Yield and fruit quality of Ewaise mango trees grown under Upper Egypt conditions as affected by application of nutrients, plant extracts, selenium and silicon

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Abstract: During 2014, 2015 and 2016 seasons, Ewaise mango trees grown under Upper Egypt conditions were subjected to three sprays with N, P, K, Mg, Zn, Fe, Mn, Cu and B, plant extracts namely extracts of turmeric and green tea and oils of garlic, onion, moringa and nigella, selenium and silicon. Fruit setting%, yield and fruit quality in response to the present treatments were investigated. Subjecting the trees to different nutrients and/ or any plant extracts, selenium or silicon had a remarkable promotion on initial fruit setting%, fruit retention%, yield and both physical and chemical characteristics of the fruit relative to the control. The promotion was ascribed to using nutrients plus any plant extracts, selenium or silicon compared to using nutrients alone. Using selenium and/or silicon was preferable than using plant extracts in enhancing yield and fruit quality. The best results with regard to yield and fruit quality of Ewaise mango trees grown under Upper Egypt conditions were obtained due to treating the trees three times with a mixture of N, P, K, Mg, Zn, Fe, Mn, Cu and B + selenium + silicon.

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1. Introduction

Poor cropping and higher fruit dropping are considered to be the serious and major problems faces mango growers in Upper Egypt. Malnutrition and unbalancing nutrition with various macro and micro nutrients is considered the main reason for such problems.

It is well known that any efforts is directed towards increasing the total yield of mango in our country as well as enhancing the fruit quality will result in a promotion in our national income.

Nutrients are essential in many plant metabolic processes. They play many important regulatory roles in plant development. Functions of nutrients are activating various enzymes involved in plant growth; enhancing the biosynthesis of carbohydrates, fats, proteins and natural hormone, and movement of carbohydrates. They are also responsible for stimulating cell division, cell enlargement, water and nutrient transport and building of amino acids **(Devlin and Withdam, 1983 and Nijjar, 1985).**

Plant extracts are used for improving production of mango fruits instead of using chemicals. The change for using plant extract against chemicals was performed because pathogens resistance to the fungicides has developed as well as for protecting our environment from pollution. It has long been recognized that naturally occurring substances in higher plants have antioxidant activity. Plant kingdom is a good source of natural preparations containing effective bioactive compounds which can be used for different application particular as food additives and health promoting ingredients in the formulations of functional foods and nutraceuticals. Nowadays, the interest has considerably increased for the use in storage studies (**Govinderajan, 1980**).

Silicon, (Si) the second most abundant element in the earth crust, has not yet received the title of essential nutrient for higher plants, as its role in plant biology is poorly understood (**Epstein, 1999**). However, various studies have demonstrated that Si application increased and enhanced plant growth considerably (**Alvarez and Datnoff, 2001**). Beneficial effects of Si are more prominent when plants were subjected to multiple stresses including biotic and abiotic stresses (**Aziz *et al*., 2002; Rodrigues *et al.,* 2003; Ma, 2004 and Tahir, *et al.,* 2006**). Silicon is also known to increase drought tolerance in plants by maintaining plant water balance, photosynthetic activity, erectness of leaves, and structure of xylem vessels under high transpiration rates (**Melo *et al*., 2003 and Hattori *et al*., 2005**). Silicon is responsible for improving water economy (**Gang *et al.,* 2003**) and leaf water potential under water stress conditions (**Matoh *et al.,* 1991**).

Selenium was found by many authors to enhance the activities of enzymes such as glutathione peroxidase, the tolerance of trees to abiotic and biotic stresses and the biosynthesis of carbohydrates and proteins. It also reduces reactive oxygen species (ROS) and protects plant cells from aging and death (**Gupta *et al*., 2000; Whanger, 2002; Rayman *et al*., 2002; Hanson *et al*., 2003 and 2004; Seppanen *et al*., 2003; Turakainen *et al*., 2004 and 2006; Kirn *et al.,* 2005; Nowak-Barbara, 2008 and Jakovljevic *et al*., 2011**).

Previous studies showed that using nutrients (**Banik *et al*, 1997; Mohamed 1998; Ahmed *et al*., 2001; Abd –Allah, 2006; Ebeid- Sanaa, 2007; El-Sayed– Esraa, 2007; Ibrahiem *et al*., 2007; El-Sayed–Esraa, 2010; Mohamed and El- Sehrawy, 2013; Abd El-Rady, 2015 and Abdelaziz *et al*., 2015**); plant extracts (**Abdelaal and Aly, 2013**; **Al Wasfy *et al*., 2013**; **Mohamed and Mohamed, 2013; Ahmed, 2014**; **Refaai, 2014a; El- Khawaga and Mansour, 2014; Refaai, 2014b; Uwakiem, 2014 and Hegazy, 2015**), silicon (**Gad El- Kareem, 2012; Abdelaal and Oraby- Mona, 2013; Ahmed *et al.,* 2013a and b; El-Khawaga and Mansour, 2014; Gad El- Kareem *et al*., 2014; Ibrahim and Al-Wasfy, 2014; Abd El-Wahab, 2015 and Mohamed *et al*., 2015**) and selenium **(Ibrahiem and Al-Wasfy, 2014; Gad El-Kareem *et al.,* 2014; Abo El-Fadle, 2017 and Masoud, 2017)** was very effective in improving vegetative growth traits and tree nutritional status of fruit crops.

The goal of this study was elucidating the effect of some nutrients, plant extracts, selenium and silicon on vegetative growth aspects, tree nutritional status, yield and fruit quality of Ewaise mango trees grown under Upper Egypt conditions.

2. Materials and Methods

This investigation was conducted during three successive experimental seasons 2014, 2015 and 2016 on uniform in vigour thirty 10- years old Ewaise mango trees onto seedling rootstock (on year status). The trees are grown in a private orchard situated at Waborate El- Mataana village, Esna district, Luxor Governorate. The selected trees are planted at 6 × 6 meters apart (6 between rows and 6 between trees). The selected trees were irrigated through furrow (surface) irrigation system. The soil texture of the tested orchard is silty clay with a water table depth not less than two meters.

The selected trees received a basal recommended fertilizer including the application of 20 m3 farmyard manure (0.35 % N, 0.45 % P2O5, and 1.2 % K2O) added in early December, 200 kg/ fed/ mono calcium superphosphate (15.5 % P2O5) added in mid-January, 450 kg/ fed ammonium sulphate (20.6% N) added in three equal dressings in February, April and July and 200 kg/ fed potassium sulphate (48 % K2O) added in two equal dressings applied in mid-February and April, in addition to the regular agricultural and horticultural practices which were followed in the orchard including micronutrient application, pruning, hoeing, irrigation with Nile water as well as pathogens, insects and weed control.

Soil samples were taken (four samples) from a depth of 0.0 to 90 cm from soil surface and were physically and chemically analyzed before study start according to the procedure outlined by **Black *et al*. (1965)** and the obtained data are shown in Table (1).

Table (1): Analysis of the tested soil:

Characters	values
Particle size distribution:	
Sand %	: 10.1
Silt %	: 50.7
Clay %	: 39.2
Texture	: Silty clay
pH (1:2.5 extract)	: 7.49
E.C (1:2.5 extract) (mmhos/ cm/ 25°C)	: 0.69
O.M. %	: 2.92
$CaCO_3$ %	: 1.74
Total N %	: 0.15
Available P (Olsen method, ppm)	: 4.2
Available K (ammonium acetate, ppm)	: 411.0

This study included the following eleven treatments from macro and micronutrients, plant extracts, silicon and selenium.

1- Control treatment (spraying with water).

2- Spraying Stimufol compound at 0.25%.

3- Spraying Stimufol compound at 0.25%+ green tea extract at 0.05%.

4- Spraying Stimufol compound at 0.25%+ nigella oil at 1%.

5- Spraying Stimufol compound at 0.25%+ moringa leaves extract at 0.05%.

6- Spraying Stimufol compound at 0.25%+ onion oil at 1%.

7- Spraying Stimufol compound at 0.25%+ garlic oil at 1%.

8- Spraying Stimufol compound at 0.25%+ turmeric extract at 0.05%.

9- Spraying Stimufol compound at 0.25%+ selenium at 5 ppm.

10- Spraying Stimufol compound at 0.25%+ silicon at 50 ppm.

11- Spraying Stimufol compound at 0.25%+ selenium at 5 ppm +silicon at 50 ppm.

Each treatment was replicated three times, one tree per each (33 trees for all treatments). Spraying of Stimufol compound, plant extracts, silicon and selenium was done three times at growth start (mid. of Feb.), just after fruit setting (mid. of April) and at three weeks later (1st week of May). Triton B as a wetting agent was added at 0.3 ml/ l water to all solutions. Foliar application was carried out till runoff (20 L/ tree).

Table (2): Analysis of Stimufol amino compound.

character	values
N %	**25% N**
P %	**16 % (P_2O_5)**
K %	**12 % (K_2O)**
MgO	**0.02%**
Fe %	**0.17%**
Zn %	**0.03%**
Mn %	**0.085%**
Cu %	**0.085%**
B %	**0.044%**

Table (3): Chemical analysis of green tea

Constituent	Values
Total carbohydrate	**11 g**
Total fats	**0.4 g**
Favonoides	**0.3 g**
Tannins	**2.9 g**
Flour	**20 mg**
N	**1.19 g**
P	**0.24 g**
K	**1.0 g**
Mg	**0.5 g**
Zn	**41.0**
Fe	**51.0**
Mn	**60.0**
Coneshin	**0.7 g**
Thiamine	**110 mg**
Vitamin A	**90.0 g**
Vitamin B	**74.1 mg**
Vitamin C	**120.0 mg**
Coffeic acid	**315.0 mg**

Table (4): Chemical composition of Black cumin seed (according to Bourgou *et al*., 2010)

Compounds	Values %
Myristic acid %	**1.0**
Palmitic acid%	**13.1**
Palmatolic acid %	**0.2**
Stearic acid%	**2.3**
Oleic acid %	**23.8**
Linoleic acid%	**58.5**
Linolenic %	**0.4**
Archaic acid%	**0.5**
Saturated fatty acid %	**16.8**
Unsaturated fatty acid %	**82.9**
Moisture %	**8.1**
Proteins %	**23.3**
ASH%	**9.9**

Table (5): Chemical composition of moringa extract (*Moringa oleifera*)

Constituents	Values
a) Vitamins (mg/100 g D.W)	
Betacarotine	**149.2**
E	**50**
A	**90**
B_1	**88.9**
B_2	**1.1**
C	**19.0**
K	**25.6**
b) Minerals (mg/100 g D.W)	
Cu	**88.7**
K	**49.9**
N	**89.9**
P	**12.9**
Mg	**20.2**
c) Amino acids (mg/100 g D.W)	
Lysine	**8.3**
Leucine	**9.3**
Threonine	**6.6**
Isoleucine	**6.3**
Cysteine	**2.4**
Methionine	**3.6**
Tryptophan	**3.3**

Table (6): Chemical composition of onion oil (Mnayer *et al*., 2014)

Compounds	Values (mg/100g D.W)
1-Propenyl propyl disulfide [a]	**7.26**
Methyl propyl trisulfide	**5.2**
Menthone	**0.34**
Methyl propyl trisulfide	**0.47**
Dimethyl tetrasulfide	**0.15**
Dipropyl trisulfide	**17.10**
Eugenol	**3.07**
2-Methyl-3,4-dithiaheptane	**6.48**
Dipropyl tetrasulfide	**0.55**
Dipropyl disulfide	**30.92**
Allyl propyl sulfide	**0.42**
Dimethy trisulfide	**0.30**

Table (7): Chemical composition of Turmeric (according to Shiyou *et al*., (2011)

Compounds	Values
β- Bisabolene %	1.3
1.8-Cineol %	2.4
p-Cymene %	3.0
p-Cymen-8-ol %	0.3
Tr-Curcumin%	6.3
Curlone %	10.6
Dehydrocurcumin %	2.2
Myrcene	0.1
α-Phellandrene %	0.1
α- Pinene %	0.1
Terpinolene %	0.3
Tr-Turmerone %	31.1
Turmerone %	10.0
Ascorbic acid (mg)	50.0
ASH (g)	6.8

Compounds	Values
Calcium (g)	0.2
Carbohydrate (g)	69.9
Fat (g)	8.9
Food energy (k Cal)	390.0
Iron (g)	47.5
Niacin (mg)	4.8
Potassium (mg)	200.0
Phosphorus (mg)	260.0
Protein (g)	8.5
Riboflavin (mg)	0.19
Sodium (mg)	30.0
Thiamine (mg)	0.09
Water (g)	6.0

Table (8): Chemical composition of garlic oils (according to Mnayer *et al*., 2014)

Compounds	Values (mg/100g D.W)
Dipropyl disulfide	**0.25**
Diallyl disulfide	**37.90**
Dimethyl trisulfide	**0.33**
Dimethyl thiophene [a]	**0.08**
Allyl methyl disulfide	**3.69**
Methyl propyl disulfide	**0.25**
Methyl 1-propenyl disulfide [a]	**0.46**
Allyl propyl sulfide	**0.09**
Bis-(1-propenyl)-sulfide [a]	**0.08**
Diallyl sulfide	**6.59**
Dimethyl disulfide	**0.15**
Allyl methyl teterosulfide	**1.07**
Allyl propyl trisulfide	**0.23**
Dially trisulfide	**28.06**
Eugenal	**0.23**

Statistical analysis was done using randomized complete block design (RCBD) with three replicates, each with one Ewaise mango trees. Each block contained eleven treatments.

During the three seasons the following measurements were recorded:

1. Percentages of initial fruit setting and fruit retention.
2. Yield/ tree expressed in weight (kg.) and number of fruits/ tree. **(Hulme, 1971)**
3. Some physical and chemical characteristics of the fruits namely weight (g), height, diameter and thickness (cm.) of fruit, pulp weight%, T.S.S.% (**A.O.A.C., 2000**), total, reducing and non- reducing sugars % **(Lane and Eynon 1965)**, total acidity (as g citric acid/ 100 ml juice) (**A.O.A.C., 2000)**, vitamin C content (as mg/ 100 ml juice) and total fibre%.

All the obtained data during the course of this study in the three successive seasons, 2014, 2015 and 2016 were tabulated and subjected to the proper statistical analysis. The differences between various treatment means were compared using new L.S.D. parameter at 5 % (according to **Snedecor and Cochran, 1967 and Mead *et al*. 1993).**

3. Results

1- Initial fruit setting and fruit retention:

It is obvious from the obtained data in Table (9) that subjecting Ewaise mango trees with nutrients (N, P, K, Mg, Zn, Fe, Mn, Cu and B) either alone or in combined with any one of the six plant extracts (oils of nigella, moringa, onion and garlic each at 1% and extracts of green tea and turmeric each at 0.05%), selenium at 5 ppm or silicon at 50 ppm resulted in significant increase in both the percentages of initial fruit setting and fruit retention over the control treatment. Treating the trees with nutrients (N, P, K, Mg, Zn, Fe, Mn, Cu and B) plus any one of the six plant extracts (oils of nigella, moringa, onion and garlic each at 1% and extracts of green tea and turmeric each at 0.05%), selenium at 5 ppm or silicon at 50 ppm had significant promotive effect on both percentages of initial fruit setting and fruit retention than using nutrients alone. Combined application of nutrients with selenium or silicon significantly was superior to using nutrients alone. Using selenium plus silicon was significantly preferable than using each alone with nutrients in improving such two parameters. Using selenium and/or silicon along with nutrients was significantly preferable than using nutrients with any plant extracts (oils of nigella, moringa, onion and garlic each at 1% and extracts of green tea and turmeric each at 0.05%). The best plant extracts applied with nutrients, arranged in ascending order were green tea at 0.05%, oils of nigella, moringa, onion and garlic each at 1% and turmeric extract at 0.05%. Exposing the trees to a mixture of all nutrients, selenium at 5 ppm and silicon at 50 ppm gave the maximum values of initial fruit setting **(8.4 & 8.0 & 8.5 %)** and fruit retention **(3.0 & 3.6 & 3.6 %)** during 2014, 2015 and 2016 seasons, respectively. The untreated trees gave initial fruit setting reached **3.9 & 4.0 & 3.9%** and fruit retention reached **0.5 & 0.6 & 0.5%** during the three seasons, respectively. The percentage of increment on the percentage of fruit retention due to using the best treatment over the control treatment reached **500 & 500 and 516.6 %** during the three seasons, respectively. These results were true during the three seasons.

2- Yield/tree:

It is clear from the obtained data in Table (9) that yield expressed in weight (kg.) and number of fruits/ tree was significantly improved in response to treating Ewaise mango trees with nutrients (N, P, K, Mg, Zn, Fe, Mn, Cu and B) alone or in combination with plant extracts (oils of nigella, moringa, onion and garlic each at 1% and extracts of green tea and turmeric each at 0.05%), selenium at 5 ppm or silicon at 50 ppm relative to the control treatment. Significant differences on the yield were observed among the eleven investigated treatments. Combined applications of nutrients and any one of plant extracts (oils of nigella, moringa, onion and garlic each at 1% and extracts of green tea and turmeric each at 0.05%), selenium at 5 ppm or silicon at 50 ppm was significantly very effective in improving the yield compared to the use of nutrients alone. Using selenium and/or silicon was significantly preferable in improving the yield than using plant extracts when applied with nutrients. Using selenium with silicon besides all nutrients gave the best results compared with using nutrients plus any plant extract. The best plant extracts in enhancing the yield when applied along with nutrients were turmeric extract, oils of garlic, onion, moringa, nigella and green tea extract, in descending order. The highest yield was recorded on the trees that received all nutrients+ selenium at 5 ppm + silicon at 50 ppm together. Yield of the promised treatment reached **69.0 & 68.5 & 70.8 kg** while in the untreated trees reached **35.1 & 35.4 & 36.2 kg** during 2014, 2015 and 2016 seasons, respectively. The percentage of increment on the yield due to using the best treatment over the control treatment reached **96.6 & 93.5 and 96.6 %** during the three seasons, respectively. These results were true during the three seasons.

3- Physical and chemical characteristics of the fruits

It is obvious from the obtained data in Table (10 to 12) that treating Ewaise mango trees three times with nutrients (N, P, K, Mg, Zn, Fe, Mn, Cu and B) alone or in combination with plant extracts (oils of nigella, moringa, onion and garlic each at 1% and extracts of green tea and turmeric each at 0.05%), selenium at 5 ppm or silicon at 50 ppm had significant promotion on fruit quality in terms of increasing weight, height, diameter and thickness of fruit, fruit pulp%, T.S.S.%, total, reducing and non–reducing sugars % and vitamin C content and decreasing total acidity % and total fibre % in the fruits relative to the control treatment. The promotion on fruit quality was significantly associated with using nutrients with turmeric extract at 0.05%, oils of garlic, onion, moringa and nigella each at 1% and green tea extract at 0.05%, in descending order. Using selenium and silicon with nutrients was significantly superior to using plant extracts in enhancing quality of the fruits. Combined applications of selenium and silicon was significantly favourable than using nutrients alone in improving quality of the fruits. The best materials applied with nutrients that were responsible for improving fruit quality were silicon, selenium and plant extracts (oils of nigella, moringa, onion and garlic each at 1% and extracts of green tea and turmeric each at 0.05%), in descending order. The best results with regard to fruit quality were recorded on the trees that treated with all nutrients (N, P, K, Mg, Zn, Fe, Mn, Cu and B) plus selenium and silicon. The untreated trees produced unfavourable effects on fruit quality. These results were true during the three seasons.

Table (9): Effect of single and combined applications of some nutrients, plant extracts, selenium and silicon on the percentages of initial fruit setting, fruit retention and yield/tree of Ewaise mango trees during 2014, 2015 and 2016 seasons.

Treatments	Initial fruit setting %			Fruit retention %			No. of fruits/tree			Yield/tree (kg)		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
1- Control	3.9	4.0	3.9	0.5	0.6	0.5	204.0	206.0	208.0	35.1	35.4	36.2
2- Spraying nutrients	4.3	4.4	4.4	0.7	0.9	0.8	215.0	217.0	218.0	37.6	38.2	39.0
3- Spraying nutrients+ green tea at 0.05%	4.7	4.8	4.8	1.0	1.2	1.1	226.0	228.0	229.0	40.7	40.1	41.0
4- Spraying nutrients+ nigella oil at 1 %	5.1	5.2	5.2	1.2	1.5	1.4	236.0	240.0	240.0	43.7	44.2	44.9
5- Spraying nutrients+ moringa extract at 1%	5.5	5.6	5.6	1.5	1.8	1.7	247.0	250.0	251.0	46.9	47.0	47.9
6- Spraying nutrients+ onion oil at 1%	6.0	6.0	6.1	1.8	2.1	2.0	260.0	260.0	262.0	50.6	49.9	51.1
7- Spraying nutrients+ garlic oil at 1%	6.5	6.5	6.6	2.0	2.4	2.4	271.0	271.0	273.0	54.2	53.1	54.3
8- Spraying nutrients+ turmeric extract at 0.05%	7.0	7.0	7.1	2.2	2.7	2.7	280.0	281.0	285.0	57.7	56.2	57.9
9- Spraying nutrients+ selenium at 5 ppm	7.5	7.3	7.6	2.5	3.0	3.0	290.0	291.0	296.0	61.2	60.5	62.5
10- Spraying nutrients+ silicon at 50 ppm	8.0	7.6	8.1	2.7	3.3	3.3	300.0	301.0	306.0	64.7	64.1	66.1
11- Spraying nutrients+ selenium+ silicon	8.4	8.0	8.5	3.0	3.6	3.6	311.0	313.0	319.0	69.0	68.5	70.8
New L.S.D. at 5%	0.4	0.3	0.4	0.2	0.3	0.3	9.0	10.0	10.0	1.8	1.7	1.6

Table (10): Effect of single and combined applications of some nutrients, plant extracts, selenium and silicon on weight, height, diameter and thickness of fruit of Ewaise mango trees during 2014, 2015 and 2016 seasons.

Treatments	Av. Fruit weight (g)			Av. Fruit height (cm)			Av. Fruit diameter (cm)			Av. Fruit thickness (cm)		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
1- Control	171.9	172.0	174.0	8.2	8.0	8.0	6.6	6.4	6.6	5.7	5.5	5.6
2- Spraying nutrients	175.0	176.0	179.0	8.5	8.2	8.2	6.8	6.6	6.8	5.9	5.7	5.8
3- Spraying nutrients+ green tea at 0.05%	180.0	180.0	183.0	8.8	8.5	8.4	7.0	6.8	7.0	6.1	6.0	6.0
4- Spraying nutrients+ nigella oil at 1 %	185.0	184.0	187.0	9.0	8.8	8.6	7.2	7.0	7.2	6.3	6.2	6.2
5- Spraying nutrients+ moringa extract at 1%	190.0	188.0	191.0	9.2	9.0	8.8	7.5	7.2	7.4	6.5	6.4	6.5
6- Spraying nutrients+ onion oil at 1%	194.5	192.0	195.0	9.5	9.2	9.0	7.5	7.5	7.6	6.7	6.6	6.7
7- Spraying nutrients+ garlic oil at 1%	200.0	196.0	199.0	9.7	9.5	9.2	7.7	7.7	7.8	7.0	6.8	6.9
8- Spraying nutrients+ turmeric extract at 0.05%	206.0	200.0	203.0	9.9	9.7	9.5	8.0	7.9	8.0	7.2	7.0	7.1
9- Spraying nutrients+ selenium at 5 ppm	211.0	208.0	211.0	10.1	9.9	9.7	8.2	9.1	8.2	7.4	7.2	7.3
10- Spraying nutrients+ silicon at 50 ppm	215.5	213.0	216.0	10.3	10.1	9.9	8.4	9.4	8.5	7.6	7.4	7.5
11- Spraying nutrients+ selenium+ silicon	221.9	219.0	222.0	10.5	10.3	10.1	8.6	9.6	8.7	7.8	7.6	7.7
New L.S.D. at 5%	**3.1**	**3.0**	**2.8**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**

Table (11): Effect of single and combined applications of some nutrients, plant extracts, selenium and silicon on the percentages of fruit pulp, T.S.S. and total and non-reducing sugars in the fruits of Ewaise mango trees during 2014, 2015 and 2016 seasons.

Treatments	Fruit pulp (%)			T.S.S (%)			Total sugars (%)			Non-reducing sugars (%)		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
1- Control	63.0	64.0	64.5	15.1	14.9	15.0	9.1	9.0	8.9	6.8	6.9	7.1
2- Spraying nutrients	64.5	65.2	66.0	15.4	15.2	15.3	9.5	9.6	9.8	7.0	7.1	7.4
3- Spraying nutrients+ green tea at 0.05%	66.0	66.5	67.2	15.8	15.6	15.7	9.8	9.9	10.0	7.2	7.3	7.7
4- Spraying nutrients+ nigella oil at 1 %	67.1	68.9	68.4	16.2	16.0	16.1	10.1	10.2	10.3	7.5	7.6	7.9
5- Spraying nutrients+ moringa extract at 1%	68.5	70.2	69.7	16.5	16.3	16.4	10.5	10.6	10.8	7.8	7.8	8.1
6- Spraying nutrients+ onion oil at 1%	70.0	71.7	71.0	16.8	16.6	16.7	11.1	11.2	11.0	8.0	8.0	8.3
7- Spraying nutrients+ garlic oil at 1%	71.1	73.0	72.3	17.1	16.9	17.0	11.7	11.8	11.2	8.3	8.3	8.5
8- Spraying nutrients+ turmeric extract at 0.05%	72.3	74.1	73.5	17.4	17.2	17.3	12.3	12.4	11.4	8.5	8.6	8.8
9- Spraying nutrients+ selenium at 5 ppm	74.0	75.2	75.0	17.7	17.5	17.6	13.0	13.1	11.6	8.8	8.9	9.0
10- Spraying nutrients+ silicon at 50 ppm	75.9	76.3	76.4	18.0	17.8	17.9	13.6	13.7	11.8	9.0	9.1	9.2
11- Spraying nutrients+ selenium+ silicon	77.3	77.5	77.8	18.4	18.2	18.3	14.1	14.2	12.0	9.3	9.4	9.5
New L.S.D. at 5%	**1.0**	**1.1**	**1.2**	**0.3**	**0.3**	**0.3**	**0.3**	**0.2**	**0.3**	**0.2**	**0.2**	**0.2**

Table (12): Effect of single and combined applications of some nutrients, plant extracts, selenium and silicon on some chemical characteristics of the fruits of Ewaise mango trees during 2014, 2015 and 2016 seasons.

Treatments	Reducing sugars (%)			Total acidity (%)			Vitamin C (mg/100 ml juice)			Total fibre (%)		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
1- Control	2.3	2.1	1.8	0.331	0.340	0.344	41.0	39.9	41.3	1.01	1.00	1.04
2- Spraying nutrients	2.5	2.5	2.4	0.311	0.325	0.329	42.2	41.2	42.5	0.97	0.98	1.01
3- Spraying nutrients+ green tea at 0.05%	2.6	2.6	2.3	0.290	0.305	0.310	44.0	43.0	44.4	0.94	0.95	0.97
4- Spraying nutrients+ nigella oil at 1 %	2.6	2.6	2.4	0.270	0.279	0.284	45.7	44.6	46.0	0.91	0.93	0.94
5- Spraying nutrients+ moringa extract at 1%	2.7	2.8	2.7	0.250	0.255	0.260	47.0	46.6	47.0	0.88	0.89	0.90
6- Spraying nutrients+ onion oil at 1%	3.1	3.2	2.7	0.230	0.239	0.244	48.3	47.3	48.6	0.84	0.85	0.86
7- Spraying nutrients+ garlic oil at 1%	3.4	3.5	2.7	0.213	0.220	0.225	50.0	49.1	50.4	0.80	0.81	0.83
8- Spraying nutrients+ turmeric extract at 0.05%	3.8	3.8	2.6	0.196	0.203	0.209	51.0	50.0	51.5	0.76	0.77	0.80
9- Spraying nutrients+ selenium at 5 ppm	4.2	4.2	2.6	0.180	0.186	0.191	52.3	51.4	52.6	0.73	0.74	0.78
10- Spraying nutrients+ silicon at 50 ppm	4.6	4.6	2.6	0.160	0.171	0.177	54.0	53.0	54.5	0.71	0.72	0.74
11- Spraying nutrients+ selenium+ silicon	4.8	4.8	2.5	0.143	0.152	0.157	56.3	55.3	56.6	0.68	0.69	0.70
New L.S.D. at 5%	**0.2**	**0.2**	**0.2**	**0.016**	**0.014**	**0.013**	**1.0**	**1.1**	**0.9**	**0.02**	**0.2**	**0.2**

4. Discussion

Nutrients are essential in many plant metabolic processes. They play many important regulatory roles in plant development. Functions of nutrients are activate various enzymes involved in plant growth, enhance the biosynthesis of carbohydrates, fats, proteins and natural hormone, and movement of carbohydrates. They are also responsible for stimulating cell division, cell enlargement, water and nutrient transport and building of amino acids (**Devlin and Withdam, 1983 and Nijjar, 1985**).

These results are in concordance with those obtained by **Banik *et al,* (1997); Mohamed (1998); Ahmed *et al.,* (2001); Abd –Allah (2006); Ebeid- Sanaa (2007); El- Sayed - Esraa (2007); Ibrahiem *et al.,* (2007); El- Sayed– Esraa (2010);; Mohamed and El- Sehrawy (2013); Abd El-Rady (2015) and Abdelaziz *et al.,* (2015)**.

Plant extracts are used for improving production of mango fruits instead of using chemicals. The change for using plant extract against chemicals was performed because pathogens resistance to the fungicides has developed as well as for protecting our environment from pollution. It has long been recognized that naturally occurring substances in higher plants have antioxidant activity. Plant kingdom is a good source of natural preparations containing effective bioactive compounds which can be used for different application particular as food additives and health promoting ingredients in the formulations of functional foods and nutraceuticals. Nowadays, the interest has considerably increased for the use in storage studies (**Govindarajan, 1980**).

This results regarding the effect of plant extract in improving yield and fruit quality of Ewaise mango trees are in agreement with those obtained by **Abdelaal and Aly, (2013); Al Wasfy *et al.*, (2013); Mohamed and Mohamed (2013); Ahmed, (2014); Refaai (2014a); El- Khawaga and Mansour (2014); Refaai (2014b); Uwakiem (2014) and Hegazy (2015)**.

Silicon, (Si) the second most abundant element in the earth crust, has not yet received the title of essential nutrient for higher plants, as its role in plant biology is poorly understood (**Epstein, 1999**). However, various studies have demonstrated that Si application increased and enhanced plant growth considerably (**Alvarez and Datnoff, 2001**). Beneficial effects of Si are more prominent when plants were subjected to multiple stresses including biotic and abiotic stresses (**Aziz *et al*., 2002; Rodrigues *et al.,* 2003; Ma, 2004 and Tahir, *et al.,* 2006**). Silicon is also known to increase drought tolerance in plants by maintaining plant water balance, photosynthetic activity, erectness of leaves, and structure of xylem vessels under high transpiration rates (**Melo *et al*., 2003 and Hattori *et al*., 2005**). Silicon is responsible for improving water economy (**Gang *et al.,* 2003**) and leaf water potential under water stress conditions (**Matoh *et al.,* 1991**).

The previous authors suggested that a silicon cuticle double layer formed on leaf epidermal tissue is responsible for this higher water potential. Results of **Lux *et al.,* (2003) and Hattori *et al.,* (2005)** suggested that Si plays an important role in water transport and root growth under drought conditions. **Bowen *et al.,* (1992)** stated that Si inhibit powders mildew in grapes. **Savuas *et al*., (2002) and Iwaski *et al.,* (2002)** stated that the favorable effects of silicon on crops seem to originate from reinforcement of the cell walls due to deposition of Si in the form of silica morphous ($SiO_2.H_2O$) and opal phytoliths consequently increases the improving light reception. The mechanical strength provided by Si to the plant tissues increases their resistance to several bacterial, fungi insect and diseases and decreased the occurrence of the physiological disorders. Si was implicated to ameliorate the adverse effects of aluminum, manganese and salinity toxicity.

The results of **Gad El- Kareem (2012); Abdelaal and Oraby- Mona (2013); Ahmed *et al.,* (2013a and b); El-Khawaga and Mansour (2014); Gad El- Kareem *et al*., (2014); Ibrahim and Al-Wasfy (2014); Abd El-Wahab (2015) and Mohamed *et al*., (2015)** supported the presents results concerning the effect of silicon on improving yield and quality of fruits of Ewaise mango trees.

Selenium was found by many authors to enhance the activities of enzymes such as glutathione peroxidase, the tolerance of trees to abiotic and biotic stresses and the biosynthesis of carbohydrates and proteins. It also reduces reactive oxygen species (ROS) and protects plant cells from aging and death (**Gupta *et al*., 2000; Whanger, 2002; Rayman *et al*., 2002; Hanson *et al*., 2003 and 2004; Seppanen *et al*., 2003; Turakainen *et al*., 2004 and 2006; Kirn *et al.,* 2005; Nowak-Barbara, 2008 and Jakovljevic *et al*., 2011**).

The results with regard to the promoting effect of selenium on yield and fruit quality of Ewaise mango trees are in harmony with those obtained by **Ibrahiem and Al-Wasfy (2014); Gad El-Kareem *et al.,* (2014); Abo El-Fadle (2017) and Masoud, (2017)**.

Conclusion

The best results with regard to yield and fruit quality of Ewaise mango trees grown under Upper Egypt conditions were obtained due to treating the trees three times with a mixture of N, P, K, Mg, Zn, Fe, Mn, Cu and B + selenium + silicon.

References

1. Abd- Allah, A. S. E. (2006): Effect of spraying some macro and micro nutrients on fruit set, yield and fruit quality of Washington Navel orange trees. J. Agric. Appl. Sci. Res. 2 (11): 1059-1063.
2. Abd El-Rady, S.E.M. (2015): Fruiting of Ewaise mango tree in relation to spraying royal jelly, Magnesium and boron. M. Sc. Thesis Fac. of Agric. Minia Univ. Egypt.
3. Abd El-Wahab, H.A.M. (2015): Response of Succary mango trees to foliar application of silicon and boron. M.Sc. Thesis Fac. of Agric. Minia Univ. Egypt.
4. Abdelaal, A.A.M. and Oraby-Mona, M.M (2013): Using silicon for increasing the mango cv Ewaise transplants to drought. World Rural Observations 5(2):36-40.
5. Abdelaal. M.H.A. and Aly, M.M. (2013): The synergistic effects of using turmeric with some antioxidants on growth vine nutritional status and productivity of Ruby seedless grapevines. Hort. Science Journal of Suez Canal Univ. vol. 1: 305-308.
6. Abdelaziz; F.H.; Mohamed, M.A. and Abd El-Rady, S.E.M. (2015): Relation of Fruiting In Ewaise Mango Trees to Foliar Application of Royal Jelly, Magnesium and Boron. World Rural Observ: 7(2):85-92.
7. Abo El-Fadle, H. M. (2017): Productivity capacity of Superior grapevines in relation to spraying selenium with some vitamins. M.Sc. Thesis Fac. of Agric. Minia Univ. Egypt.
8. Ahmed, F.; Ahmed, A. M. and Morsy, M. A. (2001): Studies on the influence of spraying some nutrients and ascorbic acid on inflorescence malformation and fruiting of Taimour mangoes. 6th Inter. Symp. on Fruit. Nut and Vegetable Production Eng. Postdam Sept. 2001. pp. 10 - 20.
9. Ahmed, F.F.; Gad El- Kareem, M. R. and Oraby-Mona, M.M. (2013 a): Response of Zaghloul date palms to spraying boron, silicon and glutathione. Stem Cell 4 (2): 29-34.
10. Ahmed, F.F.; Mansour, A.E.M.; Mahmoud, A.Y.; Mostafa, E.A.M. and Ashour, N.E. (2013b): Using silicon and salicylic acid for promoting production of Hindy Bisinnara mango trees grown under sandy soil. Middle East J. of Agric. res. 2 (2): 51-55.
11. Ahmed, M.Y.A. (2014): Effect of spraying fenugreek and sprout and some nutrients on fruiting of Keitte Mango trees grown under Aswan region conditions. World Rural Observations. 2014: 6(14): 103-108. ISSN: 1944-6543.
12. Al- Wasfy, M.M.; Ahmed, F.F. and El- Masry, A.M. (2013): Behaviour of Washington Navel orange Trees to foliar application of some plant extracts. Hort. Science Journal of Suez Canal Univ. Vol. 1: 281-285.
13. Alvarez, J. and Datnoff, E. (2001): The economic potential of silicon for integrated management and sustainable rice production. Crop. Prot. 20:53-48.

14. Association of Official Agricultural Chemists (A.O.A.C.) (2000): Official Methods of Analysis (A.O.A.C), 12th Ed., Benjamin Franklin Station, Washington D.C., U.S.A.pp.490-510.
15. Aziz, T.; Gill, M.A. and Rahmatullah, A. (2002): Silicon nutrition and crop production. Pak. J. Agric. Sci. 39(3): 181-187.
16. Banik, B. C.; Sen, S. K. and Bose, T. K. (1997): Effect of zinc, iron and boron in combination with urea on growth, flowering, fruiting and fruit quality of mango cv. Fazli. Environment and Ecology 6 (1): 122-125.
17. Black, C.A.; Evans, D.D.; Ersminger, L.E.; White, J.L. and Clark, F.E. (1965): Methods of Soil Analysis. Am. Soc. Agron. Inc. Bull. Madison, Washington, U.S.A. pp. 891-1400.
18. Bourgou, S., Bettaieb, I., Saidani, M, and Marzouk, B. (2010): Fatty Acids, Essential Oil, And Phenolics Modifications of Black Cumin Fruit under NaCl Stress Conditions. J. Agric. Food Chem. 58 (23), 12399-12406.
19. Bowen, P.; Menzies, J. and Ehret, D. (1992): Soluble silica sparys inhibit powdery mildew development on grape leaves. J. Amer. Soc. Hort. Sci. 117(6): 906-912.
20. Devlin, R. M. and Withdam, F. H. (1983): Plant Physiology. Renolds Book Corporation, New York (Chapter V).
21. Ebeid – Sanaa (2007): The promotive effect of seaweed extract and boron on growth and fruiting of Hindy Bisinnara mango trees. Minia T of Agric. Rev & Develop. Vol. (27) No. 3 pp 579-594.
22. El-Khawaga, A.S. and Mansour, A.G.M. (2014): Promoting productivity of Washington navel orange trees by using some crop seed sprout Extracts, silicon and Glutathione. Middle East Journal of Applied Sciences, 4 (3): 779-785.
23. El-Sayed- Esraa, M. H. (2007): Response of Ewaise mango trees to foliar application of boron. M. Sc. Thesis Fac. of Agric. Minia Univ. Egypt.
24. El-Sayed- Esraa, M. H. (2010): Behaviour of Ewaise mango trees to foliar application of some nutrients and seaweed extract. Ph. D. Thesis Fac. of Agric. Minia Univ. Egypt.
25. Epstein, E. (1999): Silicon. Annl. Rev. Plant. Physiol. Plant Mol-Bio. 50:641-664.
26. Gad El- Kareem, M.R. (2012): Improving productively of Taimour mango trees by using glutathione, silicon and vitamin B. Minia J. of agric. Res. & Develop 32(7): 1105-1121.
27. Gad El- Kareem, M.R.; Abdelaal, A.M.K. and Mohamed A.Y. (2014): The synergistic effect of using silicon and selenium on fruiting of Zaghloul date palm (*Phoenic dectylifera* L.) World Academy of ci. Engineering and Technology, Inter. J. of Agric. Biosystems Sci. and Engineering 8 (3):959-964.
28. Gang, H.J.K.; Chen, K.M.; Chen, G.C.; Wan, S.M. and Zhang, C.L. (2003): Effect of silicon on growth of wheat under drought. H. Plant. Nutr. 26(5):1055-1063.
29. Govinderajan, V.S. (1980): Turmeric Chemistry, Technology and Quality. CRC Nutrition 12: 199-301.
30. Gupta, M.C.; Hama, Y.W.; Campbell, C.A.; Leyshon, A.J. and Nicholoichuk, V. (1985): Boron toxicity and deficiency Canadian J. Soil Sci. 65:381-409.
31. Hanson, B., Garifullina, G. F., Lindblom, S. D., Wangeline, A., Ackley, A., Kramer, K., Norton, A. P., Lawrence, C. B. and Pilon-Smits, E. A. H. (2003): Selenium accumulation protects *Brassica juncea* from invertebrate herbivory and fungal infection. New Phytologist, 159: 461–469.
32. Hanson, B., Lindblom, S.D., Loeffler. M.L., Pilon-Smits, E.A.H. (2004): Selenium protects plants from phloem-feeding aphids due to both deterrence and toxicity. New Phytologist 162: 655–662.
33. Hattori, T; Inanaga, S.; araki, H.; An, P.; Martia, S.; Luxova, M. and Lux, A. (2005): Application of silicon enhanced drought tolerance in Sorgham bicolor. Physiologia Plantarum, 123:459-466.
34. Hegazy, M.U.M. (2015): Studies on some treatments to improve the productivity of olive fruits and fruit quality. M. Sc. Thesis Fac. of Agric. Suez Canal Univ.
35. Hulme, A. C. (1971): The Mango. Biochemistry of Fruits and their Products. Vol. 1, London pp 95 – 103.
36. Ibrahiem, H.I.M. and Al- Wasfy, M.M. (2014): The promotive impact of using silicon and selenium with potassium and boron on fruiting of Valencia orange trees grown under Minia region conditions. World Rural Observations 5 (1): 1-14.
37. Ibrahiem, H.I.M.; Ahmed, Y.M. and Ahmed, F.F. (2007): Relation of fruiting in Hindy Bisinnara mangoes to foliar nutrition with Mg, B and Zn and some antioxidants African crop Sci. Conf. Proc.8:411-415.
38. Iwaskai, K.; Meier, P.; Fecht, M. and Hart, W.I. (2002): Effect of silicon supply on apoplastic, manganese concentrations in leave sand their relation to manganese tolerance in cowper (*Vigna unguciulata*) plant Soil 238:288.
39. Jakovljevic, M.; Licina, V.; Antic- Mladenov, S. and Velickovic, M. (2011): The effects of selenium application on replant soil and its content in apple leaves and fruits. Acta Hort. 477: IV Inter. Sym. On Replant Proplems P.1.
40. Kirn, W.S.; JO, J.A. and Chung, J.S. (2005): Effect of selenium supply by trunk injection on fruit quality of Niitaka Asian Pear. Hort. Sci. 40 (4): 1083- 1084.
41. Lane, J. H. and Eynon, L. (1965): Determination of reducing sugars by means of Fehlings solution with methylene blue as indicator A.O.AC.

Washington D.C.U.S.A. pp.490- 510.

42. Lux, A.; Luxova, M.; Abe, J. Tanmoto, E. and Inanaga, S. (2003): The dynamic of silicon deposition in the sorghum root endodermis. New Physiol. 158:437-441.
43. Ma, J.F. (2004): Role of silicon in enhancing the resistance of plants of biotic and abiotic stresses. Soil Scr. Plant Nutr. 50:11-18.
44. Masoud, S.E.Y. (2017): Response of Superior grapevines grown under Sandy soil to foliar applications of Silicon and Selenium. Ph.D. Thesis Fac. of Agric. Minia Univ. Egypt.
45. Matoh, T.; Murata, S. and Takahashi, E. (1991): Effect of silicate application on photosynthesis of rice plants. Japan. J. Soil Sci. Plant Nutr. 62:248-251.
46. Mead, R.; Currnow, R. N. and Harted, A. M. (1993): Statistical Methods in Agricultural and Experimental Biology. 2nd Ed. Chapman and Hall, London pp. 10- 44.
47. Melo, S.P.; Kordnarfer, G.H.; Korndarfer, C.M.; Lana, R.M.G. and Santaon, D.G. (2003): Silicon accumulation and water deficient tolerance in grasses. Scientia Agricola 60:755-759.
48. Mnayer, D., Fabiano-Tixier, A. S., Petitcolas, E., Hamieh, T., Nehme, N., Ferrant, C., Fernandez, X and Chemat, F. (2014): Chemical composition, antibacterial and antioxidant activities of six essentials oils from the Alliaceae family. Molecules, 19(12), 20034-20053.
49. Mohamed, A. Y. (1998): Effect of some nutrients on growth, flowering, yield and quality of Hindy Bisinnara mangoes *(Mangifera indica* L.). M. Sc. Thesis Fac. of Agric. Minia Univ. Egypt.
50. Mohamed, A. Y. and El- Sehrawy, O. A. M. (2013): Effect of seaweed extract on fruiting of Hindy Bisinnara mango trees. J. of Arner. Sci. 9 (6): 537 - 544.
51. Mohamed, A. Y. and Mohamed, H. H. (2013): The synergistic effects of using turmeric with various nutrients on fruiting of Sewy date palms. Hort. Sci. J. of Suez Canal Univ. Vol. (l): 287-291.
52. Mohamed, M.A.; El- Sayed, M.A. and Abd El-Wahab, H.A.M. (2015): Response of Succary mango trees to foliar application of silicon and boron. World Rural observation 7(2):93-98.
53. Nijjar, G.S. (1985): Nutrition of Fruit Trees. Mrs. Usha Raj Kumar for Kalyanin publishers; New Delhi, pp. 10- 52.
54. Nowak- Barbara, H. (2008): Effect of selenium on selected macronutrients in maize plants. J. Elemental. 13 (4): 513 — 519.
55. Rayman, M.P. (2002): The argument for increasing selenium intake. Proceeding of the Nutrition Society, 61: 203-215.
56. Refaai, M.M. (2014a): Response of Zaghloul date palms grown under Minia region conditions to spraying wheat seed sprout extract and nano-boron. Stem Cell 5 (4): 22-28.
57. Refaai, M.M. (2014b): Impact of Spraying Extracts of Fenugreek and Rocket Seed Sprouts on Fruiting of Keitte Mango Trees. *World Rural Observations*, *6*(4), 75-80.
58. Rodrigues, F.A.; Vale, F.X.R.; Kerridorfar, G.H.; Prabhu, A.S.; Datnoff, L.E.; Oliveria, A.M.A. and Zambalim, L. (2003): Influence of silicon on Shealth blight of rice in Brazil. Crop. Prot; 22: 23-29.
59. Savuas, D.; Manos, G.; Kotsiras, A. and Souvaliotis, S. (2002): Effects of silicon and nutrient-induced salinity on yield, flower quality and nutrient uptake of gerbera grown in a closed hydroponic system. J. appl. Bot. 76 (5): 153-158.
60. Seppanen, M.; Turakainen, M. and Harikainen, H. (2003): Selenium effects on oxidative stress in potato. Plant Science, 165: 311-319.
61. Shiyou, L., Yuan, W., Deng, G., Wang, Ping., Yang, P., Aggarwal, B. (2011): Chemical composition and product quality control of turmeric (*Curcuma longa* L.). Stephen F Austin State Univ. SFA Sholarworks.
62. Snedecor, G. and Cochron, W. G. (1980): Statistical Methods. Oxford and J. B. H. Publishing Corn. 7th edition.
63. Tahir, M.A.; Rahmatullah, A.; aziz, T.; Ashraf, M.; Kanwal, S. and Magsood, A. (2006): Beneficial effects of silicon in wheat (*Triticum aestivum* L.) under salinity stress. Pak. J. Bot. 38(5):1715-1727.
64. Turakainen, M., Hartikainen, H. and Seppänen, M. (2004): Effects of selenium treatments on potato growth and concentrations of soluble sugars and starch' *Journal of Agricultural and Food Chemistry*, vol 52, no. 17, pp. 5378-5382.
65. Turakainen, M., Hartikainen, H., Ekholm, P. and Seppänen, M. (2006): Distribution of selenium in different biochemical fractions and raw darkening degree of potato (Solanum tuberosum L.) tubers supplemented with selenate' *Journal of Agricultural and Food Chemistry*, vol 54, no. 22, pp. 8617-8622.
66. Uwakiem, M.Kh. (2014): The synergistic effect of spraying some plant extracts with some macro and micro nutrients of Thompson seedless grapevines. International Journal of Plant & Soil Science 3 (10): 1290-1301.
67. Whanger, P.D. (2002): Selenium pounds in plants and animal and their biological significant. J. of the Amer. College and Nutrition. 21: 223-232.

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