International Journal of ChemTech Research
CODEN(USA): IJCRGG ISSN: 0974-4290
Vol.9, No.03pp 147-157,2016

The beneficial effect of NAA, Zn, Ca and B on fruiting, yield and fruit quality of Alphonso mango trees

[1]Merwad, M.A., [2]Eisa R.A., and [1]Saleh, M.M.S.

[1]Pomology Dept., National Research Centre, Giza, Egypt
[2]Hort. Tech. Crop Dept. National Research Centre, Giza, Egypt

Abstract: Alphonso mango trees grown under drip irrigation system were sprayed twice at flower bud emergency and full bloom individually or in combinations with zinc chelate at 0.2% (as EDATA 13% Zn), calcium chelate at 0.4% (as Amino acids 14% CaO), Boron at 200 ppm (as Mono Ethanol Di-amin) and Naphthalene acetic acid (NAA) at 25 ppm. The obtained results show that the sprayed materials (NAA + Zn + Ca + B) had a positive effect on fruit set, fruit drop and fruit retention, also in reducing malformed panicles percentage. The used materials increased yield of Alphonso mango trees especially when sprayed in combinations, since treatment No 6 (Zn + Ca) gave the highest value and increased tree yield by about 445 and 435% than the control in the first and second seasons, respectively, followed by treatment included all sprayed materials (No 16). As for fruit quality (physical and chemical properties), it's clear that spaying Zn, Ca, B and NAA gave a high quality comparing with the control. Concerning leaf mineral content, treatments included more than two spraying materials gavehigher values than those included two or single material including the control.
Key words: Alphonso mango – NAA – Zinc – Calcium – Boron – Foliar spray.

Introduction

Mango (*Mangiferaindica* L), belongs to family Anacardiaceae is one of the important fruit crops in the tropics and subtropics region. In Egypt, mango considered the most popular fruit and occupies the third place in acreage after citrus and grapes.

Although, profuse flowering, the ultimate fruit set, retention and marketable produce of mango is phenomenally low primarily due to low fruit setting and heavy fruit drop.

Fruitlet abscission is a very complex physiological process, occurs in many cultivars of mango and among 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[1,2].

Fruit drop can be significantly controlled by the plant growth regulators[3]. Auxin is well known as inhibitors of ethylene action in a number of plants[4]. In this concern, exogenous application of NAA at 50 ppm at pea and marble stage of fruit growth was beneficial in improving the fruit retention and yield of mango cv. Amrapali[5]. Similarly, spraying NAA (25 ppm) and GA_3 (25 ppm) at full bloom had a good effect on increasing fruit set, fruit retention number of fruits, fruit weight and yield of Keitt Mango[6].

Boron plays an important role in many functions of the plant such as hormone movement, activate salt absorption, flowering and fruiting process and pollen germination specially its influences on the directionality

of pollen tube growth[7]. Also, boron seems to play an important role in achieving satisfactory fruit set synthesis, transport of sugars and carbohydrate[8].

Zinc (Zn) is an essential trace element for plants, being involved in many enzymatic reactions and is necessary for their good growth and development. Zinc is also involved in regulating the protein and carbohydrate metabolism[9]. Zinc availability to plants is reduced in high pH soils. Zinc uptake rate was faster in mango trees when zincsulfate was foliar applied as compared with its soil application[10].

Calcium is considered as one of the most important mineralsdetermining the quality of fruit, since it is required for cell elongation and cell division[11]. In this respect, spraying pear trees with amino-more alone or in combination with calcium or potassium reduced the percentage of fruit drop and total acidity (%)[12].

Treatments of urea at 2%, NAA at 40 and 60 ppm, Ca Cl_2 at 2% and GA_3 at 20 and 40 ppm had significant higher yield fruit weight and volume than control. Fruit firmness and SSC were increased within all treatments with significantly increments than the control[13].

Spraying calcium, boron, zinc and sorbitol on fruit-set, yield and quality of Dashehari mango; they found that the applied chemicals had significant effect on fruit-set, yield and quality[14].

Keeping these views in mind the present investigation was carried out to study the effect of chemicals and growth regulators and some macro and micro nutrients on fruit retention, yield and quality of mango cv Alphonso.

Materials and Methods

The present investigation was carried out on Alphonso mango during two successive seasons (2012 and 2013). Trees were 10 years old at the beginning of the investigation and grown in sandy soil at New Salhyia district, Sharkia governorate. Trees were spaced at 7x7 m, irrigated via drip irrigation system and subjected to the horticultural practices as recommended by the Ministry of Agriculture. Trees were more or less similar in size and being in their on-bearing years. Zinc chelate at 0.2% (as EDATA 13% Zn), calcium chelate at 0.4% (as Amino acids 14% CaO), Boron at 200 ppm (as Mono Ethanol Di-amin) and Naphthalene acetic acid (NAA) at 25 ppm were sprayed twice at flower bud emergency and full bloom individually or in combinations. Forty eight trees were selected for this investigation and each tree was acting as replicate. The randomized complete block design was adopted with 16 treatments as shown in table (1):

Table (1):

No	Treatments	No	Treatments
1	Control (water only)	9	Ca + B
2	Zn at 0.2%	10	Ca + NAA
3	Ca at 0.4%	11	B + NAA
4	B at 200 ppm	12	Zn + B + NAA
5	NAA at 25 ppm	13	Zn + B + Ca
6	Zn + Ca	14	B + NAA + Ca
7	Zn + B	15	Zn + Ca + NAA
8	Zn + NAA	16	Zn + Ca + NAA +B

The spraying was conducted until the run off point with Triton B at 0.1 % as a wetting agent and the following parameters were measured for both seasons:

Determinations:

- Fruit set/panicle was recorded.
- Fruit drop % was calculated using the following equation: Fruit drop % = (Fruit set - Fruit retention)/ Fruit set X 100
- Fruit retention/panicle was recorded at mature stage (a week before harvest) in both seasons.

- Tree yield was harvested on late June in each season, the number of fruits per tree was counted and tree yield was weighted as Kg/tree.
- Malformed panicles percentage was calculated as follows:- No of malformed panicles/No of total panicles X 100.
- Leaf mineral content such as N, P, K and Ca as percentages, also Fe, Zn, Mn and B as ppm in dry leaves were determined as the methods described in A.O.A.C.[15].
- Fruit quality: A sample of 10 fruits of each tree was taken at the harvest time to determine the physical and chemical properties as follows:

- Physical properties i.e. fruit, peel, seed and flash weight (g), also flash/fruit ratio were determined.
- Chemical properties i.e. total soluble solids percentage (TSS %) that measured using a hand refractometer. Acidity % was determined as citric acid content using fresh juice with titration against 0.1 Na OH, while TSS/acid ratio was measured. Finally, pulp content of vitamin C and total sugars were estimated according to A.O.A.C.[15].

Statistical analysis:

Data were analyzed using analysis of variance (ANOVA) and means were compared using Duncan test[16] at $p< 0.05$ to determine the significance of differences between the conducted treatments.

Results

Fruit set, drop, retention and malformation

Table (1) shows the effect of different usage treatments on fruit set percentage. In general, all treatments increased fruit set value significantly comparing with the control (untreated trees). In this concern, treatment included all sprayed materials (No 16) recorded the highest significant value followed without significance by treatments No 15 and 11 in the first season, while in the second one the highest fruit set percentage was recorded due to treatment No 14 followed without significance by treatments No 13, 11, 15 and 16. However, the lowest fruit set value in the two seasons was obtained by the untreated trees (treatment No 1).

Concerning fruit drop, results in table (1) show that treatment No 1 (control) gave the highest percentage of fruit drop, this means that all applied treatments had reduced fruit drop value than the control. This was true in both studied seasons. However, the lowest fruit drop % was recorded by treatment No 9 in the first season, while treatment No 16 recorded the lowest value in the second season.

As for fruit retention per panicle (Table 1), treatment No 16 recorded the highest fruit retention value followed without significance by treatments 6, 9, 14 and 12. This observation was in the first season, while in the second one, treatment No 6 shows the highest value of for fruit retention followed without significance by treatment No 16. On the other hand, the lowest fruit retention value in both seasons was recorded due to the untreated trees (control).

In respect to malformed panicles percentage, it's clear from the results in Table (1) that the applied materials had a positive effect on malformation percentage in mango trees under investigation. In this concern, the highest malformation value was recorded with the untreated trees (control) in both studied seasons. However, treatment No 6 (Zn + Ca) gave the lowest malformation percentage followed by treatment No 16, 3 and 4. This observation was detected in the two studied seasons.

Yield per tree:

Results in Table (1) show that, all applied treatments showed a significant effect on tree yield compared with the control. In this respect, treatment No 6 gave the highest significant value in both studied seasons, since this treatment recorded 155.3 and 166.1 kg/tree in the first and second seasons, respectively, comparing with the control which recorded 28.5 and 31.0 kg/tree in the same seasons. In another word, treatment No 6 increased tree yield of Alphonso mango by about 445 and 435% than the control in the first and second seasons, respectively. On the other hand, treatments No 16, 9 and 8 followed treatment No 6 in recording higher yield in

both seasons of the study. However, it's observed that calcium solely or in combination with the other minerals especially zinc showed a good effect in increasing tree yield.

Fruit quality:

Fruit physical properties:

As for fruit weight, it's observed from Table (2) that treatment No 12 (Zn only) gave the heaviest fruit in both seasons, while treatments No 16 and 10 gave lighter fruits in the first and second seasons, respectively.

In respect to peel weight, results in Table (2) show that peel weight of Alphonso mango fruits was significantly affected by different treatments in both studied seasons. However, it's clear that treatment No 13 gave the highest value of peel weight in the first season, while treatment No 5 gave the highest value in the second one. On the other hand, the lowest peel value was recorded by treatments No 16 and 11 in the first and second seasons, respectively.

Regarding seed weight (Table 2), the obtained results in the first season took a similar trend to that of peel weight in the first season also, since the highest seed weight was recorded due to treatment No 2 which gave the highest value in the second season too, while the lowest seed weight value was obtained due to treatment No 10 in the second season.

Concerning flesh weight, treatment No 2 gave the highest flesh weight in both studied seasons, while the lowest value was recorded due to treatment No 16 and 11 in the first and second seasons, respectively.

As for flesh/fruit ratio, the obtained results lacked significance in the first season, while in the second one; all treatments gave the same high statistical value than treatment No 12 which gave the lowest value comparing with the other treatments.

Generally, it's observed that, although treatment No 16 recorded the highest fruit set and fruit retention values, it show low fruit weight. On the other hand, although treatment No 6 recorded low fruit set % but it had a great effect on fruit retention and fruit weight that positively reflected on the yield per tree and gave the highest values in both studied seasons.

Chemical properties:

Regarding total soluble solids in fruit pulp, results in Table (3) show that treatment No 8 gave the highest TSS value followed without significance by treatments 4, 10, 12, 11 and 16. This result was detected in the first season, while in the second one; the highest TSS content was recorded due to treatment No 4. The lowest TSS% was recorded by treatments No 5 and No 2 in the first and second seasons, respectively.

In respect to acidity percentage, the obtained results show that treatment No 5 recorded the highest value of acidity in both studied seasons, while the lowest acidity content was obtained with treatment No 4 in the first season and No 16 in the second one.

Concerning TSS/acid ratio, it's clear from table (3) that treatment No 4 gave the highest ratio followed by treatment No 16. This was true in both seasons of the study. The lowest TSS/acid ratio was recorded by treatment No 5 and No 2 in the first and second seasons, respectively.

As for ascorbic acid (vitamin c) content, it's clear from the tabulated results in Table (3) that treatment No 6 gave the highest VC content followed by treatment No 7 in the two seasons of the study. The lowest VC value was recorded by treatments No 1 and 2 in the first and second seasons, respectively.

Regarding total sugars, results in Table (3) show that treatment No 13 recorded the highest significant percentage followed without significance by treatments No 4, 6, 9, 10, 12, 16, while the lowest sugars content was recorded by treatment No 5 followed without significance by treatment 2 and 1. This was true in both studied seasons.

Leaf mineral content:

Results in table (4 and 5) show that sprayed materials had a significant effect on leaf mineral content. This was true for macro and micro elements in both studied seasons. In general, treatments included more than two spraying materials gave higher values than those included two or single material. In this respect, it's clear that treatment No 16 (Zn + Ca + B + NAA) recorded the highest value concerning N, P, K, Ca and Mn, while treatment No. 13 (Zn + Ca + B) recorded the highest value concerning Zn and B. on the other hand, the untreated trees showed the lowest values for all determined minerals either as macro or micro ones.

Discussion

The above mentioned results clearly show that the sprayed materials (NAA + Zn + Ca + B) had a positive effect on fruit set, fruit drop and fruit retention. This may be due to the role of these materials on pollen grain germination as boron, or in increasing auxin level such as zinc and NAA, also in reducing fruit drop such as calcium. The obtained results are in agreement with those concluded that spraying NAA, calcium, zinc and boron individually or in combinations raised fruit set, fruit retention and reduced fruit drop[5,6,12,17-19].

On the other hand, the used materials increased yield of Alphonso mango trees especially when sprayed in combinations, since treatment No 6 (Zn + Ca) gave the highest value in both studied seasons followed by treatment included all sprayed materials (No 16). However, these results could be due to the effect of these treatments on reducing fruit drop and increasing fruit retention also reducing the malformed panicle percentage. The obtained results are in harmony with those showed that the foliar spray of calcium, boron, zinc and NAA on mango trees produced significantly higher fruit yield per tree[5,6,14,17-20].

As for fruit quality (physical and chemical properties), it's clear that spaying Zn, Ca, B and NAA gave a high quality comparing with the control. These results confirm with those of the researchers who found that spraying mango trees with calcium nitrate, zinc sulfate, boric acid and potassium nitrate improved quality as well as physical and chemical fruit properties[18]. Also, confirm with those of the authors found that all sprayed micronutrients (Fe, B and Zn) on mango trees significantly increased the quality of fruit than the control[21]. On the other hand, the fruit weight and volume of SuccaryAbiad mango were the highest within all treatments (NAA, Ca Cl_2 and GA) compared with the control. Fruit firmness and SSC were increased within all treatments with significantly increments than the control[13].

Concerning leaf mineral content, treatments included more than two spraying materials gave higher values than those included two or single material including the control. These results are in harmony with those concluded that the foliar spray of zinc and manganese sulfates significantly increased the Zn and Mn concentrations in pomegranate leaves, respectively[22]. On the other hand, nitrogen and potassium content in leaves weresignificantly increased within urea, NAA and GA_3 higher than control, while calcium content in the leaves showed fluctuated values[13].

Conclusion

The above mentioned results clearly show that the sprayed materials (NAA + Zn + Ca + B) had a positive effect on fruit set, fruit drop and fruit retention, also in reducing malformed panicles percentage. On the other hand, the used materials increased yield of Alphonso mango trees especially when sprayed in combinations, since treatment No 6 (Zn + Ca) gave the highest value and increased tree yield by about 445 and 435% than the control in the first and second seasons, respectively, followed by treatment included all sprayed materials (No 16). As for fruit quality (physical and chemical properties), it's clear that spaying Zn, Ca, B and NAA gave a high quality comparing with the control. Concerning leaf mineral content, treatments included more than two spraying materials gave higher values than those included two or single material including the control.

Table (1): Effect of Zn, Ca, B and NAA on fruit set, drop, fruit retention, malformation and yield per tree of Alphonso mango during 2012 and 2013 seasons.

No	Treatments	Fruit set (%)		Fruit drop (%)		Fruit retention /panicle		Malformation %		Yield/ tree (kg/tree)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
1	Control	6.50 h	5.24 e	87.80 a	82.23 a	0.80 i	0.93 h	93.00 a	90.40 a	28.5 i	31.0 j
2	Zn	7.50 g	5.62 e	83.43 b	76.16 b-f	1.25 h	1.34 g	88.20 b	89.30 a	36.2 i	40.3 j
3	Ca	9.50 d	8.12 d	72.20 fg	73.63 e-h	2.64 c-e	2.14 f	56.90 g	54.70 f	60.1 f-h	72.5 fg
4	B	9.00 ef	8.00 d	70.00 hi	72.76 gh	2.70 b-e	2.18 f	62.00 ef	64.10 de	55.9 gh	66.9 g-i
5	NAA	9.20 de	9.00 c	70.66 g-i	75.00 b-g	2.70 b-e	2.25 d-f	58.80 fg	52.11 g	62.1 e-g	69.6f-h
6	Zn + Ca	10.18 c	10.09 b	70.03 hi	70.50 h	3.05 ab	2.98 a	1.20 l	2.04 l	155.3 a	166.1 a
7	Zn + B	9.675 d	10.00 b	78.26 c	75.10 b-g	2.09 g	2.49 cd	6.40 jk	7.80 k	72.0 e	76.8 fg
8	Zn + NAA	8.65 f	10.83 ab	71.90 fg	74.50 d-g	2.43 e-g	2.76 ab	8.40 j	10.90 j	102.1 bc	121.9 c
9	Ca + B	9.50 d	10.09 b	69.43 i	75.50 d-g	2.90 a-c	2.47 cd	68.20 c	69.80bc	106.8 bc	120.0 c
10	Ca + NAA	8.65 f	10.08 b	71.10 gh	78.70 bc	2.50 d-f	2.26 d-f	63.50 e	65.40 d	57.1 gh	57.6 i
11	B + NAA	10.80 ab	10.44 ab	74.40 e	79.10 ab	2.76 b-e	2.18 f	67.30 cd	68.50 c	60.8 e-g	59.3 hi
12	Zn + B + NAA	9.40 de	10.03 b	76.80 cd	77.60 b-d	2.18 fg	2.16 f	68.00 c	71.20 b	71.3 ef	77.7 f
13	Zn + Ca + B	10.50 bc	10.45 ab	76.20 d	79.00 ab	2.50 def	2.19 ef	64.00 de	62.30 e	48.5 h	57.6 i
14	Ca + B + Naa	10.50 bc	11.00 a	72.90 ef	74.90 d-g	2.85 a-d	2.70 bc	22.00 h	24.60 h	88.4 d	93.1 e
15	Zn + Ca + NAA	10.80 ab	10.27 ab	73.33 ef	76.23 b-e	2.87 a-c	2.44 de	18.00 i	19.80 i	97.4 cd	104.8 d
16	Zn + Ca + B + NAA	11.00 a	10.76 ab	71.30 gh	72.90 f-h	3.16 a	2.92 ab	3.10 kl	2.40 l	113.9 b	144.8 b
Significance at 5% level		S	S	S	S	S	S	S	S	S	S

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test.

Table (2): Effect of Zn, Ca, B and NAA on physical propertiesof Alphonso mango fruits during 2012 and 2013 seasons.

No.	Treatments	Fruit weight (g)		Peel weight (g)		Seed weight (g)		Flesh weight (g)		Flesh/fruit weight ratio	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
1	Control	238 c-e	230 cd	31.6 b-e	29.9 d-g	40.1 c-e	36.8 d	166 c-f	163 cd	0.69 a	0.71 a
2	Zn	291 a	287 a	37.8 a	37.4 ab	49.9 a	49.3 a	203 a	200 a	0.69 a	0.69 ab
3	Ca	222 c-f	238 bc	28.8 d-g	32.3 c-e	37.5 d-f	38.2 d	155 e-f	168 b-d	0.70 a	0.70 ab
4	B	254 bc	271 a	33.0 b-d	35.2 bc	40.7 b-d	45.0 b	180 a-d	190 ab	0.71 a	0.70 ab
5	NAA	275 ab	277 a	35.7 ab	39.3 a	44.0 b	46.0 ab	195 ab	191 a	0.71 a	0.69 ab
6	Zn + Ca	272 ab	260 ab	35.3 a-c	33.8 b-d	43.5 bc	42.2 bc	193 a-c	183 a-c	0.71 a	0.70 a
7	Zn + B	228 c-f	217 c-f	31.0 c-f	28.3 f-h	36.6 e-g	35.8 de	161 d-f	153 def	0.70 a	0.70 a
8	Zn + NAA	255 bc	272 a	33.2 b-d	35.3 bc	40.8 b-d	43.5 b	181 a-d	193 a	0.71 a	0.71 a
9	Ca + B	233 c-f	235 bc	31.0 c-f	30.5 d-f	38.7 d-f	39.2 cd	164 d-f	165 cd	0.70 a	0.70 ab
10	Ca + NAA	215 d-f	193 f	27.9 e-g	26.1 gh	36.4 fg	31.9 e	150 ef	135 f	0.70 a	0.70 ab
11	B + NAA	230 c-f	200 ef	29.9 d-g	26.0 h	39.1 d-f	36.0 d	160 d-f	138 f	0.69 a	0.69 ab
12	Zn + B + NAA	208 ef	202 d-f	28.4 e-g	27.6 f-h	33.3 g	36.7 d	146 ef	138 ef	0.70 a	0.68 b
13	Zn + Ca + B	209 d-f	222 c-e	27.2 fg	28.8 e-h	33.5 g	35.5 de	148 ef	157 d-f	0.71 a	0.71 a
14	Ca + B + Naa	242 b-d	228 cd	31.5 b-f	29.6 e-h	38.8 d-f	36.5 d	172 b-e	162 cd	0.71 a	0.71 a
15	Zn + Ca + NAA	236 c-e	227 c-e	30.7 d-f	29.5 e-h	40.2 c-e	36.3 d	165 def	161 cde	0.70 a	0.71 a
16	Zn + Ca + B + NAA	202 f	230 cd	26.3 g	29.9 d-g	33.1 g	36.8 d	143 f	163 cd	0.70 a	0.71 a
Significance at 5% level		S	S	S	S	S	S	S	S	NS	S

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test.

Table (3): Effect of Zn, Ca, B and NAA on chemical properties of Alphonso mango fruits during 2012 and 2013 seasons.

No	Treatments	TSS (%)		Acidity (%)		TSS/acid ratio		Vitamin C (mg/100 gm FW)		Total sugars (%)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
1	Control	14.5 c-e	13.6 fg	0.31 bc	0.31 a	46.9 fg	42.9 hi	20.8 g	23.3 g	11.3 ef	11.0 de
2	Zn	13.4 e	12.8 gh	0.32 ab	0.31 ab	42.0 gh	41.2 i	20.8 g	23.4 g	11.8 d-f	11.4 c-e
3	Ca	14.0 de	14.9 de	0.29 cd	0.28 b-d	49.9 e-g	53.8 e-g	22.2 de	24.8 de	12.2 b-e	11.8 a-d
4	B	15.9 a-c	18.9 a	0.23 h	0.22 fg	69.1 a	86.1 a	21.5 e-g	24.0 e-g	12.7 a-c	12.3 a-c
5	NAA	13.1 e	14.8 d-f	0.34 a	0.33 a	38.6 h	44.8 hi	21.0 g	23.5 g	11.2 f	10.9 e
6	Zn + Ca	14.5 c-e	14.5 ef	0.25 f-h	0.22 fg	58.0 b-e	65.9 c	23.4 a	26.2 a	12.8 a-c	12.4 ab
7	Zn + B	15.1 b-d	15.0 c-e	0.26 e-g	0.25 d-f	58.2 b-d	60.0 c-e	23.2 ab	25.9 ab	12.1 b-e	11.8 a-d
8	Zn + NAA	16.9 a	15.3 b-e	0.32 ab	0.31 ab	52.8 c-f	49.3 f-h	22.1 de	24.7 de	12.1 b-f	11.7 b-e
9	Ca + B	14.1 de	14.5 ef	0.25 f-h	0.24 e-g	57.9 b-e	62.1 cd	22.3 cd	25.0 cd	12.8 a-c	12.4 ab
10	Ca + NAA	16.7 a	16.0 b-d	0.29 cd	0.28 b-d	57.5 b-e	57.1 de	22.0 d-f	24.6 d-f	12.4 a-d	12.0 a-c
11	B + NAA	16.1 ab	16.0 b-d	0.27 d-f	0.26 de	59.6 bc	61.7 cd	22.1 de	24.8 de	12.5 a-d	12.1 a-c
12	Zn + B + NAA	15.7 a-c	14.8 d-f	0.28 de	0.27 c-e	56.0 c-e	54.8 ef	23.1 a-c	25.9 a-c	13.2 a	12.6 a
13	Zn + Ca + B	13.3 e	11.8 h	0.26 e-g	0.25 d-f	51.1 d-f	47.2 g-i	22.4 b-d	25.0 b-d	12.1 b-e	11.8 a-d
14	Ca + B + Naa	15.0 b-d	16.2 bc	0.26 e-g	0.25 d-f	57.8 b-e	64.8 c	21.5 e-g	24.0 e-g	12.0 c-f	11.6 b-e
15	Zn + Ca + NAA	14.0 de	14.9 de	0.31 bc	0.30 a-c	45.3 f-h	49.7 f-h	21.2 fg	23.7 fg	12.1 b-e	11.8 a-d
16	Zn + Ca + B + NAA	15.7 a-c	16.5 b	0.24 gh	0.21 g	65.4 ab	77.5 b	22.0 de	24.7 de	12.9 ab	12.4 ab
Significance at 5% level		S	S	S	S	S	S	S	S	S	S

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test.

Table (4): Effect of Zn, Ca, B and NAA on macro nutrients of Alphonso mango leaves during 2012 and 2013 seasons.

No	Treatments	N (%)		P(%)		K(%)		Ca(%)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
1	Control	1.54 h	1.48 i	0.125 h	0.118 j	1.04 g	1.07 f	1.03 g	1.08 e
2	Zn	1.82 fg	1.81 h	0.147 fg	0.149 hi	1.28 f	1.31 e	1.17 f	1.22 de
3	Ca	2.30 bcd	2.27 cd	0.172 bcd	0.171 cd	1.77 ab	1.78 ab	1.60 cd	1.73 ab
4	B	1.94ef	1.97 g	0.152 ef	0.155 fgh	1.25 f	1.37 e	1.20 f	1.30 d
5	NAA	1.62gh	1.75 h	0.132 gh	0.142 i	1.08 g	1.28 e	1.13 f	1.22 de
6	Zn + Ca	2.45 ab	2.41 ab	0.177 abc	0.167 de	1.61 de	1.52 d	1.73 b	1.88 a
7	Zn + B	2.18 cd	2.05 fg	0.160 def	0.162 ef	1.65 cde	1.77 b	1.60 cd	1.73 ab
8	Zn + NAA	1.87 f	1.77 h	0.164 cde	0.171 cd	1.57 e	1.62 cd	1.50 e	1.52 c
9	Ca + B	2.35 abc	2.37bc	0.185 ab	0.178 bc	1.71 bcd	1.82 ab	1.67 bc	1.80 ab
10	Ca + NAA	1.94 ef	1.77 h	0.161 cdef	0.158 fg	1.65 cde	1.77 b	1.63 c	1.76 ab
11	Zn + B + NAA	2.12de	2.18de	0.151 ef	0.152 gh	1.55 e	1.59 d	1.50 e	1.52 c
12	Zn + Ca + B	2.25 bcd	2.34 bc	0.171 bcd	0.173 cd	1.78 ab	1.90 a	1.73 b	1.82 ab
13	B + NAA	2.18 cd	2.19 de	0.164 cde	0.171 cd	1.55 e	1.64 cd	1.53 de	1.65 bc
14	Ca + B + Naa	2.28bcd	2.14ef	0.164 cde	0.159 fg	1.75 bc	1.72 bc	1.73 b	1.87 a
15	Zn + Ca + NAA	2.31bcd	2.41 ab	0.177 abc	0.181 ab	1.65 cde	1.53 d	1.73 b	1.84 ab
16	Zn + Ca + B + NAA	2.54 a	2.49 a	0.190 a	0.188 a	1.88 a	1.78 ab	1.83 a	1.92 a
Significance at 5% level		S	S	S	S	S	S	S	S

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test.

Table (5): Effect of Zn, Ca, B and NAA on micronutrients of Alphonso mango leaves during 2012 and 2013 seasons.

No.	Treatments	Fe (ppm)		Zn (ppm)		Mn (ppm)		B (ppm)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
1	Control	69.22 g	64.81 k	20.15 l	20.20 h	30.91 h	32.41 i	10.12 h	9.41 h
2	Zn	78.62 ef	73.21 j	25.02 ij	25.50 f	35.12 fg	36.64 h	14.15 ef	15.56 f
3	Ca	107.52 c	103.81 f	22.31 k	22.88 g	48.00 d	51.94 de	15.26 e	15.62 f
4	B	80.64 e	78.12 i	21.72 k	22.26 gh	36.01 f	39.79 g	18.48 d	18.72 e
5	NAA	75.94 f	73.22 j	21.94 k	22.26 gh	33.91 g	36.64 h	11.79 gh	11.44 g
6	Zn + Ca	116.26 b	112.81 b	30.21 f	32.80 d	51.91 b	56.44 ab	12.25 fg	12.48 g
7	Zn + B	107.52 c	103.80 f	27.72 g	28.62 e	48.07 d	51.99 de	18.47 d	18.72 e
8	Zn + NAA	100.80 d	91.21 h	25.66 hi	26.50 f	45.14 e	45.62 f	15.79 e	15.62 f
9	Ca + B	111.55 c	108.00 d	28.41 g	29.68 e	50.11 c	54.78 bc	20.01 bcd	22.81 b
10	Ca + NAA	109.54 c	105.60 e	25.94 h	26.50 f	48.94 cd	52.81 cd	15.00 e	15.64 f
11	B + NAA	100.80 d	91.20 h	32.41 d	36.92 c	45.79 e	45.67 f	18.79 cd	18.72 e
12	Zn + B + NAA	116.26 b	109.22 cd	42.74 a	48.52 a	51.94 b	54.65 bc	22.27 a	26.88 a
13	Zn + Ca + B	102.82 d	99.00 g	31.26 e	32.86 d	45.91 e	49.54 e	20.79 abc	21.80 bc
14	Ca + B + Naa	116.26 b	112.24 b	24.52 j	25.44 f	51.92 b	56.15 ab	21.34 ab	21.84 bc
15	Zn + Ca + NAA	116.26 b	110.41 c	35.60 c	37.10 c	51.94 b	55.25 abc	18.04 d	19.72 de
16	Zn + Ca + B + NAA	122.98 a	115.21 a	37.77 b	41.22 b	54.97 a	57.64 a	21.73 ab	20.84 cd
Significance at 5% level		S	S	S	S	S	S	S	S

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test.

References:

1. Bains, K. S.; Bajwa, G. S. and Singh, Z. (1997). Abscission of mango fruitlets. I. In relation to endogenous concentrations of IAA, GA and ABA in pedicels and fruitlets. Fruits, 52: 159-165.
2. Wahdan, M.T. and Melouk, A. E. (2004). Effect of Amcotone on vegetative growth, fruiting, fruit yield and quality of SuccaryAbiad mango trees. Agri. Res. J. Suez Canal University. 4(2):69-76.
3. Anila, R. and Radha, T. (2003). Studies on fruit drop in mango varieties. J. Trop. Agric., 41:30-32.
4. Beyer, E. M.J. (1976). A potentinhibitor of ethylene action inplants. Plantphysiol. 58, 268-271.
5. Vejendla, V.; Maity, P.K. and Banik, B.C. (2008). Effect of chemicals and growth regulators on fruit retention, yield and quality of mango cv. Amrapali. Journal of Crop and Weed 4(2): 45-46.
6. Nkansah, G.O.; Ofosu-Anim, J. and Mawuli A. (2012). Gibberellic acid and naphthalene acetic acid affect fruit retention, yield and quality of Keitt Mangoes in the Coastal Savanna Ecological zone of Ghana. American Journal of Plant Physiology, 7 (6): 243-251.
7. Robbertse, P.J.; Lock, J.J.; Stoffberg, E. and Coetzer, L.A. (1990). Effect of boron on directionality of pollen tube growth in Petunia and Agapanthus. African J. Bot., 56: 487-492.
8. Khayyat, M.; Tafazoli, E.; Eshghi, S. and Rajaee S. (2007). Effect of nitrogen, boron, potassium and zinc sprays on yield and fruit quality of date palm. American-Eurasian J. Agric. & Environ. Sci., 2 (3): 289-296.
9. Swietlik, D. (1999). Zinc nutrition in horticultural crops. Horticultural Reviews. John Wiley & Sons, Inc. New York. 23, 109-180.
10. Bahadur, L.; Malhi, C.S. and Singh, Z. (1998). Effect of foliar and soil applications of zinc sulphate on zinc uptake, tree size, yield, and fruit quality of mango. J. Plant Nutr. 21 (3), 589-600.
11. Rizzi, E. andAbruzzese, A. 1990. Effects of calcium treatment on some biochemical indexes during the developing of apple fruit. Hort. Abst., 60 (7): 4966- 4973.
12. Laila F. Haggag; Fawzi, M.I.F.; Attia, M.F.; Shahin, M.F.M.; Genaidy E.A.E. and Merwad M.A. (2014). Improving Le-conte pear trees productivity by foliar spray with calcium, potassium and liquid organic fertilizer. Middle East Journal of Agriculture Research, 3(4): 715-721.
13. Wahdan, M.T.; Habib, S.E.; Bassal, M. A. and Qaoud, E.M. (2011). Effect of some chemicals on growth, fruiting, yield and fruit quality of "SuccaryAbiad" mango cv. Journal of American Science, 2011;7(2).
14. Negi, S.S.; Singh, A.K.; Singh, C.P. (2009). Effect of foliar application of nutrients on fruit-set, yield and quality of mango cv. Dashehari. Haryana Journal of Horticultural Sciences, 38 (1/2): 20-22.
15. A.O.A.C, (1990). Official Methods of Analysis. The Association of Official Analytical Chemists. Artlington, West Virginia, USA [15]Ed. Washington D.C.
16. Duncan, D.B., 1955. Multiple range and multiple F. testes. Biometrics, 11: 1-24.
17. Saleh, M.M.S. and Eman, A.A. Abd El-Monem (2003). Improving productivity of "FagriKalan" mango trees grown under sandy soil conditions using potassium, boron and sucrose as foliar spray. Annals Agric. Sci., Ain Shams Univ., 48 (2): 747-756.
18. Ramzy, G. stino; Sahar, M. Abd El-Wahab; S.A. Hobashy and R.A. Kelani (2011). Productivity and fruit quality of three mango cultivars in relation to foliar sprays of calcium, zinc, boron or potassium. Journal of Horticultural Science & Ornamental plants, 3 (2): 91 – 98.
19. Jarande, S.D.; Patel, B.N.; Patel, B.B.; Patel Andh, N.R. and Dhuda, D. (2013). Effect of sucrose and nutrient elements on fruit set and fruit yield of mango cv. Kesar, Crop Res. 46 (1, 2 & 3): 142-145.
20. Shinde, A. K.; Patil, B. P.; Pujari, K. H.; Jadhav, B. B.; Chandelkar, A. B. and Kandalkar, M.P. (2006). Investigations on the control of fruit drop in "Alphonso" mango. Indian Journal of Plant Physiology. 11(1):93-99.
21. MoazzamAnees; Tahir, F.M.; Shahzad, J. and Mahmood, N. (2011). Effect of foliar application of micronutrients on the quality of mango (*Mangiferaindica* L.) cv. Dusehrifruit.Mycopath, 9(1)**:** 25-28.
22. Hasani, M.; Zamani, Z.; Savaghebi, G.; Fatahi R. (2012). Effects of zinc and manganese as foliar spray on pomegranate yield, fruit quality and leaf minerals. Journal of Soil Science and Plant Nutrition, 12 (3), 471-480.

*****