	#	#	Kg lint ha^{-1}
0	112 c	19 c	5 c	2001 a
50	117 b	20 b	6 b	1998 a
100	127 a	21 a	7 a	1872 b

^{z} Means within a column followed by the same letter are not significantly difference at ($\alpha \leq 0.05$).

^{y} Data were pooled over environment, year, and mepiquat pentaborate application rate as these effects were not significant.

^{x} Nodes above cracked boll.

Table 3. Effect of plant growth regulator application rate on cotton growth and development at the end of the season[z,y]

PGR Application Rate	Mean Final Plant Height	Final Nodes	NACB[x]
------------ kg ai ha^{-1} ------------	---------------- cm ----------------	----------------- # -----------------	----------------- # -----------------
0	136 a	21 a	7 a
0.06	119 b	20 b	6 b
0.11	117 b	20 b	6 b
0.17	112 c	20 b	6 b
0.23	109 c	19 c	5 c

[z] Means within a column followed by the same letter are not significantly different at ($\alpha \leq 0.05$).

[y] Data were pooled over environment, year, and mepiquat pentaborate application rate as these effects were not significant.

[x] Nodes above cracked boll.

No significant interaction was present between level of flower bud and fruiting structure removal and PGR application rate with respect to total nodes at the end of the season (Table 1). However, both percentage of flower bud and fruiting structure removal and PGR application rate had a significant effect on total nodes at the end of the season. As percentage of flower bud and fruiting structure removal increased, total nodes significantly increased (Table 2). Cotton that had 100% of the flower buds and fruiting structures hand removed at first bloom had significantly more nodes (21) at the end of the season than all other treatments. Cotton with 50% of the fruiting structures and flower buds hand removed at first bloom had significantly more nodes (20) compared to the untreated control (19) (Table 2). However, cotton that had 50% of fruiting structures and flower buds hand removed at first bloom had significantly fewer nodes compared to cotton that had 100% of the fruiting structures and flower buds hand removed at first bloom (Table 2).

Cotton that received no PGR application had significantly more nodes at the end of the season compared to cotton to which a PGR was applied. Generally, as PGR application rate increased, the number of cotton nodes decreased at the end of the season. Mepiquat pentaborate application rates between 0.06 and 0.23 kg ai ha^{-1} significantly reduced total nodes at the end of the season (Table 3). Mepiquat pentaborate applied at 0.23 kg ai ha^{-1} resulted in significantly fewer nodes (19) compared to total nodes following PGR application rates ranging from 0.06 to 0.17 kg ai ha^{-1} (Table 3). Cotton receiving mepiquat pentaborate application rates from 0.06 to 0.17 kg ai ha^{-1} had approximately 20 nodes at the end of the season.

Individually, level of fruiting structure and flower bud removal and PGR application rate had a significant impact on nodes above cracked boll at the end of the growing season. However, there was no significant interaction between percentage of fruiting structure and flower bud removal and PGR application rate (Table 1). As the percentage of fruiting structure and flower bud removal increased, the number of nodes above cracked boll also increased indicating delayed maturity (Table 2). Fruiting structure and flower bud removal rates of 0, 50, and 100% resulted in 5, 6, and 7 nodes above cracked boll at the end of the season, respectively. These data are in agreement with Jones et al. (1996) who observed a significant delay in maturity when flower buds were removed early in the growing season.

Generally, as PGR application rate increased, the number of nodes above cracked boll decreased (Table 3). Mean nodes above cracked boll ranged from five to seven with the highest coming from the untreated control (Table 3). PGR application rates ranging from 0.06 to 0.17 kg ai ha^{-1} did not result in significant differences in nodes above cracked boll at the end of the season. However, nodes above cracked boll counts following these application rates were significantly lower than those of the untreated check, suggesting that maturity can be enhanced following PGR applications. Nodes above cracked boll counts following PGR applications at 0, 0.06, 0.11, 0.17, and 0.23 kg ai ha^{-1} were 7, 6, 6, 6, and 5 respectively. These data agree with Kerby et al. (1982, 1986) and Wilde et al. (1988) who found that maturity can be earlier following PGR application.

Yield was not significantly affected by PGR application (Table 1). These results contradict the findings of Cook and Kennedy (2000) who reported increased yields when PGR applications were made in the presence of fruiting structure removal. Percentage of fruiting structure and flower bud removal had a significant impact on lint yield (Table 1). No significant differences in lint yield were observed when comparing cotton that had 50% of the fruiting structures and flower buds removed at first bloom and cotton that had no fruit removed at first bloom (Table

2). Removal of 50% of fruiting structures and flower buds at first bloom resulted in lint yield of 1998 kg of lint ha^{-1}, whereas cotton that had no fruiting structures or flower buds removed at first bloom produced 2001 kg of lint ha^{-1} (Table 2). Cotton with 100% of the fruiting structures or flower buds removed at first bloom produced significantly less lint yield when compared to all other treatments. Ungar et al. (1989) suggested that a sufficiently long growing season is critical for compensation for fruiting and flower structure loss in cotton. Based on this suggestion, the length of the growing season during the two years of this experiment was sufficient to allow compensation for up to 50% fruit removal. These data suggest that cotton can compensate for fruit loss greater than the current economic injury level however, maturity also was delayed. This can be important following late planting, or years where inclement weather necessitates early harvest. If flower bud and fruiting structure removal had occurred later in the growing season, fruiting structure compensation and thus yield, would likely be reduced (Jones et al., 1996; Ungar et al., 1989).

Fiber quality parameters including length, strength, uniformity, and micronaire were significantly affected by level of fruiting structure removal at first bloom (Table 1). In addition, PGR application had a significant effect on fiber length, strength, and uniformity (Table 1). Cotton fibers were significantly longer when 100% of the fruiting structures and flower buds were removed at first bloom, (3.01 cm) compared to fiber produced from cotton where 50% of fruiting structures and flower buds (2.98 cm) were removed at first bloom and where no fruit removal occurred (Table 4). Bernhardt and Phillips (1986) and Knight et al. (1988) found that fiber length was reduced from fruit on lower fruiting nodes, then increased in cotton produced in the mid-portion of the plant, and decreased in bolls produced in the upper portion of the plant. These data suggest that when 100% of the fruiting structures and flower buds were removed at first bloom, fruiting positions producing the shortest fiber were also removed. Moreover, when 50% of the fruiting structures and flower buds were removed at first bloom there were fewer of these positions left in the bottom portion of the plant to produce the shortest fiber. Although statistically significant differences were present, based on the Commodity Credit Corporation (CCC) Loan Chart (National Cotton Council of America, 2014), differences in fiber length due to level of fruiting structure and flower bud removal at first bloom would not have an economic impact on price received for upland cotton. Cotton fiber length was highest ($\geq$ 3.01 cm) following PGR application rates of 0.17 kg ai ha^{-1} and greater. Generally, as PGR application rate increased, fiber length also increased (Table 5). Increased fiber length following PGR application was also observed by Johnson and Pettigrew (2006).

Cotton fiber strength significantly increased as level of fruiting structure and flower bud removal at first bloom increased (Table 5). The strongest fiber was found in cotton where 100% of the fruiting structures and flower buds were hand removed at first bloom at 32.3 g tex^{-1} (Table 4). These findings are in agreement with Bernhardt and Phillips (1986) and Knight et al. (1988) who observed that the weakest fiber was produced from fruiting positions in the lower portion of the canopy, the strongest fiber came from the middle portion of the plant canopy, and fiber strength declined from cotton produced in the upper portion of the canopy. However, similar economic impacts due to fiber strength were observed for all treatments and all would have received a premium based on the CCC loan chart. Cotton fiber strength was highest (32.0 g tex^{-1}) following PGR application rates of 0.11 kg ai ha^{-1} and greater. PGR application at 0.06 kg ai ha^{-1} resulted in fiber strength similar to fiber strength from cotton that received no PGR application (31.3 vs 31.5 g tex^{-1}) (Table 5). Johnson and Pettigrew (2006) observed similar findings in that PGR application increased fiber strength. Similar to the effects observed with fruiting structure and flower bud removal, no economic differences were observed with respect to fiber strength due to mepiquat pentaborate application (data not shown).

Table 4. Effect of fruiting structure and flower bud removal rate on cotton fiber characteristics[z,y]

Fruit Removed at 1st bloom	Fiber Length	Fiber Strength	Fiber Uniformity	Micronaire
------------ % ------------	------------ cm ------------	---------- g tex^{-1} ----------	------------ % ------------	
0	2.98 b	31.4 c	83.9 b	4.6 a
50	2.98 b	31.8 b	84.1 a	4.6 a
100	3.01 a	32.3 a	84.3 a	4.5 b

[z] Means within a column followed by the same letter are not significantly difference at ($\alpha \leq 0.05$).

[y] Data were pooled over environment, year, and mepiquat pentaborate application rate as these effects were not significant.

Table 5. Effect of plant growth regulator application rate on cotton fiber characteristics[z,y]

PGR Application Rate	Fiber Length	Fiber Strength	Fiber Uniformity	Micronaire
-------- kg ai ha^{-1} --------	------------ cm ------------	---------- g tx^{-1} ----------	------------ % ------------	
0	2.95 d	31.3 b	83.8 c	4.6 a
0.06	2.98 c	31.5 b	84.0 bc	4.6 a
0.11	2.99 bc	32.0 a	84.2 ab	4.6 a
0.17	3.01 ab	32.1 a	84.3 a	4.6 a
0.23	3.01 a	32.3 a	84.4 a	4.6 a

[z] Means within a column followed by the same letter are not significantly different at ($\alpha \leq 0.05$).

[y] Data were pooled over over environment, year, and flower bud and fruiting structure removal rate as these effects were not significant.

Cotton fiber uniformity was highest where at least 50% of the flower bud and fruiting structures were hand removed at first bloom (84.1%) (Table 4). Fiber uniformity (83.9%) was significantly reduced where no fruiting structures or flower buds were removed at first bloom compared to where 50 and 100% of the fruiting structures and flower buds were removed at first bloom (Table 4). Where 50 and 100% of the flower buds and fruiting structures were removed at first bloom, a five-point higher premium would have been received based on the CCC loan chart. Plant growth regulator application rates greater than or equal to 0.11 kg ai ha^{-1} resulted in significantly greater fiber uniformity (≥ 84.2%) compared to cotton to which no PGR was applied. Additionally, there were no significant differences associated with fiber uniformity following PGR application rates ranging from 0.11 to 0.23 kg ai ha^{-1}; however, application rates of 0.17 and 0.23 kg ai ha^{-1} would have resulted in a higher premium received due to fiber uniformity.

Micronaire was significantly lower when all flower bud and fruiting structures were hand removed at first bloom (4.5) when compared to the 50% removal rate (4.6) and the untreated control (4.6) (Table 4). However, there was no economic impact associated with those differences. Bernhardt and Phillips (1986) and Knight et al. (1988) observed that fruiting positions close to the mainstem on the lower branches of the plant produce fiber with the highest micronaire, and micronaire decreases on upper and more distal fruiting positions. This suggests that if maturity is delayed, microniare could begin to decrease due to immaturity. PGR application rate did not have a significant impact on micronaire. Micronaire averaged 4.6 following PGR application at all rates (Table 5).

CONCLUSION

The level of fruiting structure and flower bud removal had a significant effect on cotton growth and yield. Although PGR application significantly impacted cotton growth, no significant impacts on yield were observed. Regardless of the level of flower bud or fruiting structure removal, increasing PGR application rate had a similar effect on cotton height, nodes, and nodes above cracked boll at the end of the season. Generally, as PGR application rates increased, cotton height and number of mainstem nodes decreased. Maturity was enhanced following PGR application. Based on these data and previous research, cotton has the potential to compensate for flower bud and fruiting structure loss greater than that of the current economic injury level employed by several states in the U.S. cotton belt. These data suggest that even in the presence of high levels of early-season fruit loss, cotton can compensate and still produce sufficient yields; however, maturity can be delayed. Delayed maturity could be important in years when the crop is planted late, when cotton is grown in short-season environments such as northeast Arkansas or southeast Missouri, or where inclement weather necessitates an early harvest. These results could differ in the event of a high level of fruit loss later in the reproductive stages of cotton.

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