EFFECTS OF GIBREL X-47 ON FLOWERING, FRUITING AND YIELD OF COTTON (*Gossypium hirsutum* L.)

by

Husen Djajasukanta

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SIGNED: Hussein Djajasukarta

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Robert E. Briggs

ROBERT E. BRIGGS
Associate Professor of Agronomy

June 14, 1969
Date

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ABSTRACT

An experiment was conducted in 1968 at Tucson, Arizona, to study effects of 21 Gibrel X-47 treatments on flowering, fruiting, and yield of two Upland cotton cultivars, Hopicala and Deltapine 16. Effects on other growth characteristics were also studied.

Single applications at different rates and two applications of a 20 ppm solution of Gibrel X-47 reduced plant height of young cotton plants.

Multiple applications of a 20 ppm solution of Gibrel X-47 resulted in a greater number of squares abscised before bloom. Gibrel X-47 induced the formation of more squares than the untreated check.

Single applications of Gibrel X-47 at different stages of growth of cotton plants up to two months of age reduced number of flowers and bolls abscised after bloom.

Greater lint per cent and lint index were found from some of the Gibrel X-47 treated plants.

Gibrel X-47 did not affect plant height at harvest, plant internode length, number of nodes per plant, number of bolls retained per plant, seed cotton yield or number of cotton bolls harvested per plot, and seed index.

Hopicala had taller plants, longer internodes, more nodes, more bolls retained per plant, more bolls harvested

per plot from the 1st harvest, fewer bolls harvested per plot from the 6th harvest and fewer bolls harvested per plot averaged over 7 harvests, a greater lint index, and a greater seed index than Deltapine 16.

Seed cotton yield or number of cotton bolls harvested and lint per cent from later harvests were greater than those from earlier harvests. Lint index and seed index were smaller.

INTRODUCTION

Gibberellic acid (gibberellin A_3) and many of its formulations stimulate plant growth. Many morphological and physiological changes have been recorded. Gibberellic acid increased stem elongation and promoted flowering in a number of plant species. There have been occasional reports of yield increases in crops.

Promising results of experiments with gibberellic acid on other crops were followed by studies of its effects on cotton. Gibberellic acid has been applied as a cotton seed treatment or as spray or dust to cotton plants. Results indicated that gibberellic acid might have an economic advantage in cotton production.

This research was conducted to study effects of Gibrel X-47, a registered formulation of gibberellic acid manufactured by Merck Chemical Division, Merck & Co., Inc., at different rates, dates, and frequencies of application on the flowering, fruiting, and yield of two cultivars of Upland cotton (Gossypium hirsutum L.) grown in 1968 at Tucson, Arizona. Effects on other growth characteristics, lint per cent, lint index, and seed index were also studied.

LITERATURE REVIEW

A number of experiments have been reported on the effect of cotton seed treatment with gibberellic acid and its formulations. In preliminary studies with cotton seed soaked in dilute solutions of gibberellic acid, Johnson et al. (16) reported that under low soil temperatures in greenhouse tests, emergence and seedling growth were increased by treatment with 40 ppm.

From greenhouse and field experiments of both undelinted and acid delinted seed treated with gibberellic acid, Ergle and Bird (9) found that gibberellic acid increased seedling height for seed planted in sand. Gibberellic acid inhibited emergence for seed planted in Lufkin fine sandy loam. Stand counts in field experiments decreased as the gibberellic acid level increased.

Increased seedling height was also reported by Bradford and Ewing (3, 4) when cotton seed were treated with gibberellic acid. However, the stand was significantly reduced. Soaking seed in different concentrations of gibberellic acid before planting caused an increase in length and width of cotyledons. In northern Nigeria, Dransfield (6) found similar results when cotton seed of the cultivar Samaru 26 J (Gossypium hirsutum L.) were soaked in gibberellic acid solutions. Increases were

obtained in hypocotyl length, seedling height, cotyledon and leaf length, and susceptibility to bacterial blight. Root development was reduced.

Negative results were found by Spooner, Frizzel, and Waddle (22). Gibberellic acid treated cotton seed planted in the field showed no differences in seedling development.

Bird and Ergle (2) stated that cotton cultivars differed significantly in rate of seedling emergence and seedling height when potassium gibberellate was applied to acid delinted seeds. Positive correlation was found between rapid emergence and seedling height of the 12 cultivars studied. Cultivars varied in their response to potassium gibberellate with the faster-emerging, taller-seedling types giving the greatest response.

Bradford and Ewing (3, 4) found that dust formulations of gibberellic acid used as cotton seed treatment did not affect seedling emergence. However, according to Johnson (11, 12), Johnson, Lane, and Cowley (14), and Johnson et al. (15, 16), Gibrel 88, a dust formulation of gibberellic acid, produced a beneficial response to seedling emergence. Treated seed emerged earlier and in many cases percentage emergence increased. Johnson (11) pointed out that soil temperature and depth of planting appeared to have a great effect on the response of cotton seed treatment with Gibrel 88.

Working with fungicides and gibberellic acid in cotton tests, Johnson et al. (14) reported that one fungicide appeared to enhance the activity of gibberellic acid.

Application of gibberellic acid to cotton seedlings or young cotton plants has affected vegetative growth. Bradford and Ewing (3, 4) reported that spraying cotton seedlings immediately after emergence significantly increased seedling height in proportion to the concentration of gibberellic acid. Length of the first internode and size of cotyledons were also significantly increased, whereas size of the second leaf was significantly decreased.

From greenhouse experiments with Empire WR cotton, Ergle (7, 8) found that the sodium salt of gibberellic acid increased the main stem length of young cotton plants in proportion to the total amount applied. This resulted from repeated applications of aqueous solutions sprayed at two-day intervals for ten periods to 15-day-old plants. Number of nodes on the main stem was not changed. Similar results were reported by Dransfield (6). When gibberellic acid was sprayed once or weekly to cotton seedlings starting 8 days after planting until the plants were 43 days old, increases were recorded in plant height, length of lower internodes, and rate of flower initiation. Reduction in root weight, stem diameter, and length of upper internodes were noted.

Spooner et al. (22) found negative results. No differences in seedling growth were observed when cotton seedlings were treated with gibberellic acid and planted in the greenhouse or field.

From experiments with normal and mutant cottons, Ergle (7) pointed out that multiple applications of gibberellic acid at the time of emergence of the first true leaf affected the height of mutant cotton. In most cases there was no apparent effect of gibberellic acid on the number of flowers produced or retained as bolls.

Special studies of the effect of gibberellic acid applied to cotton plants or individual flowers and bolls on flowering, fruiting, yield, and fiber characteristics have been reported. According to Johnson (12) and Johnson et al. (14, 16), a general increase in the number of bolls set per plant was recorded when both irrigated and non-irrigated cotton were sprayed with gibrel, an emulsifiable concentrate containing potassium gibberellate, at weekly intervals from flowering until topmost bolls were mature. This increase was not reflected in a yield increase. Micronaire tended to be higher in treated plants. Fiber length and strength were not affected. In one test, the lint yield of Stormrider, a very determinant cultivar, was almost doubled by the application of 25 ppm gibrel at the rate of 12 gallons of solution per acre.

Gibberellic acid applied to cotton as a foliar spray stimulated vegetative growth at the expense of maturity, according to Lane (17). Treatment after flowering to early- and late-fruiting plants grown with and without nitrogen fertilizer failed to stimulate growth sufficiently to offset the influence of an early boll crop. Vegetative growth and flowering ceased early. Although plants treated with gibberellic acid appeared somewhat larger, yield from treated plants was slightly less than the check.

According to Millhollon (19), spraying whole plants at the rate of 18 grams of gibberellic acid in 48 gallons of water per acre decreased boll abscission. The number of bolls set per plant was increased by approximately 19%. Increased boll set was apparently offset by decreased boll size. Yield was not increased.

Dransfield (6) stated that spraying 3-month-old cotton plants with different concentrations of gibberellic acid delayed boll shedding.

In the Sudan, Jackson and Fadda (10) found that spraying aqueous solutions of gibberellic acid to the topmost expanded leaves of irrigated, urea-fertilized cotton plants of the cultivar XL 1 (Gossypium barbadense L.) at different dates and rates of application affected flowering. A concentration of 100 micrograms or more per plant applied to young plants retarded flowering. Though some

treatments increased the number of flower buds produced, shedding was also increased and yield was generally reduced. Gibberellic acid treatment also greatly increased the rate of vegetative growth, but did not result in earlier flowering.

Mathur and Mittal (18) and Mittal and Mathur (20) observed that a single application of gibberellic acid solution to 5-week-old plants just before anthesis increased flower induction, shedding and retention, boll setting and retention, and seed cotton yield. Plant height and internode length were also increased. Weight of 100 seed, and seed and lint weight per plant were significantly higher.

According to Walhood (24, 27), application of gibberellic acid to apical buds of cotton plants in all stages of cut-out (cessation of vegetative and fruiting bud development) was followed by an immediate resumption of growth. In both cut-out and continuously growing plants, the rate of new nodes produced was the same but internode length of continuously growing plants was longer.

According to Arndt (1), dusting and repeated spraying of cotton plants after the first flowers opened at weekly intervals for 6 weeks with potassium gibberellate showed no effect on the total number of flowers produced, mature bolls, yields, and the fiber properties of length, uniformity, and fineness. Similar results were reported by Walhood (26, 27) and Walhood and Carns (28) with airplane

application of gibberellic acid to field-grown cotton both as dust and spray at early flowering or approaching peak bloom. It appeared that gibberellic acid was not effective in controlling flower or boll shedding.

Studies on the response of cotton plants grown in two different soil types to gibberellic acid applied to the apical buds of individual plants were reported by Walhood (26), Walhood and Carns (28), and Carns and Walhood (5). Yield increases were only found on plants growing on lighter soils. Fiber properties were not affected. Gibberellic acid increased plant height and reduced boll size of cotton plants grown on both soil types.

Walhood (24, 25, 27), Walhood and Carns (28), and Carns and Walhood (5) reported that aqueous solutions of gibberellic acid applied to flowers at anthesis or to 1-day-old bolls of field-grown cotton increased boll retention. Gibberellic acid stopped or reversed the boll abscission process. The boll setting properties of gibberellic acid negated the shedding caused by boll load. There was an increase in boll diameter. The average mature boll weighed less, probably due to the large number of smaller and less-seeded bolls which were retained by gibberellic acid.

According to Millhollon (19), treatment of individual flowers with gibberellic acid at daily intervals resulted in smaller plants with a much heavier boll load.

than the control. Boll size was greatly reduced by such treatments. The increased boll load and increased growth that resulted from gibberellic acid treatments also reduced the seed size and quality of fiber produced.

Dransfield (6) found that individual treatment of young cotton bolls increased their retention but had no effect on yield or lint characteristics.

Johnson and Addicott (13) studied the effect of gibberellic acid applied to all flowers on boll retention of cotton plants grown in nutrient culture. No differences were found between the gibberellic acid treatments and control for any of the characters measured.

On the premise that an increase in the production of natural auxin, indole acetic acid, reduced boll abscission, Walhood (24, 25, 27) found that the application of indole acetic acid increased boll shedding. Increased boll shedding was readily blocked by using gibberellic acid.

Studies to control fruiting of cotton plants with the application of other growth substances have given negative results. Singh and Dargan (21) reported that the application of indole acetic acid, naphtalene acetic acid, and indole butyric acid did not affect boll number, yield per plant, ginning per cent, seed and lint indexes, and yield per acre. According to Trudigan (23), multiple application of alpha naphtalene acetic acid did not affect

the total fallen fruit forms, fruit form production, number of harvested bolls, or yield.

MATERIALS AND METHODS

The experiment was conducted at the University of Arizona Campbell Avenue Farm, Tucson, Arizona, during 1968. The soil was Gila sandy loam.

The seedbed was prepared following standard practices for commercial cotton production. A preplant irrigation was applied one week before planting. The test was irrigated one month after planting and every 10 days for 10 applications. Water was applied for 30 minutes at each irrigation from a pump with a flow of 2648.80 liters per minute. Four days after the first four irrigations, the land was cultivated. No cultivations were made after the fifth and later irrigations. No fertilizer was applied. The previous crop was alfalfa.

Seed of acid delinted Hopicala and Deltapine 16 cotton cultivars were hand-dropped on April 24, 1968, using a tractor mounted planter. The row width was 81.44 centimeters. Young seedlings were thinned to single plants 15.24 centimeters apart.

A split-plot design with four replications was used with the two cultivars as main plots and the Gibrel X-47 as subplots. The Gibrel X-47 treatments used are shown in Table 1. The solution of Gibrel X-47 was sprayed to the top of the plants at a rate of 15.14 cubic centimeters per

Table 1. Gibrel X-47 treatments applied on Hopicala and Deltapine 16 cotton cultivars, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Treatment	Rate of application	Date(s) of application
	ppm	
1	Check	-
2	10	May 27
3	20	May 27
4	40	May 27
5	10	June 3
6	20	June 3
7	40	June 3
8	10	June 10
9	20	June 10
10	40	June 10
11	10	June 17
12	20	June 17
13	40	June 17
14	10	June 24
15	20	June 24
16	40	June 24
17	10	July 1
18	20	July 1
19	40	July 1
20	20	May 27 and July 1
21	20	May 27, June 10, and July 1
22	20	May 27, June 3, 10, 17, 24, and July 1

square meter. The solution was sprayed using a paper chromatography sprayer when the plants were small with pressure supplied from a three gallon hand sprayer. Later, as the plants grew older, the liquid was sprayed using a three-gallon hand sprayer with a single nozzle.

The 2.09-square-meter plots were single 2.44 meter rows with 15 plants excluding two border plants.

The following data were obtained:

1. plant heights in centimeters, measured from ground level to the top of the main stem
2. maximum plant height in centimeters at harvest
3. average internode length in centimeters at harvest
4. number of nodes at harvest
5. number of squares abscised before bloom
6. number of flowers and bolls abscised after bloom
7. number of bolls retained
8. seed cotton yield per plot
9. number of bolls harvested per plot
10. lint per cent
11. lint index
12. seed index

Yield data and number of bolls harvested were obtained from the entire plot. Plant height during the growing season, number of squares, flowers, and bolls abscised, and the number of bolls retained were obtained

from three plants chosen at random from each plot. Numbers of squares, flowers, and bolls were recorded on individual plant charts to follow their growth and development.

Plant heights were measured weekly beginning one week after treatment and recorded for 6 consecutive weeks. After harvest, three typical plants were removed from each plot for the determination of maximum plant height, average internode length, and number of nodes.

The plots were harvested 6 times at weekly intervals with a 7th harvest 3 weeks after the 6th harvest. Seed cotton weight was obtained from perfect bolls and the good seed cotton from partially bad bolls. Calculated number of bolls harvested include both good and bad bolls.

Lint per cent, lint index, and seed index were determined from seed cotton samples from each weekly harvest. Seed cotton samples which were less than 45 grams were not analyzed.

Data were analyzed using the standard analysis of variance and treatment means were compared using a t test. Lint per cent, lint index, and seed index of the 1st, 2nd, and 7th pickings were not analyzed.

RESULTS AND DISCUSSION

Plant Height

The average plant height one and two weeks after treatment with Gibrel X-47 is shown in Tables 2 and 3, respectively. With all Gibrel X-47 treatments applied to 4-week-old cotton plants, the average height one and two weeks after treatment was significantly shorter than those of the untreated check. Similar results were obtained with a multiple treatment where 20 ppm Gibrel X-47 was applied to 4-week-old plants and repeated one week later. Since there was no report of retarded cotton plant height in the literature following application of gibberellic acid, reduced cotton plant height found in this experiment probably was not due to Gibrel X-47 alone, but to some other unknown factors.

There were no significant differences between height of untreated and treated plants with different rates and frequencies of application of Gibrel X-47 at any other stage of growth. These results differed from those of similar experiments reported by other researchers. A number of researchers (3, 4, 5, 6, 7, 10, 18, 26, 28) reported that single or multiple applications of gibberellic acid at different rates, dates, and frequencies of application increased plant heights.

Table 2. Average plant height one week after treatment with Gibrel X-47, over two cotton cultivars, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Rate of application	Date of application	Plant height
ppm		cm
Check	-	16.76
10	May 27	13.75**
20	May 27	14.05**
40	May 27	14.73*

L.S.D. 5%: 1.88.

L.S.D. 1%: 2.52.

Table 3. Average plant height after treatment with Gibrel X-47, recorded on June 10, 1968, over two cotton cultivars, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Rate of application	Date(s) of application	Plant height
ppm		cm
Check	-	20.95
10	May 27	17.86**
20	May 27	18.18**
40	May 27	18.46*
10	June 3	19.12
20	June 3	18.91
40	June 3	19.76
20	May 27 and June 3	18.36*

L.S.D. 5%: 2.07.

L.S.D. 1%: 2.77.

The average height of Hopicala was significantly higher at the 1% level than Deltapine 16 at each of the 6-weekly measurements. Similar results were also found for the average plant height at harvest (Table 4).

Internode Length and Number of Nodes

There were no significant differences in average plant internode length and average number of nodes at harvest between the untreated and treated cotton plants with different rates, dates, and frequencies of Gibrel X-47 application over two cotton cultivars. These results would be expected since no differences were observed in the average plant height at harvest with the application of Gibrel X-47.

Hopicala produced significantly more nodes and had longer internodes than Deltapine 16 (Table 5).

Number of Squares Abscised Before Bloom

The average number of squares per plant abscised before bloom are presented in Table 6. Cotton plants treated with a 20 ppm solution of Gibrel X-47 three or six times during the second, third, and fourth month of the growing period abscised more squares before bloom than untreated plants. Single applications of Gibrel X-47 did not significantly affect the number of squares abscised before bloom. Similar results were reported by Jackson and Fadda (10).

Table 4. Average plant height of two cotton cultivars at different ages of growth and at harvest (maximum height), over all Gibrel X-47 treatments, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Age of plant	Cultivar		L.S.D. 1%
	Hopicala	Deltapine 16	
weeks	cm	cm	
5	15.83	13.28	2.42
6	21.05	16.50	3.03
7	25.29	19.90	1.44
8	33.94	26.68	4.02
9	47.08	37.68	4.05
10	61.71	52.22	4.36
harvest	118.28	97.68	4.08

Table 5. Average internode length and number of nodes of two cotton cultivars over all Gibrel X-47 treatments, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Cultivar	Internode length	Number of nodes
	cm	
Hopicala	4.25	27.33
Deltapine 16	3.76	25.49
L.S.D. 1%:	0.17	1.37

Table 6. Average number of squares abscised before bloom of cotton plants treated at different dates with various rates of Gibrel X-47 over two cultivars, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Rate of application	Date(s) of application	Squares abscised per plant
ppm		
Check	-	25.74
10	May 27	23.04
20	May 27	29.51
40	May 27	30.66
10	June 3	20.50
20	June 3	22.05
40	June 3	25.34
10	June 10	26.50
20	June 10	29.50
40	June 10	27.18
10	June 17	20.08
20	June 17	22.11
40	June 17	23.89
10	June 24	25.36
20	June 24	27.41
40	June 24	25.54
10	July 1	22.96
20	July 1	28.45
40	July 1	29.51
20	May 27 and July 1	26.38
20	May 27, June 10, and July 1	36.11**
20	May 27, June 3, 10, 17, 24, and July 1	33.65*

L.S.D. 5%: 7.94

L.S.D. 1%: 9.31

With the greater number of squares abscised before bloom with multiple application of Gibrel X-47, it appears that Gibrel X-47 induced the formation of more squares than normal.

There were no significant differences in the average number of squares per plant abscised before bloom between Hopicala and Deltapine 16 cotton cultivars.

Number of Flowers and Bolls Abscised After Bloom

The average number of flowers and bolls per plant abscised after bloom is shown in Table 7. Single application of a 10 ppm solution of Gibrel X-47 applied at different dates of application during the 2nd and 3rd month of the growing period reduced the number of flowers and bolls abscised after bloom. Similar results were found with single applications of 20 and 40 ppm solutions of Gibrel X-47 when plants were 5, 7, or 8 weeks old. Average number of flowers and bolls abscised after bloom were increased when 9-week-old plants were sprayed with 20 or 40 ppm solutions of Gibrel X-47. Multiple applications of Gibrel X-47 were similar to the check treatment.

Although some of the Gibrel X-47 treatments applied at an early stage of growth did not affect the average number of flowers and bolls abscised after bloom, many of the treatments with Gibrel X-47 reduced the average number of flowers and bolls abscised after bloom. Other

Table 7. Average number of flowers and bolls abscised after bloom of cotton plants treated at different dates with various rates of Gibrel X-47 over two cultivars, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Rate of application	Date(s) of application	Flowers and bolls abscised per plant
ppm		
Check	-	5.20
10	May 27	0.99**
20	May 27	4.50
40	May 27	6.25
10	June 3	1.38**
20	June 3	1.05**
40	June 3	1.40**
10	June 10	0.83**
20	June 10	5.04
40	June 10	3.65
10	June 17	1.18**
20	June 17	0.71**
40	June 17	1.03**
10	June 24	1.04**
20	June 24	1.41**
40	June 24	1.36**
10	July 1	1.38**
20	July 1	7.96**
40	July 1	7.41*
20	May 27 and July 1	4.74
20	May 27, June 10, and July 1	5.03
20	May 27, June 3, 10, 17, 24, and July 1	4.84

L.S.D. 5%: 1.89.

L.S.D. 1%: 2.50.

researchers (6, 19) observed similar results. According to Walhood (24, 25, 27), gibberellic acid stopped or reversed the boll abscission process.

The number of flowers and bolls abscised after bloom in Hopicala and Deltapine 16 cotton cultivars was similar.

Number of Bolls Retained

No significant differences were found in the number of bolls retained when cotton plants were sprayed with Gibrel X-47 at different rates, dates, and frequencies of application. Other researchers (6, 19, 24, 25, 27) found that applications of gibberellic acid to individual flowers or young bolls increased the number of bolls retained.

In this experiment, where Gibrel X-47 was sprayed over the top of the plant, possibly the treatment was less effective than spraying individual flowers or young bolls. Johnson (12) and Johnson et al. (14, 16) reported that spraying cotton plants with gibrel increased the number of bolls set per plant although this was not reflected in a yield increase.

Hopicala plants retained an average of 2.68 more bolls than Deltapine 16 which retained an average 10.25 bolls.

Seed Cotton Yield

No significant differences were found in yield of seed cotton between the untreated and treated plants with different rates, dates, and frequencies of application of Gibrel X-47 over both cultivars. Similar results were reported by other researchers (1, 6, 12, 13, 15, 19, 24, 26).

At the 6th harvest, Deltapine 16 produced 50.53 grams more seed cotton per plot than Hopicala, which produced 126.97 grams; whereas, at any of the other harvests, both Hopicala and Deltapine 16 cultivars produced similar amounts of seed cotton.

Compared with the first harvest, seed cotton yield from the 6 subsequent harvests were higher (Table 8).

Number of Bolls Harvested

The application of Gibrel X-47 at different rates, dates, and frequencies of application did not affect the number of bolls harvested per plot. Since there were no differences in yield of seed cotton, these results would be expected.

The average number of bolls of Deltapine 16 harvested for the entire season over all Gibrel X-47 treatments was significantly greater than Hopicala. This was also true with Deltapine 16 at the 6th harvest; whereas, at the 1st harvest, Hopicala had more cotton bolls (Table 9).

Table 8. Average yield of seed cotton per plot at different harvests over two cultivars and all Gibrel X-47 treatments, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Harvest	Seed cotton yield
	g
First	19.60
Second	30.20*
Third	198.47**
Fourth	193.48**
Fifth	200.63**
Sixth	152.23**
Seventh	84.73**

L.S.D. 5%: 15.99.

L.S.D. 1%: 21.05.

Table 9. Average number of cotton bolls harvested per plot of two cotton cultivars over all Gibrel X-47 treatments, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Harvest	Cultivar		L.S.D.	
	Hopicala	Deltapine 16	5%	1%
	bolls			
First	8.30	4.64	3.06	5.62
Second	8.88	7.09	n.s.[a]	
Third	38.21	41.69	n.s.	
Fourth	31.86	39.51	n.s.	
Fifth	33.85	40.72	n.s.	
Sixth	23.48	40.35	7.92	14.54
Seventh	11.27	21.71	n.s.	
Average of seven	22.26	27.96	2.55	4.68

[a]Not significant at 5% level.

Compared with the first or second harvest, yield of cotton bolls from the 5 subsequent harvests were higher (Table 10).

Lint Per Cent

The average lint per cent of cotton as affected by various Gibrel X-47 treatments over two cotton cultivars and four harvests periods are presented in Table 11. The average lint per cent was significantly higher than the check treatment when 4-week-old cotton plants were treated with 20 or 40 ppm solutions of Gibrel X-47. Similar results were found when 20 ppm Gibrel X-47 was applied to 8- or 9-week-old plants or with 2 applications to 4- and 9-week-old plants.

The average lint per cent of cotton from the third harvest period was significantly greater than the untreated check from many of the Gibrel X-47 treatments (Table 12). No significant differences in lint per cent were found from the 4th, 5th, or 6th harvest.

The average lint per cent of Hopicala was similar to Deltapine 16.

The average lint per cent of cotton at four different weekly harvest periods over all Gibrel X-47 treatments and two cultivars is shown in Table 13. The average lint per cent of the sixth harvest was significantly greater than the other three harvests.

Table 10. Average number of cotton bolls per plot at different harvests over two cultivars and all Gibrel X-47 treatments, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Harvest	Cotton bolls
First	6.47
Second	7.98
Third	39.95**
Fourth	35.69**
Fifth	37.28**
Sixth	31.92**
Seventh	16.49**

L.S.D. 5%: 2.81.

L.S.D. 1%: 3.69.

Table 11. Effect of Gibrel X-47 treatments on average lint per cent over two cotton cultivars and four harvest periods, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Rate of application	Date(s) of application	Lint per cent
ppm		
Check	-	36.40
10	May 27	36.97
20	May 27	37.48*
40	May 27	37.43*
10	June 3	37.05
20	June 3	37.24
40	June 3	37.30
10	June 10	37.21
20	June 10	36.43
40	June 10	36.58
10	June 17	37.12
20	June 17	36.28
40	June 17	36.46
10	June 24	37.17
20	June 24	37.57*
40	June 24	36.90
10	July 1	36.59
20	July 1	37.38*
40	July 1	37.15
20	May 27 and July 1	37.42*
20	May 27, June 10, and July 1	36.01
20	May 27, June 3, 10, 17, 24, and July 1	36.61

L.S.D. 5%: 0.97.

L.S.D. 1%: 1.28.

Table 12. Effect of Gibrel X-47 treatments on average lint per cent from the third harvest period over two cotton cultivars, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Rate of application	Date(s) of application	Lint per cent
ppm		
Check	-	35.45
10	May 27	37.04**
20	May 27	37.45**
40	May 27	37.64**
10	June 3	36.35
20	June 3	37.64**
40	June 3	38.70**
10	June 10	36.43
20	June 10	35.86
40	June 10	36.70*
10	June 17	36.89*
20	June 17	36.29
40	June 17	36.05
10	June 24	36.83*
20	June 24	37.51**
40	June 24	36.18
10	July 1	36.56
20	July 1	36.96*
40	July 1	37.13**
20	May 27 and July 1	37.45**
20	May 27, June 10, and July 1	35.75
20	May 27, June 3, 10, 17, 24, and July 1	36.75

L.S.D. 5%: 1.22.

L.S.D. 1%: 1.62.

Table 13. Average lint per cent at different harvest periods over two cotton cultivars and all Gibrel X-47 treatments, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Harvest	Lint per cent
Third	36.71
Fourth	36.69
Fifth	36.95
Sixth	37.43**

L.S.D. 5%: 0.28.

L.S.D. 1%: 0.37.

Lint Index and Seed Index

The effect of various Gibrel X-47 treatments to the lint index of Hopicala and Deltapine 16 cotton cultivars from the third harvest is shown in Table 14. There was an interaction between cultivars and Gibrel X-47 treatments. With Hopicala, only two treatments resulted in significantly higher lint index while lint index of Deltapine 16 was significantly higher than the untreated check in 14 of the 21 Gibrel X-47 treatments.

From the fourth harvest, Table 15, lint index of cotton from 4-week-old plants treated with a 10 ppm solution of Gibrel X-47 was significantly higher than the untreated check. No significant differences in lint index were found in the 5th and 6th weekly harvest periods.

The average lint index and seed index of Hopicala cotton from each of the four harvest periods over all Gibrel X-47 treatments were significantly greater than Deltapine 16 (Tables 16 and 17, respectively).

The average lint index and seed index at different harvest periods over all Gibrel X-47 treatments and 2 cultivars are shown in Tables 18 and 19, respectively. Lint index and seed index of cotton from the 4th, 5th, and 6th harvests were significantly lower than from the 3rd harvest.

Dransfield (6) reported that gibberellic acid did not affect lint index or seed index. Similar results were found by Singh and Dargan (21) from experiments with other

Table 14. Lint index of two cotton cultivars treated with Gibrel X-47 from the third harvest, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Rate of application	Date(s) of application	Cultivar	
		Hopicala	Deltapine 16
ppm		lint index	
Check	-	7.80	6.23
10	May 27	7.48	7.28**
20	May 27	8.13	7.28**
40	May 27	8.53*	7.15**
10	June 3	7.78	6.75
20	June 3	8.38	7.08**
40	June 3	7.68	7.10**
10	June 10	8.15	6.50
20	June 10	7.88	6.33
40	June 10	7.50	7.10**
10	June 17	8.15	7.08**
20	June 17	7.68	6.73
40	June 17	8.18	6.45
10	June 24	8.18	6.93*
20	June 24	8.13	7.03**
40	June 24	8.40*	6.83*
10	July 1	7.80	7.13**
20	July 1	7.78	7.18**
40	July 1	8.30	6.88*
20	May 27 and July 1	8.08	7.18**
20	May 27, June 10, and July 1	7.88	6.63
20	May 27, June 3, 10, 17, 24, and July 1	7.68	6.93

L.S.D. 5%: 0.59.

L.S.D. 1%: 0.79.

Table 15. Effect of Gibrel X-47 treatments on the average lint index from the fourth harvest over two cotton cultivars, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Rate of application	Date(s) of application	Lint index
ppm		
Check	-	7.10
10	May 27	7.73**
20	May 27	7.09
40	May 27	7.26
10	June 3	6.75
20	June 3	6.91
40	June 3	7.18
10	June 10	7.19
20	June 10	6.99
40	June 10	7.01
10	June 17	7.28
20	June 17	6.91
40	June 17	7.16
10	June 24	6.98
20	June 24	7.26
40	June 24	7.26
10	July 1	6.83
20	July 1	7.16
40	July 1	7.08
20	May 27 and July 1	7.50
20	May 27, June 10, and July 1	6.66
20	May 27, June 3, 10, 17, 24, and July 1	7.08

L.S.D. 5%: 0.46.

L.S.D. 1%: 0.61.

Table 16. Average lint index of Hopicala and Deltapine 16 cotton cultivars from four harvest periods over all Gibrel X-47 treatments, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Harvest	Cultivar		L.S.D. 1%
	Hopicala	Deltapine 16	
	lint index		
Third	7.98	6.91	0.42
Fourth	7.69	6.53	0.51
Fifth	7.77	6.44	1.13
Sixth	7.22	6.29	0.27
Average of four	7.66	6.54	0.21

Table 17. Average seed index of Hopicala and Deltapine 16 cotton cultivars from four harvest periods over all Gibrel X-47 treatments, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Harvest	Cultivar		L.S.D. 1%
	Hopicala	Deltapine 16	
	seed index		
Third	13.54	12.08	0.81
Fourth	13.09	11.41	0.87
Fifth	13.15	11.05	0.79
Sixth	12.01	10.53	0.62
Average of four	12.95	11.27	0.35

Table 18. Average lint index of cotton from four harvest periods over two cultivars and all Gibrel X-47 treatments, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Harvest	Lint index
Third	7.44
Fourth	7.11**
Fifth	7.10**
Sixth	6.75**

L.S.D. 1%: 0.12.

Table 19. Average seed index of cotton from four harvest periods over two cotton cultivars and all Gibrel X-47 treatments, University of Arizona Campbell Avenue Farm, Tucson, Arizona, 1968.

Harvest	Seed index
Third	12.81
Fourth	12.25**
Fifth	12.10**
Sixth	11.27**

L.S.D. 1%: 0.21.

growth regulating substances. Results from this experiment indicated that lint index was significantly different with some Gibrel X-47 treatments and harvest periods.

SUMMARY

An experiment was conducted in 1968 at Tucson, Arizona, to study effects of 21 Gibrel X-47 treatments on flowering, fruiting, and yield of two Upland cotton cultivars, Hopicala and Deltapine 16. Effects on other growth characteristics were also studied.

The Gibrel X-47 treatments included 3 rates applied once at 6 dates and a 20 ppm solution applied 2, 3, and 6 times. A split-plot design was used. The characteristics of treated plants were compared to those of untreated plants as the check.

Single applications at different rates and two applications of a 20 ppm solution of Gibrel X-47 reduced plant height of young cotton plants. Application to older plants did not affect plant height.

Multiple applications of a 20 ppm solution of Gibrel X-47 resulted in a greater number of squares abscised before bloom. Gibrel X-47 induced the formation of more squares, since these potential flower and fruit forms that abscised before bloom were produced in greater numbers by treated plants than by untreated plants.

Single application of Gibrel X-47 at different stages of growth of cotton plants up to two months of age

reduced the number of flowers and bolls abscised after bloom.

Greater lint per cent and lint index were found from some of the Gibrel X-47 treated plants.

Gibrel X-47 did not affect plant height at harvest, plant internode length, number of nodes per plant, number of bolls retained per plant, seed cotton yield or number of cotton bolls harvested per plot, and seed index.

Hopicala had taller plants, longer internodes, more nodes, more bolls retained per plant, more bolls harvested per plot from the 1st harvest, fewer bolls harvested per plot from the 6th harvest and fewer bolls harvested per plot averaged over all 7 harvests, a greater lint index, and a greater seed index than Deltapine 16.

Compared to the first few harvest periods, later harvests gave higher seed cotton yield per plot, more bolls harvested per plot, and higher lint per cent, but smaller lint index and seed index.

Results from the treatments used in this research indicated that Gibrel X-47 would have little or no benefit for cotton production in Arizona with the conventional management and plant populations used today.

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