

Effect of some chemicals on growth, fruiting, yield and fruit quality of "Succary Abiad" mango cv.

Wahdan, M. T., Habib, S. E., Bassal, M. A. And Qaoud, E. M.

Department of horticulture, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt.

Wahdan2011@gmail.com

Abstract : The present investigation was carried out in two successive seasons of 2007 and 2008 on mango cv. "Succary Abiad", at Abou Swear region, Ismailia Governorate, Egypt in a sandy soil and irrigated with immersed irrigation system, to study the effect of some chemicals and growth regulators on growth, leaf mineral contents, fruiting, yield and fruit quality. The trees were subjected to eleven treatments using urea 2%, NAA 40 and 60 ppm, Ca Cl₂ 2%, GA₃ 20 and 40 ppm and water spraying as control. The results revealed that, spraying with urea, NAA and GA₃ at all concentrations significantly increased shoot length, number of leaves per shoot and leaf area higher than control while urea showed the superiority effect. Nitrogen and Potassium content in leaves significantly increased within urea, NAA and GA₃ higher than control. Calcium content in the leaves showed fluctuated values during the two seasons within the different treatments although Ca Cl₂ 2% sprayed at two months after full bloom showed the highest values in the two seasons of study. All treatments had significantly higher yield than control in the two seasons. The fruit weight and volume were the highest within all treatments compared with control. Fruit firmness and SSC were increased within all treatments with significant increments than control. Vitamin C was significantly increased in fruits harvested from trees sprayed with GA₃ 40 ppm at two months after full bloom. Total sugars in the fruits significantly increased higher than control within all treatments except GA₃ 20 ppm added at one month after full bloom.

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1. Introduction

Mango (*Mangifera indica* L) is considered the king of fruits in many countries (Purseglove, 1972). In Egypt, mango cultivated area reached 184204 fed. (Ministry of Agriculture, 2007). More than 40% of this areas exists in Ismailia, which the main cultivar planted is "Succary Abiad". Mango yield worldwide are generally poor, ranging from 4 to 9 t/ha in the major production countries (Oosthuyse, 1993). This is attributable to wide tree spacing malformation, alternate bearing, environmental factors and fruit drop (Jana and Sharangi, 1998).

In spite of adequate flowering, low fruit yield in mango orchards have been experienced because of low initial fruit set and subsequently higher fruitlet abscission (Singh and Singh, 1995). Fruitlet abscission is a very complex physiological process, occurs in many cultivars of mango and at all stages of development, but it is particularly high during the first 3-4 weeks after pollination and accounts for over 90 % loss of set fruitlets (Bains, *et al.*, 1997 and Wahdan and Melouk, 2004).

Several factors affect fruitlet abscission and some of the reasons suggested are the lack of pollination and failure of fertilization, ovule abortion, and embryo degeneration, hormone content, climatic factors (day length, temperature and wind),

inadequate soil moisture and low photosynthate level (Whiley, 1986 and Bains, *et al.*, 1997).

The use of growth substances and some chemical compounds may regulate fruit set in many fruit crops. Many investigators found that spraying mango trees with NAA at different concentrations (20, 25 and 40 ppm) increased fruit set percentages and fruit retention (Oksher *et al.*, 1980 and Singh and Ram, 1983). Auxin is well known as inhibitors of ethylene action in a number of plants (Beyer, 1976). Moti-Singh *et al.*, (1987) with Langra and Dashehari cvs stated that NAA or GA₃ each 5-25 ppm once sprayed at full bloom or twice at full bloom and at pea stage or thrice plus at marble stage increased fruit retention. Singh *et al.* (1991) found that the highest fruit retention and yield/tree were recorded on mango cv. (Amrapali) by spraying urea with 3 % at pea stage.

The main objective of this study was to investigate the effect of some chemicals and growth regulators on growth, leaf mineral contents, fruit set, yield and fruit quality.

2. Materials and Methods

The present study was conducted throughout two successive seasons of 2007 and 2008 on mango cv. "Succary Abiad". The trees were grown in private orchard at Abou Swear region, Ismailia Governorate,

in a sandy soil and irrigated with immersed irrigation system. Trees were 30-year-old, planted at 7×7 m space, grown under the same common agricultural practices. Thirty-three healthy trees were selected nearly similar in vigour and size.

The work in this experiment aimed to study the effect of some chemicals and growth regulators on growth, leaf mineral contents, fruiting, yield and fruit quality of the previously above-mentioned mango cultivar. The experimental treatments were as follow:

- 1- Control treatment was sprayed with tap water.
- 2- Urea 1% sprayed once at full bloom.
- 3- Urea 1% sprayed once at one month after full bloom.
- 4- NAA 40 ppm once at one month after full bloom.
- 5- NAA 60 ppm once at one month after full bloom.
- 6- Ca Cl₂ 2% once at one month after full bloom.
- 7- Ca Cl₂ 2% once at two months after full bloom.
- 8- GA₃ 20 ppm once at one month after full bloom.
- 9- GA₃ 40 ppm once at one month after full bloom.
- 10- GA₃ 20 ppm once at two months after full bloom.
- 11- GA₃ 40 ppm once at two months after full bloom.

Thus, eleven treatments were investigated, where all treatments were arranged in a complete block randomized design and each treatment was replicated three times with one tree per replicate. So, thirty three trees were used (11 treatments × 3 replicates).

Studying parameters:

1. Vegetative growth:

At the beginning of the first growth cycle, ten shoots per tree were tagged.

Shoot length (cm), number of leaves per shoot and leaf area (cm²) by using Electronic Digital Planimeter (HAFF com. Germany) were measured at November.

2. Leaf mineral contents:

Sample of twenty leaves per tree were picked from the 3rd and 4th node below panicle after two months of full bloom. The samples were washed, dried, ground and digested using sulphoric acid and hydrogen peroxide according to Chapman and Pratt (1961). N, P, K and Ca were determined in the digested solution as follows:

- a) Total nitrogen was determined using the micro-Kjeldahl method as described by Pregl (1945).
- b) Phosphorus was estimated colorimetrically by the stannous chloride method according to Truog and Meyer (1929).
- c) Potassium content was determined by Flame photometer according to method of Jackson (1958).

- d) Calcium was determined by titration against versenate solution (Na-EDTA) according to Chapman and Pratt (1961).

3. Fruit set and fruit retention:

The number of fruits per panicle was counted after 15 days of full bloom to determine the initial number of fruits per panicle. The initial fruit set was calculated as a percentage. After recording the initial fruit set, the number of fruits per panicle was recorded at mature stage. The percentage of retained fruits at harvest time was calculated.

4. The yield:

In each season, at harvest time, the numbers of fruits per panicle and per tree were counted for each treatment. Tree yield in kilograms was estimated by multiplying the number of fruits per tree and the average fruit weight.

5. Fruit quality:

At harvest time, samples of 5 firm ripe (commercial stage) fruits were taken from each replicate to study the average of fruit, skin and stone weight (g), fruit length (cm), width (cm), fruit shape index (length/width), fruit thickness (cm), pulp/fruit ratio (net ratio), fruit volume (cm³), fruit firmness (kg/cm²) by using effegi pentrometer, soluble solids content (SSC %) by hand refractometer, fruit acidity, SSC/Acid ratio, vitamin C, total carotene, total, reducing and non-reducing sugars, and total phenols were determined as described by A.O. A. C. (1995).

6. Statistical analysis:

Data were subjected to the analysis of variance and a complete block design was used (Steel and Torrie, 1980). Analysis of variance and mean comparison (LSD, at 5%) were done by MSTAT-C program version 7 (1990).

3. Results

3.1. Effect of spraying Urea, NAA, CaCl₂ and GA₃ on vegetative growth:

All the treatments at all concentrations significantly increased the shoot length compared with control, (Table, 1). The highest values (22.1 and 16.0 cm) were obtained from 20 ppm of GA₃ at one month after full bloom and 2% of urea at one month after full bloom, while the control gave the lowest values (5.3 and 2.3 cm) in the first and second seasons, respectively.

In the same table data showed that, all concentrations of Urea, NAA, CaCl₂ and GA₃ at any date of applications had significant effects on the number of leaves per shoot. The highest values reached 16.6 and 10.2 leaves per shoot with 20 ppm of GA₃ applied at one month after full bloom and 2 % of CaCl₂ applied at one month after full bloom compared with control (7.1 and 4.5 leaves per shoot) in the first and second seasons, respectively.

Results in Table (1), reveal that leaf area significantly increased by using Urea, NAA, CaCl_2 and GA_3 at all concentrations and at any date of applications. GA_3 at 20 ppm when sprayed on mango trees at one month after full bloom gave the highest values (85 and 81.1 cm^2) compared with control (69.9 and 67.1 cm^2) in the first and second seasons, respectively.

content in all treatments was higher than it in control. The higher value of nitrogen in leaves (1.19 %) was proved with 2 % of CaCl_2 at month after full bloom followed by (1.15 and 1.16 %) 2 % of CaCl_2 applied at two months after full bloom and 2 % of Urea sprayed at one month after full bloom, respectively, compared with 1.06 % of control (Table, 1).

Data in the same table show no clear trend for the effect of all treatments on leaf phosphorus content in both seasons.

As for potassium content, all tested treatments at all concentrations recorded significantly higher percentage of leaf potassium contents than those of control in both seasons. Data in Table (1) illustrated that the highest values of leaf potassium content (0.67 and 0.70 %) were obtained from 20 ppm of GA_3 applied at two months after full bloom and 2 % of CaCl_2 sprayed at one month after full bloom compared with control which gave the lowest values of leaf potassium content (0.52 %) in both seasons, respectively.

As for leaf calcium content data presented in the same table show clear trend in this respect, in both seasons the application of 2 % CaCl_2 at two months after full bloom gave the highest values of leaf calcium content (1.44 and 1.31 %) in the first and second seasons, respectively.

3.3. Effect of spraying Urea, NAA, CaCl_2 and GA_3 on fruit retention and yield:

Concerning, fruit retention percentage data in Table (2) illustrated that all treatments in both obtained from trees treated with Urea 2 % at one month after full bloom in both seasons, respectively.

3.4. Effect of spraying Urea, NAA, CaCl_2 and GA_3 on fruit characteristics:

Data in Table (3) indicated the variances fruit characteristics throughout the two seasons of study. Fruit weight was the highest within all treatments with significant increments than control except the application of GA_3 40 ppm at two months after full bloom in the first season. But in the second one the highest value (413.8 g) of fruit weight was obtained within the Urea 2 % at one month after full bloom

3.2. Effect of spraying Urea, NAA, CaCl_2 and GA_3 on leaf macro elements content:

In the first season, all treatments increased leaf nitrogen content compared with control. The highest value (1.28 %) was obtained with 2 % of Urea sprayed at full bloom followed by (1.23 %) which obtained with 2 % of Urea applied at one month after full bloom and 2 % of CaCl_2 at both dates compared with control treatment which gave 1.12 % nitrogen leaf content. In the second season, nitrogen leaf seasons significantly increased fruit retention percentage. The highest values (25.68 and 25.42 %) were obtained with Urea 2% at one month after full bloom compared to lowest values (12.91 and 11.57 %) with control in both seasons, respectively.

Data in Table (2) indicate that in both seasons, number of fruits per tree, were the highest on trees treated with 2 % of Urea at one month after full bloom (213.7 and 194.3 fruits per tree). While, the lowest values were on untreated trees (130 and 118 fruits per tree) in the first and second seasons, respectively. Generally, all treatments significantly had higher in this parameter than control except the treatment of GA_3 40 ppm applied at two months after full bloom which showed no significant differences compared with control in both seasons. In the second season, the fruit number per tree showed that clear trend was detected but all values were lower than it in the first one. This was due to mango trees being characterized by alternative bearing. So the higher fruit number in the first season means that most trees were under on year bearing while in second one, the trees were under off year bearing.

The yield per tree (kg/tree) in the first season in all treatments was higher than it in the second one. This increase could be due to the number of fruits per tree as shown in the same table. The lowest yield per tree (42.7 and 38.8 kg/tree) was obtained from control trees in both seasons which could be attributed to the lowest fruit number per tree. While, the highest yield per tree (73 and 80 kg/tree) was

treatment, while the lowest values (321.5 and 296.9 g) were obtained within CaCl_2 treatments compared with control (328.6 g). In the same table, data tabulated that, fruit pulp weight in the first season, showed no significant response to treatments except treatment of Urea 2 % at full bloom and NAA 40 ppm at one month after full bloom. On the other hand in the second one all treatments increased pulp weight than control except calcium treatments which gave lowest values of pulp weight (255.7 and 231.2 g) compared with control (265.5 g).

With respect to fruit net ratio, data presented in Table (3), also show that no clear trend was detected.

Whereas, all treatments significantly decreased fruit net ratio in the first season. In the second one, the treatments of Urea at two dates, NAA 40 ppm at one month after full bloom and GA₃ 20 ppm at one month after full bloom only gave values higher than control.

In the same table it is clear that, all treatments at all concentrations significantly increased fruit length in the first season except the treatment of GA₃ 40 ppm at two dates, but in the second one it is no clear trend except the treatments of Urea 2 % at one month after full bloom and GA₃ 20 ppm at one month after full bloom which gave highest values (11.8 and 11.4 cm) compared to control and GA₃ 40 ppm at two months after full bloom which gave lowest values (10.7 and 10.0 cm), respectively. Data also, revealed that, spraying with Urea 2 % at one month after full bloom, NAA 60 ppm at one month after full bloom, CaCl₂ 2% at two months after full bloom and GA₃ 20 ppm at one month after full bloom significantly increased fruit width compared with another treatments in the first season, while in the second one, the highest value (8.2 cm) was obtained with Urea 2% at one month after full bloom and GA₃ 20 ppm at one month after full bloom compared to lowest values (7.5 and 7.6 cm) which obtained with CaCl₂ 2% at two months after full bloom and GA₃ 40 ppm at two months after full bloom, respectively.

Regarding to fruit shape (length/width ratio) it is clear from the data presented in Table (3) also, that no significant differences between the control and other treatments except the treatments of NAA 40 ppm at one month after full bloom and CaCl₂ 2 % at two months after full bloom which gave highest values (1.38 and 1.40) compared with control (1.33) in the first season. While, in the second one also, no significant differences obtained between control and other treatments in fruit length and width ratio except the treatment of Urea 2 % at one month after full bloom which gave highest value (1.43) and treatments of GA₃ 40 ppm at two dates which gave lowest values (1.32 and 1.32) in comparison with control (1.38).

Data in Table (3) also, revealed that skin firmness was the highest within all treatments with significantly increments than control in both seasons. In the first season, the highest values (1.59, 1.50 and 1.43) of firmness were obtained with GA₃ 20 ppm at one month after full bloom followed by CaCl₂ 2 % at two months after full bloom and CaCl₂ 2 % at one month after full bloom respectively. While, in the second one, the treatments of GA₃ 20 ppm at one month after full bloom, GA₃ 40 ppm at two months after full bloom and CaCl₂ 2 % at two months after full bloom gave the highest values (1.37, 1.33 and 1.29), compared with control treatment which gave

the lowest values (1.02 and 1.00) in both seasons respectively.

3.5. Effect of spraying Urea, NAA, CaCl₂ and GA₃ on chemical properties:-

Data in Table (4) show the effect of Urea, NAA, CaCl₂ and GA₃ spraying on the fruit chemical properties. Results tabulated in Table (4) indicated that SSC in the first season responded to all treatments, so significant differences were observed among almost treatments and control. In the second season, all treatments appeared more SSC than control (14.3) except treatment of GA₃ 20 ppm at one month after full bloom (13.7) in comparison with highest value (17.1) which obtained with Urea 2 % at full bloom.

Fruit acidity in the two seasons had no clear trend. Anyhow, in the first season, fruit acidity increased as a result of Urea and GA₃ at one month after full bloom spraying compared with control and other treatments. While, in the second one, the acidity value for control fruits was significantly increased in comparison with all treatments. SSC/acid ratio in the first season was the highest in the fruits harvested from trees treated with CaCl₂ 2 % at two months after full bloom (62.7) while the lowest values appeared in the fruits of Urea 2 % at full bloom (23.4). The other treatments gained intermediate values. However, in the second one, all treatments gave higher values than control (22.0). As concerns of vitamin C, data presented in the same table reveal that in both seasons the highest values were obtained in the fruits harvested from trees sprayed with GA₃ 40 ppm at two months after full bloom (33.1 and 32.6 mg/100g), respectively. While, almost treatments trended to significantly decreased in values of vitamin C in both seasons in comparison with control.

Regarding total sugars, data in Table (4) reveal that the values of total sugar tended to increase as a result of spraying with all treatments more than control except treatments of GA₃ at one month after full bloom in both seasons and treatment of GA₃ 20 ppm at two months after full bloom in the second season only.

Total phenols in the fruits throughout the two seasons had no clear trend. Anyhow, in the first season total phenols were higher in the fruits harvested from trees treated with NAA 60 ppm at one month after full bloom (0.114 %) while the lowest values appeared in the fruits of Urea 2 % at one month after full bloom (0.076 %). The other treatments gave intermediate values. However, in the second one, data showed significant response of total phenols to any treatment used in this study compared with control.

In the same table, data reveal that in both seasons fruits carotenes content significantly increased in all treatments except treatments of GA₃ at two months

after full bloom which gave lowest values of carotenes (4.56 and 3.20 mg/100g) compared with control (5.42 mg/100g) in second seasons only.

Table (1): Effect of Spraying Urea, NAA, Ca Cl₂ and GA₃ on vegetative growth parameters and leaf macro elements content of mango cv. "Succary Abiad" in 2007 and 2008 seasons.

Treatment	Shoot length (cm)		Number of leaves/Shoot		Leaf area (cm) ²		N %		P %		K %		Ca %	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Control	5.3 f	2.3 h	7.1 f	4.5 e	69.9 f	67.1 f	1.12 e	1.06 d	0.36 ab	0.36 b	0.52 d	0.52 d	1.23 cde	1.12 d
Urea 2% at F. B.	8.2 e	6.1 ef	8.3 def	6.7 cd	75.0 d	74.7 d	1.28 a	1.14 b	0.34 ab	0.67 a	0.52 d	0.58 c	1.28 c	1.24 b
Urea 2% at M. A. F. B.	15.6 b	16.0 a	11.5 b	6.9 cd	79.9 c	74.1 d	1.23b	1.15 ab	0.35 ab	0.46 b	0.59 c	0.69 a	1.20 e	1.20 bc
NAA 40 ppm at M. A. F. B.	8.3 e	6.7 e	9.4 cd	6.6 cd	79.3 c	71.5 e	1.21 c	1.14 b	0.38 a	0.48 b	0.53 d	0.63 c	1.20 e	1.21 b
NAA 60 ppm at M. A. F. B.	6.8 ef	5.7 f	7.6 ef	7.5 bcd	71.5 ef	77.6 bc	1.20 c	1.05 d	0.28 c	0.37 b	0.62 c	0.58 c	1.22 cde	1.13 d
Ca Cl ₂ 2% at M. A. F. B.	13.1 c	9.3 c	7.7 ef	10.2 a	73.8 de	82.2 a	1.23 b	1.19 a	0.35 ab	0.35 b	0.60 c	0.70 a	1.22 cde	1.02 e
Ca Cl ₂ 2% at 2 M. A. F. B.	7.3 e	11.5 b	8.4 de	6.3 d	73.3 de	77.3 c	1.23 b	1.16 ab	0.39 a	0.38 b	0.70 b	0.63 bc	1.44 a	1.31 a
GA ₃ 20 ppm at M. A. F. B.	22.1 a	4.7 g	16.6 a	8.3 b	79.9 c	82.2 a	1.15 d	1.09 cd	0.39 a	0.49 b	0.60 c	0.59 c	1.37 b	1.15 cd
GA ₃ 40 ppm at M. A. F. B.	7.6 e	6.7 e	10.4 bc	8.4 b	82.5 b	81.0 a	1.23 b	1.04 d	0.32 bc	0.38 b	0.61 c	0.61 c	1.27 cd	1.11 d
GA ₃ 20 ppm at 2 M. A. F. B.	6.8 ef	5.6 f	8.9 de	7.6 bc	85.0 a	81.1 a	1.12 e	1.12 bc	0.35 ab	0.35 b	0.76 a	0.69 ab	1.21 de	1.13 d
GA ₃ 40 ppm at 2 M. A. F. B.	9.8 d	8.1 d	8.5 de	7.1 cd	82.8 ab	78.9 b	1.23 b	1.07 d	0.39 a	0.43 b	0.60 c	0.69 ab	1.22 cde	1.21 b

Values with the same small letter in each column are not significantly different at 5 % level

F. B. = Full Bloom

M. A. F. B. = One month after Full Bloom

2 M. A. F. B. = Two Months after Full Bloom

Table (2): Effect of Spraying Urea, NAA, Ca Cl₂ and GA₃ on tree yield of mango cv. "Succary Abiad" in 2007 and 2008 seasons.

Treatment	Fruit retention (%)		Yield/Tree			
			Number		Kg	
	2007	2008	2007	2008	2007	2008
Control	12.91 d	11.57 e	130.0 g	118.0 g	42.7 f	38.8 g
Urea 2% at F. B.	19.39 c	19.47 d	181.7 bc	165.0 bc	63.9 d	58.4 b
Urea 2% at M. A. F. B.	25.68 a	25.42 a	213.7 a	194.3 a	73.0 a	80.4 a
NAA 40 ppm at M. A. F. B.	19.91 c	19.03 d	143.0 ef	130.0 ef	50.2 e	53.7 c
NAA 60 ppm at M. A. F. B.	21.09 bc	23.19 abc	177.7 cd	161.7 cd	67.3 c	55.2 c
Ca Cl ₂ 2% at M. A. F. B.	21.29 bc	21.17 bcd	182.0 bc	165.3 bc	68.1 bc	53.1 c
Ca Cl ₂ 2% at 2 M. A. F. B.	22.01 bc	21.58 bcd	186.3 b	169.3 b	70.7 ab	50.3 d
GA ₃ 20 ppm at M. A. F. B.	24.15 ab	23.72 ab	171.0 d	155.3 d	64.3 d	58.2 b
GA ₃ 40 ppm at M. A. F. B.	22.83 abc	22.40 abcd	149.0 e	135.7 e	52.5 e	46.0 e
GA ₃ 20 ppm at 2 M. A. F. B.	21.09 bc	20.01 cd	138.3 f	125.7 f	51.4 e	44.1 ef
GA ₃ 40 ppm at 2 M. A. F. B.	19.86 c	20.52 bcd	136.7 fg	124.3 fg	44.8 f	41.8 f

Values with the same small letter in each column are not significantly different at 5 % level

F. B. = Full Bloom

M. A. F. B. = One month after Full Bloom

2 M. A. F. B. = Two Months after Full Bloom

Table (3): Effect of Spraying Urea, NAA, Ca Cl₂ and GA₃ on physical characteristics of mango cv. "Succary Abiad" in 2007 and 2008 seasons.

Treatment	Fruit weight (g)		Pulp weight (g)		Pulp weight/ Fruit weight %		Fruit dimensions				Fruit shape (Length/ Width ratio)		Fruit firmness (kg/cm ²)	
	2007	2008	2007	2008	2007	2008	Length (cm)		Width (cm)		2007	2008	2007	2008
							2007	2008	2007	2008				
Control	328.7 c	328.6 e	285.7 c	265.5 f	86.9 a	80.8 d	10.7 ef	10.7 cde	8.0 bc	7.7 bcd	1.33 c	1.38 bc	1.02 g	1.00 f
Urea 2% at F. B.	352.4 b	353.8 c	298.5 a	293.9 d	84.7 b	83.1 b	11.0 cde	11.0 bc	8.0 bc	8.0 ab	1.37 abc	1.38 bc	1.30 de	1.24 d
Urea 2% at M. A. F. B.	341.5 b	413.8 a	272.4 d	339.1 b	79.8 d	82.0 c	11.2 bc	11.8 a	8.3 a	8.2 a	1.35 bc	1.43 a	1.33 de	1.17 e
NAA 40 ppm at M. A. F. B.	350.7 b	413.4 a	272.9 d	347.4 a	77.8 e	84.0 ab	11.0 cd	10.8 cd	8.0 c	7.9 abcd	1.38 ab	1.36 bc	1.34 de	1.17 e
NAA 60 ppm at M. A. F. B.	378.3 a	341.4 d	296.1 ab	270.5 ef	78.3 e	79.3 ef	11.1 bcd	10.9 cd	8.3 a	7.9 abcd	1.34 bc	1.38 bc	1.23 f	1.13 e
Ca Cl ₂ 2% at M. A. F. B.	374.8 a	321.5 f	284.6 c	255.7 g	75.9 f	79.6 ef	11.0 cd	10.6 cde	8.1 bc	7.7 bcd	1.37 abc	1.37 bc	1.43 c	1.24 d
Ca Cl ₂ 2% at 2 M. A. F. B.	379.7 a	296.9 g	288.2 bc	231.2 h	75.9 f	77.9 g	11.6 a	10.2 ef	8.3 a	7.5d	1.40 a	1.35 cd	1.50 b	1.29 bc
GA ₃ 20 ppm at M. A. F. B.	376.1 a	374.9 b	286.7 c	318.8 c	76.2 f	85.0 a	11.4 ab	11.4 ab	8.3 a	8.2 a	1.37 abc	1.39 b	1.59 a	1.37 a
GA ₃ 40 ppm at M. A. F. B.	351.6 b	339.4 d	285.8 c	270.4 ef	81.3 c	79.7 e	10.8 def	10.5 def	8.0 c	7.9 abc	1.35 bc	1.32 d	1.34 de	1.25 cd
GA ₃ 20 ppm at 2 M. A. F. B.	371.7 a	350.7 c	286.1 c	275.8 e	77.0 ef	78.6 fg	11.0 cd	10.6 cde	8.2 ab	7.7 bcd	1.34 bc	1.37 bc	1.29 ef	1.26 cd
GA ₃ 40 ppm at 2 M. A. F. B.	327.6 c	336.5 d	254.4 e	273.5 e	77.6 e	81.3 cd	10.6 f	10.0 f	7.8 d	7.6cd	1.35 bc	1.32 d	1.37 cd	1.33 ab

Values with the same small letter in each column are not significantly different at 5 % level

F. B. = Full Bloom

M. A. F. B. = One month after Full Bloom

2 M. A. F. B. = Two Months after Full Bloom

Table (4): Effect of Spraying Urea, NAA, Ca Cl₂ and GA₃ on chemical properties of mango cv. "Succary Abiad" in 2007 and 2008 seasons.

Treatment	SSC %		TA %		SSC/ TA ratio		Ascorbic acid (mg/100g)		Total Sugars		Total Phenols		Carotenes (mg/100g)	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Control	14.7 f	14.3 f	0.45 c	0.65 a	32.8 e	22.0 h	29.8 b	28.3 b	11.2 de	13.4 e	0.085 c	0.143 a	0.90 i	5.42 h
Urea 2% at F. B.	15.7 cd	17.1 a	0.67 a	0.45 cd	23.4 f	37.6 bc	29.8 b	23.4 c	13.8 b	14.8 abc	0.116 a	0.138 b	1.21 g	12.71 b
Urea 2% at M. A. F. B.	15.7 cd	16.4 b	0.66 a	0.56 b	23.9 f	29.1 fg	22.9 g	20.3 de	14.7 a	15.2 a	0.076 e	0.084 de	5.09 a	16.45 a
NAA 40 ppm at M. A. F. B.	15.8 cd	16.7 ab	0.47 c	0.53 b	33.5 e	31.4 ef	26.2 d	22.1 cd	13.0 c	15.0 ab	0.078 de	0.075 f	5.13 a	7.14 f
NAA 60 ppm at M. A. F. B.	14.9 ef	15.3 d	0.36 d	0.39 ef	41.7 d	39.2 ab	28.3 c	18.7 e	13.1 bc	13.9 de	0.114 a	0.103 c	2.64 f	6.10 g
Ca Cl ₂ 2% at M. A. F. B.	15.3 de	15.9 c	0.34 de	0.46 c	45.6 c	34.7 cde	22.7 g	23.5 c	13.3 bc	13.8 de	0.077 e	0.082 e	2.78 e	6.28 g
Ca Cl ₂ 2% at 2 M. A. F. B.	16.5 b	15.1 de	0.26 f	0.41 de	62.7 a	37.1 bcd	24.7 e	27.7 b	11.8 d	14.3 bcd	0.084 cd	0.085 de	3.81 b	8.44 d
GA ₃ 20 ppm at M. A. F. B.	16.2 bc	13.7 g	0.69 a	0.37 ef	23.6 f	37.5 bc	24.2 ef	27.4 b	10.9 e	11.8 f	0.085 c	0.060 g	3.63 c	9.59 c
GA ₃ 40 ppm at M. A. F. B.	17.1 a	15.1 de	0.55 b	0.56 b	31.0 e	26.9 g	29.9 b	24.0 c	11.3 de	12.0 f	0.103 b	0.103 c	3.34 d	7.68 e
GA ₃ 20 ppm at 2 M. A. F. B.	16.1 bc	14.8 e	0.32 de	0.35 f	50.4 b	41.9 a	23.3 fg	22.6 c	12.8 c	12.0 f	0.100 b	0.101 c	1.21 g	4.56 i
GA ₃ 40 ppm at 2 M. A. F. B.	15.1 ef	15.3 d	0.29 ef	0.45 cd	51.4 b	34.0 de	33.1 a	32.6 a	14.7 a	14.1 cde	0.088 c	0.087 d	1.07 h	3.20 j

Values with the same small letter in each column are not significantly different at 5 % level

F. B. = Full Bloom

M. A. F. B. = One month after Full Bloom

2 M. A. F. B. = Two Months after Full Bloom

4. Discussions

Concerning vegetative growth it could be attributed to the nitrogen effect on plants and easily incorporated into the plant metabolism. The obtained results are in agreement with the findings of Sergent *et al.* (2000). They found that spraying Urea on mango trees gave the largest significant effects on vegetative growth: shoot length, number of leaves per shoot and leaf area.

The present results regarding the influence of Urea, CaCl₂, NAA and GA₃ application on leaf macro element contents are in accordance with those found by El-Shewy (1999), Ghosh & Ghattopadhyay (1999), McKenzie (1995), Hermoso *et al.* (1997).

Regarding fruit retention and yield the obtained results are in harmony with these of Shinde *et al.* (2006), who reported that the foliar spray of Urea and NAA on mango trees produced significantly higher fruit yield per tree. Moreover, the results are in accordance with Rani and Brahmachari (2004) on application of CaCl₂ and GA₃.

Concerning fruit physical characteristics the present results are accordance with those of Gupta and Brahmachari (2004) and Shinde *et al.* (2008) who found that the foliar application of Urea and NAA were effective in improving the fruit characters on mango. Regarding to the effect of GA₃ on fruit quality of mango, Sarkar and Ghosh (2005) mentioned that the spray application with GA₃ increased fruit weight, volume and length of fruit. The role of GA₃ was to multiply and to lengthen the meristem cells, which resulted in the increase of fruit volume and weight.

With regard to effect of Urea, CaCl₂, NAA and GA₃ application on fruit chemical properties the obtained results are in agreement with those of Jain (2006) who found that the application of Urea had shown significant increase in the soluble solids contents (SSC). Due to the application of Urea the functioning of number of enzymes might than been stimulated, affecting the physiological processes, which in turn hydrolyzed starch and helped in metabolic activity during the change available starch into sugar and SSC. Also, the obtained results are in harmony with those of Sharkawy (2006) who mentioned that CaCl₂ spraying increased SSC and fruit sugars. Moreover, the results of the tested treatments confirm those of Gupta and Brahmachari (2004), and Sarkar and Ghosh (2005) all of them mentioned that NAA spraying on mango trees increased SSC, SSC/acid ratio, sugars and decreased both acidity and vitamin C. finally the obtained results agree with Sarker and Ghosh (2005) who found that the spray application with GA₃ on mango trees increased SSC and total sugars.

5. Conclusion

Foliar spray mango trees with Urea, NAA, and GA₃ at all concentrations significantly increased shoot length, number of leaves per shoot and leaf area higher than control while urea showed the superiority effect. All treatments significantly increased the yield higher than control in the two seasons. Fruit quality in general improved by treatments. The fruit weight and volume were the highest within all treatments compared with control. Fruit firmness and SSC were increased within all treatments with significantly increments than control. Vitamin C was significantly increased in fruits harvested from trees sprayed with GA₃ 40 ppm at two months after full bloom. Total sugars in the fruits significantly increased higher than control within all treatments except GA₃ 20 ppm added at one month after full bloom.

Corresponding Author

M. T. Wahdan

Horti. Dept. Fac. of Agric., Suez Canal University, Ismailia Governorate, Egypt.

Box. P. 41522

Wahdan2011@gmail.com

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