Journal of Applied Sciences Research, 9(6): 3497-3507, 2013
ISSN 1819-544X
This is a refereed journal and all articles are professionally screened and reviewed

ORIGINAL ARTICLES

Effect of foliar application of some micronutrients and growth regulators on some Egyptian cotton cultivars

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ABSTRACT

Two field experiments were carried out in Giza Experiment and Agriculture Research Station, Faculty of Agriculture, Cairo University in 2011 and 2012 seasons to study the response of Giza 90 and Giza 92 Cotton cultivars to foliar application of Gibberellic acid (GA_3) at level of 100 ppm and/or Ascorbic acid at level of 500 ppm and spray a combined of each of iron, manganese and zinc each at concentration of 2g / liter with or without application (control). Spraying took place twice, at the beginning of the flowering stage and 15 days later. The results showed that. Cultivars varied significantly in each of plant height, No. of sympodial branches, No. of open bolls per plant, seed index, earliness and seed oil and protein percentage but did not vary significantly in boll weight, seed cotton yield/ feddan and lint percentage in both seasons. Fiber technology differ significantly in fiber length ,strength in both seasons and micronaire value in second seasons. Giza 92 was superior in all traits under study.Application of micronutrients and/or growth regulators particularly (micronutrients + GA_3) significantly affected all traits under study such as, plant height. No. of open bolls per plant, seed index, seed cotton yield / feddan, lint percentage, earliness percentage, seed oil and protein percentage and fiber properties in both seasons. The interaction between cultivars and spraying treatments under study affected all characters under study whereas Giza 92 surpassed Giza 90 when received foliar application with micronutrients + GA_3 100 ppm in all traits under study particularly no. of bolls/ plants, seed cotton yield/feddan, earliness, seed oil and protein percentage and as well the highest fiber length, strength and best reading in Micronaire reading averages in both seasons. Application of micronutrients and/or growth regulators especially (micronutrients + GA_3) increased plant contents from macro and micronutrients (N, P, K, Ca, Fe, Zn and Mn), chlorophylls, carotenoides and also total sugars, total free amino acids and total soluble phenol (in leaf) in both seasons compared with the control treatment. Giza 92 was superior in all traits under study than Giza 90, in these respects.

Key words: cotton, micronutrients, growth regulators, chemical composition.

Introduction

Growth regulators have been reported to increase the yield of seed cotton and lint when were applied to field plants. Naturally occurring and synthetic regulators have an important role in the growth and development processes and hence yield. They also, induce the biosynthesis of allele chemicals, secondary plant constituents that may protect plants against infection injury caused by plant eating pests. Gibberellins, however have the unique ability among plant hormones to stimulate extensive growth of intact plant. Clark and Carpenter (1995) found that, four application of each of the products PGRIV and cytokine (with a nutritional packages) begun at squaring and applied approximately every two weeks thereafter to Pima s-6 cotton, however increased yields by maximum of 370 lbs. Seed cotton /acre compared with the untreated check. (PGR) increase growth, fruit retention and seed cotton yield which promote germination, enhance vegetative growth, activates plant cell metabolism and thereby improves growth and yield. Abd El-Naby (1986) found that, all GA_3 treatment increased no. of open bolls / plant seed cotton yield / plant and boll weight, while lint % and seed index were not significantly affected. Atia and Ebaid (1990) found that, No. of total bolls/plant, boll weight, lint percentage, seed index, seed cotton yield / plant and / Feddan were increased by spraying cotton plants with GA_3.Also, El – Shasly and El Masri (2003) obtained the same results.

With regard to ascorbic acid, some studies have been also reported that, ascorbic acid had positive effect on plant growth and development, ascorbic acid is a product of D-glucose metabolism which affects nutritional cycles activity in higher plants and hence plays an important role in the electron transport system Malik and Singh (1982).

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Factors that decrease photosynthesis or increase respiration increase cotton fruit abscission, among these factors air pollution with cadmium which had two possible mechanism for toxicity on photosynthesis the first mechanism is that cadmium can alter chlorophyll biosynthesis by inhibiting protochlorphyllide reductase. The second one is that cadmium can alter the photosynthetic electron transport by inhibiting the water splitting enzyme located at the oxidizing site of photo system (Lagriffoul *et al*., 1998). Baunernfeind 1982) reported that, spraying plant with ascorbic acid gives plants protection against the air polluting damage, or due to its role in protecting the plant lipids from peroxidation caused by free radicals (Kunert and Ederer. 1985) and by reducing the concentration of cadmium and consequently its uptake (Amer and Sherif, Fatma 2001). Brav *et al*. (1983) found that, spraying 100 ppm ascorbic acid at the flowering stage gave higher seed cotton yield/ plant and / hectar. Ghourab and Wahdan, Gamalat (2000) found that, one spray with ascorbic acid significantly increased plant height however two sprays at rate of 200 ppm significantly increased the No. of fruiting branches/ plant, no. of open bolls/ plant as a result of reducing boll shedding and seed cotton yield. El – Shazly and El–Masri (2003) and Elyan, Sohair(2008) Obtained the same results with foliar application of 1000 ppm ascorbic acid.

Foliar nutrition of cotton plant with some micronutrients (Zn, Fe, and Mn) is an attempt to increase cotton growth and yield and seed quality since the Egyptian soil has been affected by its deficiency in micronutrients particularly after building the high Dam. (Nabhan 1966). Abd el – Al *et al*., (1988), Abd El – Shafy (1998) and Abd -El Shafy *et al*. 2001. Also, El-Kahslan *et al*. (1995), Girgis (1992), Wahdan, Gamalat *et al*. (1994) and Elyan, Sohair(2008) obtained the same results with application with micronutrients on cotton plants increased seed oil and protein percentage and leaf chlorophyll. Anderson and Worthington (1972)and El-Kashlan *et al*.(1995)

The aim of this investigation was to study the response of Egyptian cotton cultivars Giza 90 and 92 to foliar application with ascorbic acid, Gibberellic acid, micronutrients as compared with untreated plats regarding yield and plant chemical composition.

Materials And Methods

Two field experiments were carried out in Giza Experimental and Agricultural Research Station, Fac. of Agricultural, Cairo University in 2011 and 2012 seasons to study the response of Giza 90 and Giza 92 cotton cultivars to application of growth regulators and micro elements as follows:

(1) Control (untreated but, sprayed with tap water at the time of foliar application of the other treatments as control.
(2) Micronutrients (Fe, Zn , Mn) 2g/l.
(3) Ascorbic acid 500 ppm. (A.A)
(4) Gibberellic acid at level of 100 ppm (GA_3).
(5) AA + GA3 + micronutrient
(6) Micronutrients + 500 pm A.A.
(7) Micronutrients + 100 ppm GA_3

Whereas the three micronutrients zinc, iron and manganese were applied in the form of zinc sulphate ($ZnSO_4$ -$7H_2O$) ferrous sulphate (Fe_2SO_4. $7H_2O$) and Manganese sulphate ($MnSO_4$ – $4H_2O$) Each micronutrients was sprayed at the concentration of (2g/liter) and the foliar solution was 200 liter/ feddan. Surfactant as solution (Tween20) at the rate of 2g/liter was added.

In all treatments, foliar spray was performed twice, at the beginning of flowering and 15 days later. Using hand operated compressed air at the rate of 200 liter/ fed.

The seeds were planted on the fourth week of March in both seasons in rows 60 cm apart and hills 20 cm apart where two plant per hill were left after thinning . The other cultural practices were carried out according to the usual practices in the cotton fields. The preceding crop was berseem in both seasons. Nitrogen at a level of 60 kg N/fed. as ammonium nitrate (33.5 %N) and potassium (48 kg K_2O/ fed) as potassium sulphate (48% K_2O) were partly split and side dressed at the first and second irrigations. Phosphorus (30 kg P_2O_5) as calcium super phosphate (15.5% P_2O_5) was applied as broadcast during seed bed preparation A split plat design with four replications was used with cultivars in the main plots and spraying treatments in a located sub plots. The plot consisted of 6 ridges 60cm and 4 meter long (3.6 x 4 =14.4) m^2.

Ten guarded plants were taken at random from each plot to determine growth attributes and yield components. Seed cotton yield/ feddan was calculated from the two central rows, of each plot. Soil analysis of the experiments site in the two growing seasons is shown in Table (1).

Table 1: Soil mechanical and chemical analyses of the upper 50cm depth in 2011 and 2012 seasons

Mechanical analysis	2011	2012	Chemical analysis	2011	2012
Clay%	42.71	48.29	Available N(ppm)	22.2	25.3
Silt%	39.23	34.73	Available P(ppm)	6.9	7.8
Sand%	15.23	14.46	Available K(ppm)	250.0	240.0
$CaCO_3$ %	2.70	2.40	Available Fe (ppm)	8.1	8.2
TSS%	0.13	0.12	Available Mn (ppm)	4.3	5.7
Texture	Clay loam	Clay loam	Available Zn (ppm)	0.8	0.9
pH	8.3	8.6	Ec mmohs/cm 25C	0.96	0.85

Studied traits:

A- Growth traits:

1- Plant height (cm).
2- No. of sympodial branches / plant.

B- Yield and yield components:

1- No. of open boll/ plant.
2- Boll weight (g)
3-Seed index (g)
4- Seed cotton yield/feddan. (kentar =157 kg)
5-Earliness %: Determined as percentage of seed cotton yield of first pick to total seed cotton/ plot.
6- Lint percentage. Sample lint weight to seed cotton weight expressed as percentage.

C-Seed quality:

1- Seed oil and protein percentage were determined by the methods described by A. O. A. C (1975).

D- Fiber properties:

The following fiber properties were measured as follows:
1-Fiber length was determined by the digital fibrograph .
2- Fiber strength (pressely index) by using the pressely tester at zero gauge length and recorded as pressely index values.
3-Fiber fineness measured by micronair apparatus in Micronair units fiber study was conducted at the Faculty of Agriculture, Cairo University in fiber lab .

E- leaf nutrient content:

After 120 days from sowing, a sample of 20 leaves was taken from the youngest fully expanded leaf (4^{th} leaf from the apex of the main stem) from each plot (Gebaly2011). Leaf sample was analyzed after preparation to determine the nutritional status of cotton plant as follows.

Total N with Micro – Keldahl method Allen (1953). Other nutrient extraction total P, K, Ca, Fe, Zn and Mn were determined according to the procedures suggested by (Chapman and Prott, 1978). Leaves concentrations of chlorophyll a, b and carotenoid were determined using colorimetric method as described by Nornai.(1982)

Mean values were compared at 0.05 level by Duncan's and Multiple Range Test according to Snedecor and Cochran (1981).

Soil analysis was performed according to Jackson (1973) except for micronutrients determined according to Lindsay and Norvell (1978).

Results And Discusston

A- Plant growth attributes:

It is evident from Table (2) that, cotton varieties varied significantly in plant height and No. of fruiting branches/ plant where Giza 92 had at par taller plants than Giza 90 in the two seasons. Growth regulators and trace elements had a significant effect on plant height where, use of micronutrient + GA_3 gave the highest averages of plant height as compared with the other and control treatment. This may be due to significant increased in each of No. of main stem internodes and/or internodes length. GA_3 treated plants might have had consequently increased GA_3 biosynthesis which has a role in cell division and expansion and hence internodes

elongation, this result is in agreement with those obtained by Wahdan, Gamalat (1990) and El – Shazly and Masri (2003). GA3 also might have had increased the leaf macro and micronutrient contents this in turn might have increased the production of metabolites, synthesized and thus the plant had the chance to bear more fruiting branches. The interaction between varieties and micronutrient + GA_3 had significant affections on plant height and number of sympodial branches / plant in both seasons as shown in table (3) where the highest averages of plant height and no. of sympodial branches were recorded by Giza 92 when plants were sprayed with micronutrient + GA_3 compared with untreated treatment (control).

Use of micronutrient on cotton plant significantly increased plant height and No. of fruiting branches

Table 2: Main effects of varieties, growth regulators and/or micronutrients on some growth and yield attributes in the two seasons.

Main effects	Plant height (cm)		No. of fruiting branches/plant		No. of open bolls/plant		Seed index (g)		Boll weight (g)		Seed Cotton yield/fed. (K.)	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Varieties												
Giza 90	130.98	135.84	13.58	15.05	15.21	15.50	9.64	9.84	2.24	2.42	9.26	9.92
Giza 92	135.10	138.38	14.40	16.25	15.92	16.62	9.90	10.14	2.27	2.48	9.51	10.25
F test	*	*	*	*	*	*	n.s	*	n.s	n.s	n.s	n.s
1-Control	120.35	123.80	12.00	12.85	13.70	13.95	9.04	9.11	2.00	2.09	8.25	8.62
2- Micro.	123.95	126.60	12.75	14.20	14.45	14.70	9.47	9.56	2.13	2.28	8.94	9.35
3-A A (500 ppm)	128.0	130.45	12.95	14.85	15.05	15.45	9.57	9.66	2.20	2.38	9.07	9.81
4-GA3 (100 ppm)	134.30	137.65	14.25	16.20	15.40	15.85	9.56	9.82	2.28	2.46	9.46	10.15
5-AA+ GA3+micron	136.95	142.45	14.95	16.55	16.35	16.70	9.61	10.20	2.32	2.57	9.71	10.36
6- Micro.+AA	140.35	147.00	15.35	17.75	16.70	17.45	10.45	10.46	2.38	2.68	9.90	11.05
7- Micro. +GA3	147.40	151.35	15.70	17.80	17.35	18.35	10.70	10.98	2.50	2.73	10.33	11.26
LSD at 0.05 level	4.74	5.12	1.04	1.16	1.66	1.82	0.22	0.18	0.25	0.50	0.53	0.78

AA=Ascorbic acid (micro) = micronutrient Fe, Mn, Zn. GA_3= Gibberellic acid

Abd -El Al *et al*. (1988), Girgis (1992) Wahdan *et al*. (1994) and Abd El – Shafy (1998). Spraying of micronutrient increased significantly plant height, No. of sympodial branches/ plant compared to untreated plants. The increase in growth characters might be due to that manganese acts as an activator for many enzymes which promote plant growth and flower production (Ohki, 1973) also these increase may be due to the influence of zinc on auxin level. As for iron it is an essential element for plant growth, photosynthesis and other light dependant processes (Amberger, 1974).

B- Yield and yield components:

Data in Tables 2,3,4 and 5 showed that varieties, had a significant effect on No of open bolls / plant and seed index (second season) and Earliness percentage in both seasons where Giza 92 was superior to Giza 90 regarding these characters. Cultivars didn't differ significantly in seed index (first season) boll weight, seed cotton yield/fed. and lint percentage.

The foliar application treatments had a significant effect on yield and yield component traits in both seasons such as no. of open bolls/ plant, seed index, boll weight, seed cotton yield / fed, lint % and Earliness percentage in both seasons. The use of (micronutrient + GA_3) spraying treatment recorded the higher readings in all traits in both seasons.

Regarding to GA_3 treated plants that produced higher No. of open bolls / plant, heavier bolls and higher seed cotton yield / feddan as compared with the control treatment, this may be due to that sprayed cotton plants with GA_3 produced larger number No. of flowers / plant with a significant increase in boll set (Abd el - Al, 1981).

As GA_3 antagonize, the effect of abscisic acid (ABA), which causes boll shedding or to that gibberellins may retard abscission of intact fruit by mobilizing. nutrients to that fruit and by stimulating growth. Bondok at al., (1999a,b) and El-Shazly and Masri (2003) found that spraying cotton plant with GA3 significantly increased the level of auxin and gibberellin like substances over the control.

Abd El - Naby (1986) reported that GA_3 treatment increased no. of open bolls/plant, boll weight and seed cotton yield / fed. While seed index and lint percentage were not significantly affected Abdel -Al *et al*., (1990) come to the same result. Atia and Ebaid (1990)Wahdan, Gamalat (1990) and El – Shazly and El – Masri (2003) reveled that spraying cotton plant with GA_3 increased No. of open bolls, boll weight, lint percentage, seed index and seed cotton yield/ feddan.

Table 3: The effect of first order interaction of cotton varieties and micronutrients and/or growth regulators on some growth attributes and yield components in the two seasons.

Treatment	Plant height (cm)		No. of fruiting branches/plant		No. of open bolls/plant		Boll weight (g)		Seed Cotton yield/fed. (K.)		Seed index (g)	
	Varieties		Varieties		Varieties		Varieties		Varieties		Varieties	
	G90	G92	G90	G92	G90	G92	G90	G92	G90	G92	G90	G92
2011												
Control	119.9	120.8	11.8	12.2	13.5	13.9	1.98	2.02	8.17	8.33	9.00	9.08
Micro.	123.6	124.3	12.4	13.1	14.3	14.6	2.08	2.19	8.85	9.03	9.36	9.58
A A	127.2	128.8	12.5	13.4	14.9	15.2	2.16	2.24	8.91	9.24	9.44	9.70
GA_3	129.7	138.9	13.9	14.6	15.1	15.7	2.29	2.28	9.45	9.48	9.49	9.63
AA+GA_3+micro.	133.8	140.1	14.6	15.3	15.9	16.8	2.24	2.30	9.65	9.78	9.51	9.72
Micro.+AA	137.2	143.5	14.8	15.9	16.0	17.4	2.38	2.39	9.82	9.99	10.11	10.79
Micro. +GA3	145.5	149.3	15.1	16.3	16.8	17.9	2.48	2.52	10.02	10.76	10.58	10.83
LSD 0.05	5.48	6.11	0.65	1.66	0.33	0.42	0.11	0.09	1.22	0.43	0.97	0.76
2012												
Control	122.1	125.5	12.6	13.1	13.9	14.0	2.07	2.11	8.54	8.70	9.03	9.19
Micro.	125.4	127.8	13.7	14.7	14.6	14.8	2.18	2.38	8.89	9.82	9.47	9.66
A A	129.7	131.2	14.2	15.5	15.0	15.9	2.33	2.43	9.61	10.02	9.59	9.73
GA_3	135.8	139.5	15.5	16.9	15.2	16.5	2.43	2.50	10.00	10.31	9.76	9.89
AA+GA_3+micro.	140.6	144.3	15.8	17.3	15.7	17.7	2.55	2.59	10.05	10.68	9.81	10.80
Micro.+AA	147.2	146.8	16.5	17.8	16.3	18.6	2.70	2.66	11.14	10.97	10.31	10.92
Micro. +GA3	150.1	153.6	17.1	18.5	17.8	18.9	2.72	2.74	11.22	11.30	10.91	11.05
LSD 0.05	7.21	6.52	0.92	0.84	0.45	0.51	0.26	0.13	1.47	1.07	1.02	0.79

AA=Ascorbic acid (Micro.)= micronutrient Fe, Mn, Zn. GA_3= Gibberellic acid

Table 4: Main effects of cotton varieties growth regulators and/or micronutrient on some growth attributes and yield components in the two seasons.

Main effects	Lint %		Earliness %		Fiber length (m.m.)		Fiber strength		Micronaire reading	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Varieties										
Giza 90	35.21	36.13	52.95	57.67	30.49	30.72	35.01	35.72	3.87	4.24
Giza 92	35.62	36.70	60.12	63.58	33.50	33.98	44.07	44.45	3.35	3.39
F test	n.s	n.s	*	*	*	*	n.s	*	*	n.s
Control	34.13	34.84	49.64	54.94	30.68	31.03	36.84	36.65	3.38	3.49
Micro.	34.26	35.02	51.29	57.59	31.47	31.70	37.84	37.93	3.38	3.48
A A	34.54	35.50	54.69	59.83	31.70	31.94	38.36	39.08	3.49	3.69
GA3	35.66	36.65	59.07	61.53	32.19	32.44	40.29	40.14	3.65	3.84
AA+GA3+micro.	35.90	37.19	59.82	61.93	32.43	32.81	40.97	41.85	3.73	4.00
Mic.+AA	36.28	37.7	60.31	63.08	32.66	33.16	41.14	42.29	3.79	4.06
Micro. +GA3	37.16	38.03	62.45	65.48	32.86	33.38	41.35	42.65	3.97	4.16
LSD 0.05	1.08	0.9	5.41	6.60	0.16	1.20	2.40	3.43	0.33	0.27

AA=Ascorbic acid (micro) = micronutrient Fe, Mn, Zn. GA_3= Gibberellic acid

Data demonstrate that No. of open bolls per plant, boll weight and seed cotton yield / feddan were increased with spraying micronutrient compared to the control. The beneficial effect of spraying trace micronutrient elements could be attributed to the role of micronutrient on fundamental metabolic reactions and acceleration of protein synthesis which affects boll development and hence promoting open bolls number which resulted in increased seed cotton yield of the first picking showing there by a major role in boll ripening. Girgis (1992) and El – Kashlan *et al* (1995), indicated that the increase in seed index might be due to increase in the amount of the metabolites synthesized by the plants.

Regarding the interaction between varieties and spraying micronutrients and growth regulators had a significant effect on yield and yield components in both seasons whereas spray cotton plant (Giza 92) with (trace element + GA_3) superior in all traits under study in both seasons.

C- Fiber properties:

Data in Tables (4) and (5) reveled that all fiber properties under study were significantly affected by spraying cotton plant with micronutrient and / or growth regulators in both seasons.

Namich, Alia (2006) found that, spraying growth regultors did not significantly affects micronaire reading and other fiber properties. Elayan, Sohair (2008) showed that, auxin had significant effects on fiber length and fiber fineness.

Table 5: The effect of first order interaction of cotton varieties and micronutrients and/or growth regulators on some attributes and yield components in the two seasons.

Treatment	Lint %		Earliness %		Fiber length (m.m.)		Fiber strength		Micronaire reading	
	Varieties		Varieties		Varieties		Varieties		Varieties	
	G90	G92	G90	G92	G90	G92	G90	G92	G90	G92
2011										
Control	34.00	34.26	49.55	49.73	29.11	32.25	32.11	41.58	3.45	3.11
Micro.	34.16	34.37	47.23	52.36	29.65	33.30	33.62	42.07	3.49	3.28
A A	34.28	34.80	50.11	59.27	29.99	33.42	34.42	42.30	3.56	3.43
GA_3	35.56	35.76	54.00	64.15	30.87	33.51	35.76	44.82	3.74	3.51
AA+GA_3+micro.	35.89	35.91	54.69	64.96	30.99	33.88	36.20	45.75	4.20	3.27
Micro.+AA	36.28	36.29	55.50	65.13	31.35	33.97	36.37	45.92	4.27	3.32
Micro. +GA3	36.33	37.99	59.62	65.29	31.52	34.20	36.59	46.11	4.39	3.56
LSD 0.05	1.08	1.23	3.66	4.97	0.99	1.13	2.04	2.33	0.35	0.21
2012										
Control	34.57	35.11	53.48	56.41	29.57	32.50	32.29	41.02	3.90	3.09
Micro.	34.80	35.24	56.79	58.39	29.78	33.63	34.11	41.75	3.86	3.10
A A	35.10	35.91	57.00	62.67	30.01	33.87	34.93	43.23	4.11	3.27
GA_3	36.44	36.86	57.71	65.35	30.95	33.93	36.56	43.72	4.38	3.32
AA+GA_3+micro.	36.73	37.65	58.13	65.74	31.12	34.51	36.78	46.93	4.42	3.59
Micro.+AA	37.51	37.89	59.35	66.82	31.66	34.67	37.59	47.00	4.50	3.63
Micro. +GA3	37.78	38.29	61.23	69.73	31.96	34.79	37.80	47.50	4.53	3.79
LSD 0.05	2.13	1.97	4.20	7.20	1.07	1.62	2.83	3.52	0.19	0.14

AA=Ascorbic acid (micro) =micronutrient Fe, Mn, Zn. GA_3= Gibberellic acid

D- Chemical constituents of cotton plants:

D- 1- Seed oil and protein content:

Data in table (6) showed that, the tested treatments gave a significant effect on oil and protein percentages in cotton seeds in the two seasons. Both characters were increased by using (micronutrient + GA_3) compared with the control treatment. Whereas Giza 92 with spray (micronutrient + GA_3) recorded the highest values in oil and protein percentage in both seasons 22.93, 22.11 %) and (21.56, 22.25 %) respectively. Abd El – Shafy (1998) and Wassel (2000) found that, spraying cotton with micronutrient led to a significant increase in seed oil and protein percentage. The beneficial effect of spraying with trace elements could be attributed to the role of trace elements on fundamental metabolic reactions and acceleration protein synthesis which affects boll development and formation Meyer and Anderson (1972) and El-Hamawi (1977).

Table 6: Effects Gibberellic acid, Ascorbic acid and Micronutrient on oil , and crude protein(C.P.) percentages of cotton seeds in both seasons.

Varites	Treatment	Oil %		C.P %	
		2011	2012	2011	2012
Giza 90	Control	18.23	19.11	17.06	17.88
	Micro.	18.99	19.30	17.30	18.94
	A A (500 ppm)	19.60	20.83	18.69	17.00
	GA_3 (100 ppm)	19.73	20.91	19.19	19.88
	AA+ GA3+Micro.	19.86	21.65	17.69	18.00
	Micro. +AA	20.43	21.88	16.81	17.88
	Micro. +GA_3	20.51	22.93	22.00	21.56
Mean		19.62	20.94	18.39	18.59
Giza 92	Control	19..22	19.51	17.44	18.00
	Micro.	19.53	20.50	18.24	19.94
	A A (500 ppm)	19.75	20.96	19.81	18.31
	GA_3 (100 ppm)	19.93	21.86	20.75	19.31
	AA+ GA_3+ Micro.	20.11	21.93	19.75	18.94
	Micro. +AA	20.53	22.09	18.13	18.31
	Micro. +GA_3	21.25	22.11	23.44	22.25
Mean		20.05	21.28	19.65	19.29

AA=Ascorbic acid (micro) =micronutrients Fe, Mn, Zn. GA_3= Gibberellic acid

D- 2 -Chlorophylls and Caritonoieds:

Data in table (7) showed that, the spraying treatments gave a higher Chlorophylls and Caritonoieds contents in cotton leaves in the two seasons. Both characters were increased by using (micronutrient + GA_3) compared with the control treatment. Whereas Giza 92 with spray (micronutrient + GA_3) recorded the higher average in Chlorophylls and Caritonoieds in both seasons.

In this respect ,Kassem *et al.* (2009) found that cotton plants treated with various treatments of IAA and kinetin showed higher leaves content of chlorophyll a, b and total chlorophyll .Also , addition of GA_3 increased chlorophyll Zaghlool and Ibrahim,(2006).

Table 7: Effect of foliar application of Gibberellic acid , Ascorbic acid and Micronutrient on chlorophyll a and b and carotenoides in leaves of cotton plants (120 days after planting) 2011-2012 seasons

Varites	Treatment	Chlorophyll a(mg/g fw)		Chlorophyll b(mg/g fw)		Caritonoides(mg/g fw)	
		2011	2012	2011	2012	2011	2012
Giza 90	Control	0.80	0.86	0.29	0.32	0.08	0.09
	Micro.	0.85	0.88	0.43	0.45	0.09	0.10
	A A (500 ppm)	0.90	0.94	0.32	0.46	0.09	0.10
	GA_3 (100 ppm)	0.99	0.97	0.41	0.42	0.10	0.11
	AA+ GA_3+ micro.	0.97	1.00	0.44	0.43	0.11	0.11
	Micro. +AA	1.03	1.02	0.63	0.56	0.11	0.12
	Micro. +GA_3	1.04	1.03	0.64	0.61	0.13	0.14
	Mean	0.84	0.96	0.45	0.46	0.10	0.11
Giza 92	Control	0.88	0.87	0.40	0.41	0.09	0.09
	Micro.	0.98	0.96	0.41	0.43	0.10	0.10
	A A (500 ppm)	0.99	0.99	0.43	0.45	0.10	0.11
	GA_3 (100 ppm)	1.00	1.01	0.44	0.47	0.10	0.11
	AA+ GA_3+ micro.	1.00	1.00	0.46	0.45	0.10	0.11
	Micro. +AA	1.01	1.02	0.49	0.50	0.11	0.12
	Micro. +GA_3	1.03	1.05	0.52	0.54	0.12	0.15
	Mean	0.98	0.98	0.45	0.46	0.10	0.11

AA=Ascorbic acid (micro) =micronutrient Fe, Mn, Zn. GA_3= Gibberellic acid

D -3- Macro and micronutrients:

Data in tables (8,9and10) show the effect of foliar application of GA_3, AA and trace elements on N,P,K and Ca cotton leaves and seeds and Fe , Zn and Mn in leaves at 120 days after planting only two seasons .The highest average of N,P,K and Ca were obtained from application of (GA_3 + micronutrient) followed by foliar application of 100 ppm GA_3 and 500ppm AA respectively compared with the other and control treatments. The same trend of is shown results in table (10) on leaves in the two seasons where all treatments showed the higher average than untreated plants. The positive response of leaves macro and micronutrients to GA_3 may be due to its role in enhancing an organ ability to function as a nutrient sink (Addicott and Addicott1982). Also (Housley and Deverall,1961) indicated that GA_3 significantly increased the leaf macro and micronutrients contents under study as shown in tables(8,9 and 10) might have had increased the production of metabolites synthesized and thus the plant had the chance to bear more fruiting branches. Moreover, GA_3 treatment might have had led to the production of an inhibitor which retarded auxin destroying system namely the IAA oxidation system. Furthermore, Bondok *et al.*(1991 a&b) found that GA_3 applied to cotton plant significantly increased the levels of auxin and gibbereillin –like substances over the control and recorded insignificant levels of inhibitors.

The favorable effect of AA on leaf macronutrients (N,P,K and Ca) content and leaf micronutrients (Fe, Zn and Mn) content may be due to that ascorbic acid enhances nutritional status in higher plants as reported by (Grun *et al*.1982). Also (Rady and El Sawah 2009) reported that the effect of antioxidants, especially ascorbic acid on producing healthy plants leads to enhancing the plants to have a great ability for uptake of elements. Moreover, Gonzaiez- reyes *et al*.(1994) concluded that ascorbate free radical caused hyper polarization of plasma membranes, and this energization could then facilitate transport processes across such membranes .Most of the previous results are in consistent with those of Ali (2000)), Rady and El-sawah(2009).

Data in table (10) show the effect of foliar application of GA_3, AA and trace elements on determination of Fe , Zn and Mn on leaves only in the two seasons .All treatments showed the higher average of micronutrients than the control .In this respect Abdel-S hafy *et al*.(2001) reported that spraying Fe, Zn and Mn twice i.e. at beginning of flowering stage and 15 days later gave the best effect in promoting plant growth, yield and chemical constituents of leaves and seeds the increase in growth characters might be due to that manganese acts as an activator for many enzymes which promote plant growth and flower production (Ohki 1973). Also this increase may be due the influence of zinc on auxin level (Skoog,1940).

Table 8: Effects Gibberellic acid, Ascorbic acid and Micronutrient on N, P, K and Ca in cotton leaves at 120 days after planting 2011-2012 seasons

Varites	Treatment	N %		P%		K%		Ca%	
		2011	2012	2011	2012	2011	2012	2011	2012
	Control	2.23	2.11	0.28	0.29	2.16	2.20	0.88	0.92
Giza 90	Micro.	2.30	2.26	0.25	0.28	2.41	2.45	0.93	0.98
	A A (500 ppm)	2.33	2.41	0.26	0.30	2.54	2.57	0.97	0.95
	GA_3 (100 ppm)	2.47	2.53	0.31	0.33	2.68	2.61	1.11	1.21
	AA+ GA_3 micro.	2.33	2.43	0.29	0.27	2.61	2.59	0.98	1.00
	Micro. +AA	2.44	2.36	0.31	0.29	2.66	2.63	1.21	1.42
	Micro. +GA_3	2.50	2.57	0.36	0.34	2.83	2.96	1.31	1.43
	Mean	2.37	2.38	0.29	0.30	2.56	2.57	1.06	1.13
	Control	2.25	2.36	0.23	0.25	2.18	2.21	0.90	0.92
	Micro.	2.36	2.31	0.26	0.25	2.44	2.37	0.95	0.95
Giza 92	A A (500 ppm)	2.39	2.41	0.28	0.29	2.41	2.42	0.98	1.01
	GA_3 (100 ppm)	2.50	2.46	0.32	0.33	2.78	2.80	1.10	1.12
	AA+ GA_3+micro.	2.45	2.37	0.28	0.31	2.66	2.71	1.05	1.13
	Micro.+AA	2.50	2.45	0.3 0	0.36	2.31	2.34	1.32	1.22
	Micro. +GA_3	2.57	2.55	0.30	0.37	3.10	3.11	1.36	1.29
	Mean	2.43	2.41	0.30	0.31	2.55	2.42	1.13	1.09

AA=Ascorbic acid (micro) = micronutrient Fe, Mn, Zn. GA_3= Gibberellic acid

Table 9: Effects Gibberellic acid, Ascorbic acid and Micronutrient on N, P, K and Ca of cotton seeds in the 2011-2012 seasons

Varites	Treatment	N %		P%		K%		Ca%	
		2011	2012	2011	2012	2011	2012	2011	2012
	1-Control	3.22	3.37	0.24	0.22	0.96	0.94	0.65	0.61
Giza 90	Micro.	3.26	3.38	0.28	0.27	1.21	1.17	0.76	0.72
	A A (500 ppm)	3.53	3.21	0.31	0.28	1.24	1.20	0.81	0.77
	GA_3 (100 ppm)	3.62	3.75	0.33	0.30	1.60	1.54	0.92	0.94
	AA+ GA_3+ micro.	3.34	3.40	0.27	0.28	1.42	1.32	0.94	0.90
	Micro. +AA	3.17	3.37	0.32	0.30	1.63	1.58	0.98	0.98
	Micro. +GA_3	4.15	4.07	0.35	0.34	1.91	1.84	1.00	0.99
	Mean	3.47	3.51	0.30	0.28	1.42	1.37	0.87	0.84
	Control	3.29	3.40	0.22	0.21	1.22	1.18	0.67	0.65
	Micro.	3.44	3.76	0.27	0.25	1.34	1.28	0.78	0.74
Giza 92	A A (500 ppm)	3.74	3.45	0.30	0.28	1.37	1.30	0.87	0.82
	GA_3 (100 ppm)	3.92	3.64	0.35	0.33	1.66	1.68	0.95	0.95
	AA+ GA_3+ Micro.	3.73	3.57	0.33	0.30	1.42	1.46	0.94	0.91
	Micro. +AA	3.42	3.45	0.33	0.33	1.31	1.28	1.04	1.01
	Micro.+GA_3	4.42	4.20	0.39	0.37	1.99	1.97	1.05	1.03
	Mean	3.71	3.64	0.31	0.30	1.47	1.45	0.90	0.87

AA=Ascorbic acid (micro) = micronutrient Fe, Mn, Zn. GA_3= Gibberellic acid

Table 10: Effects Gibberellic acid, Ascorbic acid and Micronutrient on Fe ,Zn and Mn in cotton leaves at 120 days after planting 2011-2012 seasons

Varites	Treatment	Fe (ppm)		Zn(ppm)		Mn(ppm)	
		2011	2012	2011	2012	2011	2012
	Control	216.2	209.5	34.52	37.71	44.44	45.11
Giza 90	Micro.	260.0	258.4	40.41	41.51	49.43	52.11
	A A (500 ppm)	249.0	247.0	42.80	44.81	50.81	49.40
	GA_3 (100 ppm)	252.4	251.0	47.71	49.72	54.66	55.16
	AA+ GA_3+ micro.	261.4	266.0	43.91	44.11	53.43	54.41
	Micro. +AA	266.2	271.0	44.11	46.33	56.61	54.15
	Micro. +GA_3	271.3	276.0	49.81	50.11	61.80	63.70
	Mean	253.8	254.4	43.32	44.78	53.03	53.43
	Control	221.0	227.1	36.72	35.82	43.32	44.51
	Micro.	263.3	259.3	41.17	42.61	52.91	55.11
Giza 92	A A (500 ppm)	251.0	253.4	43.22	45.18	51.18	50.17
	GA_3 (100 ppm)	268.2	271.5	44.41	47.11	56.71	53.21
	AA+ GA_3+ micro.	263.2	269.4	43.60	48.43	53.61	50.11
	Micro. +AA	270.0	273.0	45.11	50.12	57.71	54.40
	Micro. +GA_3	275.1	279.2	49.96	53.20	62.42	65.33
	Mean	258.8	261.8	43.46	46.07	53.98	53.26

AA=Ascorbic acid (micro) = micronutrient Fe, Mn, Zn. GA_3= Gibberellic acid

As for iron it is an element essential for photosynthesis and other light depending processes (Amberger,1974). The present results indicate that GA_3 increased the leaves macro and micronutrients contents and hence improved cotton plant growth.

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d- 4-Total sugars, total free amino acids and total soluble phenol:

Data in tables (11) and (12) show the effect of foliar application of GA_3, AA and Micronutrients on total sugars, total free amino acids and total soluble phenols in leaves and seeds in the two seasons. The highest averages in leaves and seeds of total sugars , total free amino were obtained from application of (GA_3 + Micronutrients) followed by foliar application of 100 ppm GA_3 and 500 ppm AA respectively compared with the other and control treatments followed by GA_3 and AA. Treatment by AA increased total sugars than control in both cultivars. This may be due to AA seemed to stimulate the biosynthesis of carbohydrate contents ie. reducing- and total soluble sugars (Ghourab and Wahdan, Gamalat 2000).

On the other hand El-Sayed and El-Menshawi (2006) reported that ,spraying or soaking IAA gave an increase in carbohydrate components (reducing –non reducing- total soluble sugars) compared with control. This increases may be due to either the stimulation of carbohydrate formation by photosynthesis

Concerning the effect of foliar application of GA_3, AA and trace elements on determination of total soluble phenols in cotton leaves in the two seasons, the results in table (11) showed that, application of trace elements + GA3 increased total soluble Phenols on cotton leaves as compared with the control . This effect may be due to the increase in biosynthesis of such compounds from other related compounds such as carbohydrate and amino acids. In this connection, Alia and Kassem(2002) found that ,certain monophenols enhanced abscission in cotton, and they found that there is a role of phenols in abscission prosccion process. Moreover Shahid and Wanasundara (1992) stated that ,phenolic antioxidants play important roles as free radical terminators and sometimes, as a metal chelators.

Table 11: Effects Gibberellic acid, Ascorbic acid and Micronutrient on total sugars , total free amino acids(mg/g D.W.) and total soluble phenol (mg/g F.W.) in cotton leaves at 120 days after planting 2011-2012 seasons

Varites	Treatment	total sugars (mg/g)		total free amino acids (mg/g)		total soluble phenol (mg/g)	
		2011	2012	2011	s 2012	2011	2012
	Control	12.14	13.55	5.96	5.99	1.22	1.33
Giza90	Micro.	14.00	15.04	5.70	5.82	1.16	1.24
	A A (500 ppm)	15.86	16.21	6.69	5.78	1.38	1.51
	GA_3 (100 ppm)	15.42	14.65	7.14	6.91	1.92	2.01
	AA+ GA_3+ micro.	14.66	15.11	6.92	6.97	1.38	1.44
	Micro. +AA	13.11	14.36	6.14	5.21	1.82	1.92
	Micro. +GA_3	16.86	16.61	7.64	7.91	2.43	2.51
Mean		14.55	15.06	6.60	6.37	1.62	1.71
	Control	13.20	13.61	5.74	6.11	1.27	1.42
	Micro.	15.13	14.62	5.98	6.01	1.77	1.82
Giza 92	A A (500 ppm)	16.10	15.11	6.78	6.96	1.37	1.48
	GA_3 (100 ppm)	16.00	16.72	7.17	6.99	1.63	1.88
	AA+ GA_3+ micro.	15.36	15.38	6.95	6.96	2.24	2.11
	Micro. +AA	14.34	15.36	6.10	7.22	2.58	2.41
	Micro. +GA_3	16.55	16.41	8.58	8.71	2.92	3.11
Mean		15.25	15.32	6.76	6.99	1.97	2.03

AA=Ascorbic acid (micro) =Micronutrient Fe, Mn, Zn. GA_3= Gibberellic acid

Table 12: Effects Gibberellic acid, Ascorbic acid and Micronutrient on total sugars and total free amino acids (mg/g D.W.) of cotton seeds in the 2011-2012 seasons

Varities	Treatment	Total sugars (mg/g)		Total free amino acids(mg/g)	
		2011	2012	2011	2012
	Control	14.36	14.46	0.59	0.61
Giza 90	Micro.	15.20	15.70	0.79	0.82
	A A (500 ppm)	16.01	15.92	1.63	1.72
	GA_3 (100 ppm)	16.11	16.31	1.07	1.11
	AA+ GA_3+ Micro.	15.46	16.00	0.88	0.96
	Micro. +AA	16.01	15.81	0.87	0.88
	Micro. +GA_3	16.45	15.54	1.83	1.85
Mean		15.66	15.82	1.09	1.14
	Control	13.68	14.11	0.82	0.81
	Micro.	16.10	15.82	1.42	1.44
Giza 92	A A (500 ppm)	17.01	16.13	1.09	1.12
	GA_3 (100 ppm)	16.60	16.62	1.05	1.03
	AA+ GA_3+Micro.	16.68	16.31	0.99	1.02
	Micro. +AA	16.61	16.11	1.04	1.03
	Micro. +GA_3	16.86	16.93	1.66	1.82
Mean		16.22	15.96	1.15	1.18

AA=Ascorbic acid (micro) = Micronutrient Fe, Mn, Zn. GA_3= Gibberellic acid

In this study Micronutrients Fe, Mn and Zn sprayed for two tims at the beginning of flowering stage and the following spray after 15 days + GA_3 (100 ppm) gave the best effect in promoting plant growth, yield , oil and protein percent and chemical constituents of leaves and seeds.

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