

RESPONSE OF GIZA 83 COTTON CULTIVAR TO SEQUENTIAL APPLICATIONS OF GIBBERELIC ACID (GA₃) AND MEPIQUAT CHLORIDE (PIX)

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ABSTRACT

This investigation was carried out at Mallawi Agric. Res. Station, Minia Governorate during 2001 and 2002 seasons to study the response of Giza 83 cotton cultivar to the application of gibberellic acid (GA₃) and mepiquat chloride (pix) applied in sequential foliar applications as follows:

1- Control. 2- Spraying GA₃ at seedling stage (SES) + pix at early flowering stage (EFS). 3- Spraying GA₃ at squaring stage (SQS) + pix at EFS 4- Spraying GA₃ twice at SES and SQS + pix at EFS. The used concentration of both GA₃ and pix was 50 ppm.

However, results showed that the application of GA₃ once at SES or at SQS with sequent spray of pix at EFS positively influenced growth characters; plant height, number of nodes per stem and number of sympodia per plant, producing vigorous but balanced plants with greater both fruiting capacity and reproductive efficiency through enhancing number of total fruiting sites, flowers, open bolls and total bolls per plant along with reducing fruit shedding% leading to a significant increase in seed cotton yield per feddan.

The application of GA₃ twice at SES and SQS + pix at EFS enhanced plant growth and its fruiting capacity by increasing significantly plant height, number of main stem nodes, number of sympodia, total fruiting sites, flowers and total bolls per plant but it failed to increase seed cotton yield due to the significant increase in unopened bolls per plant and delaying crop maturity associated with this treatment.

The results of chemical constituents of leaves obtained from treated cotton plants showed that application of GA₃ once at SES or at SQS and then spraying pix at EFS increased significantly chlorophyll (a, b and total), carotenoides, carbohydrate contents (reducing sugars, non-reducing sugars and total soluble sugars) and phenolic compounds.

Gibberellic acid and mepiquat chloride treatments had no significant effects on internode length, number of days from sowing to either first flower or first open boll, boll weight, lint % and fiber quality. Only in 2002 season, seed index was significantly increased by the treatments included one spray of GA₃ at SQS or two sprays of GA₃, followed by spraying Pix at EFS.

INTRODUCTION

Cotton plants have complex structure owing to its indeterminate growth habit and unique branching nature (Mauney, 1986), so it gives a very dynamic growth response to environment and management (Oosterhuis, 1990), presenting difficulties to cotton growers attempting to control plant growth that gives maximum yield.

Yield reductions are commonly observed in cotton fields due to excessive vegetative growth or poor and limited growth, thus the growth of cotton plant should be closely monitored. Adaptive operations could be

performed when needed to readjust the plant metabolic pathway at appropriate time. Landivar *et al.* (1995) stated that plant growth regulators are advantageous since their activity is under the control of the farm managers which gives them the flexibility to regulate plant growth to suit the current growing conditions for maximizing benefits.

Regulation of cotton growth and improvement of its yield have been investigated by many researchers using the integration of plant growth enhancers and/or inhibitors in a sequential multi-phased application program in which growth regulators serve as effective tools in modifying the growth of cotton plants as needed according to the plant growth status and the current growing conditions (Oosterhuis, 1990; Livingston and Parker, 1994; Oosterhuis and Zhao, 1994; Roberston and Cothren, 1995; Hickey, 1995 and Turner, 1996). So early application of GA₃ may be beneficial in enhancing seedling growth to establish vigorous seedling capable of overcoming the suppressive effects of unsuitable early season climatic conditions and the associated pest impacts to give well established plants with higher fruit capacity, while later application of Pix (mepiquat chloride) could prevent the risk of vegetative growth that often tied with vigorously grown plants resulting in higher yields.

The present study was conducted to evaluate the effect of sequential applications of GA₃ and Pix on growth, chemical constituents and yield of Egyptian cotton cultivar Giza 83.

MATERIALS AND METHODS

The present work was conducted at Mallawi Agric. Res. Sta., Minia Governorate, during the two successive seasons of 2001 and 2002 to study the response of Giza 83 cotton cultivar to the sequential applications of the growth stimulant gibberellic acid (GA₃) and the growth inhibitor mepiquat chloride (pix).

The experimental design was complete randomized blocks with four replicates. Plot area was 13 m² including 5 ridges, 4 m long and 65 cm apart. Cotton seeds were planted at the last week of March in both seasons in hills spaced 20 cm leaving two seedling per hill at the thinning time. Other cultural practices were done as recommended for cotton cultivation. The growth regulators treatments were:

- 1- Control.
- 2- Spraying GA₃ at seedling stage + pix at early flowering stage.
- 3- Spraying GA₃ at squaring stage + pix at early flowering stage.
- 4- Spraying GA₃ twice at seedling stage and squaring stage + pix at early flowering stage.

Both GA₃ and Pix was applied at the concentration of 50 ppm.

The studied characters were:

- I- Growth characters (recorded at harvest time): final plant height (cm), No. of main stem nodes, internode length (cm) and No. of fruiting branches/plant.

II- Chemical constituents: A sample of the fourth leaves from the plant apex was taken after 15 days from pix application to determine the following chemical constituents:

- 1- Chlorophyll content (chls a and b): were determined according to Arnon (1949) and carotenoids content was determined according to Rolbelen (1957).
- 2- Carbohydrate contents: total soluble sugars and reducing sugars, were determined according to Ceming (1975) and A.O.A.C. (1965), respectively.
- 3- Polyphenol: were determined according to Simons and Ross (1971).

III- Earliness parameters: No. of days from sowing to first flower and first open boll and earliness percentage.

IV- Yield and yield components: No. of flowers/plant, No. of total bolls/plant, boll shedding%, boll weight (gm), seed cotton yield (Kent./fed.), lint% and seed index (gm).

V- Fiber quality: micronaire reading (fiber fineness) and Pressely index (fiber strength) were determined according to A.S.T.M. (1975) conditions.

Data were subjected to the statistical analysis outlined by Snedecor and Cochran (1981), using the least significant difference (LSD) for means comparison.

RESULTS AND DISCUSSION

A- Growth characters:

It is obvious from results presented in Table (1) that cotton plants received both GA₃ and pix were generally taller with more nodes per main stem and higher number of fruiting branches in comparison with the control plants. The highest values of these growth characters were produced by the treatment which applied, two sprays of GA₃ followed by using one spray of GA₃ at squaring stage (SQS). Internode length was not significantly affected by the sequential applications of GA₃ and pix indicating that the obtained increase in plant height was due to promoting both boll cell division and cell elongation which increased number of main stem nodes, in turn increased number of sympodia per plant since each more node represents a site for additional fruiting branches.

The obtained results of chemical composition may be in good harmony with the findings of Nickel (1982) who stated that synthetic growth regulating chemicals are extremely valuable in the commercial control of crop growth through changing the endogenous level of the naturally occurring substances allowing modifications in plant growth and development to a particular direction and to a desired extent.

It is well known that plant growth is mainly controlled by the levels of endogenous phytohormones and exogenous application of GA₃ was found by Abdel-Al (1981) to increase within plant contents of GA₃, auxin and cytokinins which all are characterized by their stimulative effects on plant

growth through promoting both cell division and cell elongation. Also, Wahdan (1990) found that GA₃ application reduced level of the growth inhibitor abscisic acid within cotton plants. Therefore, it seems logical that plant growth enhancement obtained in this study was owing to early season application of GA₃ which induced plant growth allowing the plant to produce an early increase in main stem nodes and in so doing that, it increased number of sympodia per plant, while sequential application of pix maintained the internodes unelongated by GA₃ application. In this connection, Oosterhuis and Zhao (1994) reported that the application of the growth enhancer PGR IV, contains GA₃ + IBA, at early growth stages caused an early increase in plant growth through promoting photosynthesis activity and nutrient uptake. While later application of pix restricted vegetative growth during the reproductive phase (Livingston and Parker, 1994). Similar results were reported by Hickey (1995) and Turner (1996).

B- Chemical constituents of cotton leaves:

1- Chlorophyll contents:

Data presented in Table (2) show that the sequential applications of GA₃ and pix had significant effects on chlorophyll content in cotton leaves (a, b and total chlorophyll). Results indicate that spraying GA₃ at SES and SQS with sequent spray of pix at EFS had a clear positive effect on total chlorophyll contents comparing with the control. These results would be attributed to the enhancing effect of GA₃ on the synthesis of nucleic acid, which control protein synthesis, leading to stimulate the biosynthesis of phytol which is an essential compound for chlorophyll formation. The present results are in agreement with findings of Wahdan (1990), Grigis (1993), Ramachandra-Reddy *et al.* (1996) and El-Gabier (2002), who reported the enhancing effect of GA₃ and pix on chlorophyll formation.

2- Carotenoid content:

Data presented in Table (2) indicate that spraying GA₃ at SES, SQS with sequent spray of pix at EFS and application of GA₃ twice at SES and SQS + pix at EFS had significant effects on carotenoid content in cotton leaf.

In general, it could be concluded however, that GA₃ increased carotenoid. Since biosynthesis of GA₃ and carotenoids had the same pathway, thus addition of exogenous gibberellins would increase the amount of plant hormone in plant tissue and this might direct or stimulate the pathway in favour of carotenoid synthesis. Such results are in agreement with the findings of Wahdan (1990) and El-Gabier (2002), who reported that GA₃ application increased carotenoid synthesis.

3- Carbohydrate contents:

Concerning the effect of sequential application of GA₃ and pix on carbohydrate contents, results shown in Table (2) indicate that spraying GA₃ once at seedling stage (SES) or at (SQS) with pix at early flowering stage (EFS) and also application of GA₃ twice at SES and SQS + pix at EFS, increased significantly reducing sugar, non-reducing and total soluble sugar contents in cotton leaf. Such increase in carbohydrate contents could be explained according to the conclusion of Jones *et al.* (1974) and Wahdan (1990) who reported that GA₃ and pix (individually) could stimulate the activity

or synthesis of enzymes which would regulate the metabolism and biosynthesis of carbohydrate.

4- Phenols content:

Results in Table (2) show that all treatments of GA₃ + pix increased the phenols contents in cotton leaves, as compared with the control. In general the large increase on poly and total phenol was observed by application of GA₃ at SES and SQS + pix at EFS. It could be concluded that phenolic substance played an important role in the control of abscission. Poly phenols inhibit the action of IAA oxidase and tend to reduce boll shedding percent (Addicott, 1970). Thus, the high level of total phenols in leaves as a result of GA₃ + pix application, could be expected to increase auxin level and reducing sugars content which in turn led to a decrease in boll shedding percentage (Table 3).

The obtained results of chemical composition may be in good accordance with the findings of Nickel (1982) who reported that synthetic growth regulating chemicals are extremely valuable in controlling crop growth through changing the endogenous level of the naturally occurring substances allowing modifications in plant growth and development to a particular direction and to a desired extent.

C- Earliness parameters:

Data of earliness parameters shown in Table (1) reveal that sequential applications of GA₃ and pix had no significant effects on number of days from sowing to either No. of days to first flower or first open boll. However, earliness% was significantly reduced by the treatment included spraying GA₃ at SES + SQS and pix (EFS) in both seasons, indicating that the application of pix, which known as earliness promoter, failed to push the crop to earlier maturation when was preceded by twice GA₃ application. It is appear that the effects of GA₃ + pix treatments on earliness of yield may be corresponding to their effects on plant growth. The results of this study disagreed with those of Oosterhuis *et al.* (1995) who reported that the application of the growth promoter PGR IV and pix together promote crop maturation.

Yield and its components:

With concern to the effect of sequential application of GA₃ and pix on yield and its components, results shown in Table (3) indicate that spraying GA₃ once at seedling stage (SES) or at squaring stage (SQS) with pix at early flowering stage (EFS), in general, enhanced both fruiting capacity and reproductive efficiency of the cotton plant through increasing its total number of flowers and number of open bolls with reducing boll shedding% leading to a significant increase in seed cotton yield per feddan. Otherwise, the application of GA₃ twice at SES and SQS + pix at EFS enhanced only the plant fruiting capacity by encouraging the plant to produce greater numbers of flowers and total bolls per plant but it failed to increase seed cotton yield due to the significant increase in unopened bolls per plant and delaying crop maturity associated with this treatment. GA₃+ pix also had significant effects on boll weight and lint%, while seed index was significantly increased with spraying GA₃ at SES and SQS + pix in 2002 season, only.

Table (1): Effect of spraying gibberellic acid (GA₃) and mepiquat chloride (pix) on some growth and earliness characters of Giza 83 cotton cultivar in 2001 and 2002 seasons.

Growth regulators treatment	Plant height (cm)	No. of main stem nodes/plant	Internode length (cm)	No. of fruiting branches/plant	No. of days to first flower	No. of days to first open boll	Earliness %
Control	96.8	25.9	3.73	14.6	81.8	133.1	61.1
GA ₃ (SES)+pix(EFS)*	98.3	26.6	3.69	15.3	82.1	133.1	60.2
GA ₃ (SQS)+pix(EFS)	99.8	26.9	3.71	15.5	81.7	132.8	61.2
GA ₃ (SES+SQS)+pix(EFS)	101.3	27.3	3.71	15.9	81.6	133.4	56.1
L.S.D. 5%	N.S.	0.8	N.S.	0.8	N.S.	N.S.	3.4
	2002 season						
Control	88.6	23.9	3.71	13.9	82.0	132.6	71.9
GA ₃ (SES)+pix(EFS)*	91.0	25.0	3.65	14.6	82.6	132.4	71.7
GA ₃ (SQS)+pix(EFS)	93.3	25.3	3.69	15.0	81.3	132.5	69.2
GA ₃ (SES+SQS)+pix(EFS)	96.7	25.9	3.73	15.6	82.3	133.1	68.4
L.S.D. 5%	5.1	1.0	N.S.	1.0	N.S.	N.S.	3.2

* SES, SQS and EFS indicate seedling, squaring and early flowering stages, respectively.

Table (2): Effect of spraying gibberellic acid (GA₃) and mepiquat chloride (Pix) on some chemical constituents of cotton leaves (Giza 83) in 2002 season.

	Chlorophylls			Caroten-oids	Carbohydrate			Phenols		
	a	b	total		R.S.	Non R.S.	T.S.S.	Mono.	Poly.	Total
Control	5.38	1.50	6.88	0.69	11.13	5.49	16.62	4.89	8.30	13.19
GA ₃ (SES)+pix(EFS)*	5.83	1.67	7.50	0.81	17.06	6.05	23.11	5.83	9.80	15.63
GA ₃ (SQS)+pix(EFS)	5.60	1.63	7.23	0.75	12.82	5.66	18.48	5.09	9.89	14.98
GA ₃ (SES+SQS)+pix(EFS)	5.51	1.54	7.05	0.75	11.40	5.99	17.89	4.91	8.62	13.53
L.S.D. 5%	0.14	0.06	0.12	0.03	0.52	0.63	0.78	0.06	0.11	0.32

* SES, SQS and EFS indicate seedling, squaring and early flowering stages, respectively.

Table (3): Effect of the application of gibberellic acid (GA₃) and mepiquat chloride (Pix) on yield and yield components and fiber quality of Giza 83 cotton cultivar in 2001 and 2002 seasons.

	No. of flowers /plant	No. of total bolls/ plant	Boll shedding %	Boll weight (gm)	Lint %	Seed index (gm)	Seed cotton yield (kent/ fed)	Pressely index	Micronair reading
2001 season									
Control	16.87	9.94	40.83	2.87	40.04	10.7	8.66	9.5	5.0
GA ₃ (SES)+pix (EFS)*	17.89	12.88	28.40	2.97	39.64	10.9	9.56	9.6	5.2
GA ₃ (SQS)+pix (EFS)	19.39	13.36	31.10	2.93	39.61	10.8	9.23	9.4	5.2
GA ₃ (SES+SQS) + pix (EFS)	19.74	13.16	33.33	2.86	39.65	11.1	8.62	9.5	5.1
L.S.D. 5%	2.1	1.8	4.2	N.S.	N.S.	N.S.	0.49	N.S.	N.S.
2002 season									
Control	16.38	11.06	32.47	2.86	40.9	10.5	10.09	9.6	4.9
GA ₃ (SES)+pix (EFS)*	19.11	13.72	28.20	2.94	40.4	10.8	11.32	9.5	5.1
GA ₃ (SQS)+pix (EFS)	19.67	14.28	27.40	2.91	40.1	11.1	10.87	9.5	5.1
GA ₃ (SES+SQS)+ pix (EFS)	19.32	13.93	27.89	2.82	40.0	11.4	10.21	9.4	5.0
L.S.D. 5%	3.9	2.7	4.0	N.S.	N.S.	0.50	0.50	N.S.	N.S.

* SES, SQS and EFS indicate seedling, squaring and early flowering stages, respectively.

Such yield increases due to the sequent application of GA₃ and pix could be attributed to their complementary effects on plant growth and development as early season application of GA₃ produced vigorous and well-established plants with greater overall fruiting potential, while sequent application of pix at EFS, through restricting vegetative growth, may improve the partitioning of metabolites towards the reproductive sinks leading to reducing fruit shedding and increasing open bolls and seed cotton yield. In this connection, Gua and Oosterhuis (1994) concluded that PGR IV and pix had counteracting effects on plant height and synergistic effects on number of bolls and seed cotton yield. Similar results were reported by Robertson and Cothren (1995), Hickey (1995) and Oosterhuis *et al.* (1995).

Fiber quality:

Results presented in Table (3) reveal that sequential application of GA₃ and pix did not exert any significant effects on fiber strength (Pressely index) or fiber fineness (micronaire value). Wahdan (1990) found insignificant effects on fiber quality due to the application of each GA₃ and pix.

It could be concluded from this study that:

1. The application of GA₃ once at SES or at SQS followed by one spray of pix at EFS improved plant growth and development resulting in higher seed cotton yield.
2. The application of two sprays of GA₃ at SES and SQS with sequent spray of pix at EFS enhanced plant growth and its fruiting capacity but did not increase seed cotton yield.
3. The application of GA₃ once at SQS or twice at SES and SQS even with sequent spray of pix at EFS delayed crop maturity through reducing earliness%.

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استجابة صنف القطن جيزة ٨٣ للرش المتتابع بالجبرلين وكلوريد المبيكويث (بكس)

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معهد بحوث القطن - مركز البحوث الزراعية - جيزة

أجرى هذا البحث بمحطة البحوث الزراعية بملوى بمحافظة المنيا خلال موسم الزراعة ٢٠٠١ - ٢٠٠٢ لدراسة استجابة صنف القطن جيزة ٨٣ للرش المتتابع بمنظى النمو الجبرلين وكلوريد المبيكويث (بكس) وذلك برش الجبرلين فى مراحل النمو المبكرة للنبات متبوعاً برش البكس أثناء النمو التمرى حيث كانت معاملات التجربة: ١- مقارنة ٢- رش الجبرلين فى مرحلة البادرات + بكس عند بداية التزهير ٣- رش الجبرلين فى مرحلة الوسواس + بكس عند بداية التزهير ٤- رش الجبرلين مرتين (فى مرحلتى البادرات والوسواس) + بكس عند بداية التزهير. وكان التركيز المستخدم لكلا من الجبرلين والبكس ٥٠ جزء فى المليون.

وتشير النتائج إلى أن الرش الجبرلين مرة واحدة سواء فى مرحلة البادرات أو فى مرحلة الوسواس متبوعاً برش البكس عند بداية التزهير كان له تأثيراً إيجابياً على نمو النبات مما أدى إلى زيادة السعة الثمرية للنبات بزيادة عدد الأفرع الثمرية وعدد المواقع الثمرية الكلى وعدد الأزهار وعدد اللوز الكلى للنبات وكذلك إلى زيادة الكفاءة الثمرية للنبات بزيادة عدد اللوز المتفتح/نبات ونقص النسبة المئوية لتساقط الثمار مما أدى إلى زيادة معنوية فى محصول القطن الزهر/فدان.

بينما نتج من المعاملة بالجبرلين مرتين (فى مرحلة البادرات ومرحلة الوسواس) مع رش البكس عند بداية التزهير زيادة معنوية فى صفات النمو وكذلك السرعات الثمرية للنبات من خلال زيادة معنوية فى طول النبات وعدد عقد الساق الرئيسى وعدد الأفرع الثمرية وعدد المواقع الثمرية وعدد الأزهار وعدد اللوز الكلى للنبات ولكن ذلك لم يودى إلى زيادة محصول القطن الزهر / فدان وذلك للزيادة المعنوية فى عدد اللوز غير المتفتح/نبات ونقص النسبة المئوية للتبكير نتيجة لهذه المعاملة.

تشير النتائج إلى أن الرش بالجبرلين فى مرحلة البادرات أو مرحلة الوسواس أو الإيتين معاً متبوعاً برش البكس عند بداية التزهير يودى إلى زيادة معنوية فى محتوى الأوراق من معظم المكونات الكيميائية مثل الكلوروفيل بأنواعه والكاربوهيدرات الكلية المختزلة والغير مختزلة وكذلك المركبات الفينولية. لم يكن للمعاملة بالجبرلين + البكس أى تأثير معنوى على طول السلامة وعدد الأيام من الزراعة حتى ظهور أول زهرة أو تفتح أول لوزة ومتوسط وزن اللوزة والنسبة المئوية للشعر وكذلك صفات الجودة : نعومة ومتانة الشعر بينما كان هناك زيادة معنوية فى معامل البذرة فى موسم ٢٠٠٢ فقط نتيجة للمعاملتين المتضمنتين رش الجبرلين فى مرحلة الوسواس أو رش الجبرلين مرتين بالإضافة إلى رش تالية بالبكس عند بداية التزهير.