

Response of Some Mango Cultivars Grown Under Middle Egypt Region Conditions to Some Seaweed Extract and Salicylic Acid Treatments

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Abstract: This study was carried out during 2017 and 2018 seasons to examine the effect of spraying Salicylic acid at 50 to 200 ppm and/or seaweed extract at 0.05 to 0.2 % on yield and fruit quality of three mango Cvs FagriKalan, Zebda and Alphonse grown under Minia region condition. The maximum yield expressed in number of fruits per trees and weight (kg.) was recorded in mango cvs FagriKalan, Zebda and Alphonse, in descending order. The highest values of weight, height, diameter and thickness of fruit, fruit pulp%, edible to non edible portions of fruit, total acidity % and total fiber% and the lowest values of fruit firmness, fruit peel%, T.S.S, total, reducing and non-reducing sugars and vitamin C were recorded on mango Cv. Alphonse. Yield and both physical and chemical characteristics of the fruit were clearly improved in response to treating the trees three times with Salicylic acid at 50 to 200 ppm and/or seaweed extract at 0.05 to 0.2 % relative to the control. Using seaweed extract was superior than treating the trees with Salicylic acid. Carrying out three sprays (growth start, just after fruit setting and after one month later) of a mixture of Salicylic acid at 100 ppm and seaweed extract at 0.1 % was responsible for promoting the yield of mango cvs FagriKalan, Zebda and Alphonse. The best mango cvs grown successfully under Minia region conditions were FagriKalan, Zebda and Alphonse according to their higher yield, in descending order.

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1. Introduction

Different cultivars of mango were varied in their performance and these differences are governed by various genetic, cultural and environmental factors. Due to the variation in performance of different mango cultivars, the suitability of these cultivars from the consumers point of view are often evaluated from different angles. A study of growth, yield and pomologically important external and internal characteristics of the fruit in mango cultivars is warranted to provide the important criteria for the evaluation of such cultivars (Whiley and Schaffer, 1993, Devilliers, 1998 and Majumder *et al.*, 2001).

Investigation on compounds capable of reducing the sensitivity of crops to most stresses are of great importance from both the theoretical and the practical point of view. Salicylic acid was first demonstrated to play a definite role in the tolerance of plants to biotic and abiotic stresses. It may cause a reduction on oxidative stress in plants and promote the antioxidative capacity and protective compounds such as polyamines.

Application of seaweed extracts is very effective in enhancing growth and uptake of nutrients, resistance of plants to unfavorable stress conditions namely low or high temperatures, diseases and pests, physical and chemical properties

of the soil, fruit setting and production of trees. (Norric *et al.*, 2002; Planes- Leyva *et al.*, 2003 and Aziz *et al.*, 2003).

A great variation on yield and both physical and chemical characteristics of the fruits was observed in different mango cvs growing under various climatic conditions (Hammam 2000; El-Masry 2001; Mohamed 2001; Ragab *et al.*, 2002; Hassan *et al.*, 2004; Abd El- Hadi 2006 and Fahmy 2016).

Application of seaweed extracts had an announced promotion on yield and fruit quality of different mango cvs. (Irizar- Garza *et al.*, 2003; Ebeid – Sanaa, 2007; Mouftah, 2007 Mohamed and El-Sehrawy, 2013, Ahmed *et al.*, 2013a and Oraby, 2013).

Salicylic acid is responsible for promoting yield and fruit quality of different mango Cvs and related fruit crops (Saied, 2011; Ahmed, 2011; Masoud and El- Sehrawy, 2012; Ahmed *et al.*, 2013b; Ahmed *et al.*, 2014 and Mohamed, 2014).

The target of this study was examining the effect of different concentrations of salicylic acid and seaweed extract on yield and fruit quality of three mango cv. FagriKalan, Zebda and Alphonse grown under Minia region condition.

2. Materials and Methods

This study was established during two consecutive seasons of 2017 and 2018 in a private orchard situated at El-Shorafa village, eastern bank of Minia city, Minia district, Minia Governorate where the texture of the soil is silty clay with a water table depth not less than two meters. Three mango cvs FagriKalan, Zebda and Alphonso were selected for achieving this study. All mango cvs were at the same age namely 14- years old at the start of this study. They were budded on Succary mango rootstock. They are planted at 6 x 6 meters apart. Trees of each mango cv. were almost uniform in vigour.

The results of the orchard soil analysis (according to **Black, 1965**) are shown in table (1).

All mango cvs received basal recommended fertilizers including the application of 20 m³/fed farmyard manure (0.35% N, 0.45% P₂O₅ and 1.2% K₂O) added in early December, 200 kg./fed of monocalcium superphosphate (15.5 % P₂O₅) added in mid January, 450 kg./ fed. ammonium sulphate (20.6% N) added in three equal dressings in the first week of 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 already followed in the orchard including pruning, micronutrients application, hoeing, irrigation with Nile water as well as pathogens, pests and weed control.

Monthly minimum and maximum temperatures as well as relative humidity percentages for Minia region during 2017 and 2018 seasons were obtained from Malawy Meteorological Station and the data are shown in Table (2).

Table (1): Mechanical, physical and chemical analysis of the tested orchard soil

Characteristics	Values
Particle size distribution	
Sand %	12.22
Silt %	57.00
Clay %	30.78
Texture	Silty clay
pH (1: 2.5 extract)	8.11
E.C. (1: 2.5 extract mmhos/ 1 cm/ 25°C)	0.66
Organic matter %	2.22
CaCO ₃ %	1.29
Macronutrients values	
Total N %	0.11
P (ppm, Olsen method)	26
K (ppm, ammonium acetate)	464
Mg (ppm)	146.00
S (ppm)	6.96
B (hot water extractable)	0.27
EDTA extractable (ppm)	
Zn	1.31
Fe	11.21
Mn	10.25
Cu	1.88

Table (2): Monthly average temperature and relative humidity % for the two seasons of 2017 & 2018.

Month	2017				2018			
	Temperature e °C		R.H. %		Temperature e °C		R.H. %	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Jan.	7.4	24.2	31.0	87.0	6.0	23.2	29.0	89.0
Feb.	10.1	28.4	22.0	69.0	8.1	23.9	25.0	84.0
March.	10.9	31.3	16.0	63.0	10.0	29.6	16.0	69.0
April	15.0	35.1	14.0	48.0	16.0	37.3	13.0	43.0
May	21.0	39.9	17.0	47.0	20.0	39.9	14.0	38.0
June	19.0	39.7	18.0	61.0	20.1	40.9	16.0	53.0
July	19.6	41.1	18.0	80.0	21.8	43.2	17.0	62.0
August	20.0	41.3	21.0	81.0	20.0	39.8	22.0	72.0
Sept.	19.8	40.0	21.0	73.0	18.8	40.1	21.0	71.0
Oct.	18.2	36.4	25.0	73.0	13.7	33.7	23.0	89.0
Nov.	11.3	31.0	29.0	93.0	10.2	29.3	28.0	91.0
Dec.	7.4	26.3	30.0	94.0	7.5	25.1	28.0	92.0

RH % = Relative humidity %

Source: Malawy Meteorological Station

This experiment included thirteen treatments from two factors (A & B). The first factor (A) consisted from three mango cvs arranged follows a₁) FagriKalan, a₂) Zebda and a₃) Alphonse. The second factor (B) included the following ten treatments:

- b₁) Control (sprayed with water trees).
 b₂) Spraying salicylic acid at 50 ppm (50 mg L⁻¹)
 b₃) Spraying salicylic acid at 100 ppm (100 mg L⁻¹).

- b₄) Spraying salicylic acid at 200 ppm (200 mg L⁻¹).
- b₅) Spraying seaweed extract at 0.05% (0.5 g L⁻¹).
- b₆) Spraying seaweed extract at 0.1% (1.0 g L⁻¹).
- b₇) Spraying seaweed extract at 0.2% (2.0 g L⁻¹).
- b₈) Spraying salicylic acid at 50 ppm + seaweed extract at 0.05%.
- b₉) Spraying salicylic acid at 100 ppm + seaweed extract at 0.1%.
- b₁₀) Spraying salicylic acid at 200 ppm + seaweed extract at 0.2%.

Each treatment was replicated three times, one tree per each. The total number of mango trees required for achieving of this study was 90 trees on the basis of thirty trees for each mango cv. for facilitating the solubility of salicylic acid few drops of ethyl alcohol were used. Spraying of salicylic acid and seaweed extract was done three times at growth start (1st week of March), just after first setting stage (mid. of April) and at one month later (mid. of May). Triton B as a wetting agent at 0.1 % was added to all spraying solutions and application via leaves was done till runoff. Chemical analysis of seaweed extract are shown in Table (3).

Table (3): Analysis of seaweed extract (according to James, 1994).

parameters	values
Moisture %	: 6.0
O.M. %	: 45 – 60
Inorganic matter %	: 45 – 60
Protein %	: 6 – 8
Carbohydrates %	: 35 – 50
Aliginic acid %	: 10 – 20
Mannitol %	: 4 – 7
Total N %	: 1.0 – 1.5
P %	: 0.02 – 0.09
K %	: 1.0 – 1.2
Ca %	: 0.2 – 1.5
S %	: 3 – 9
Mg %	: 0.5 – 0.9
Cu (ppm)	: 1.0 – 6.0
Fe (ppm)	: 50 – 200
Mn (ppm)	: 5 – 12
Zn (ppm)	: 10 – 100
B (ppm)	: 20 – 100
Mo (ppm)	: 1 – 5
Cytokinins %	: 0.02
IAA %	: 0.03
ABA %	: 0.01

This experiment was arranged in a randomized complete block design (RCBD) in split plot

arrangement where the three mango cvs and the ten treatments of salicylic acid and seaweed extract occupied the main and subplot, respectively. Each treatment replicate three times one tree per each.

Harvesting was achieved when the flesh of the fruits became yellowish and when the fruits shoulder swells to become rounded or flattened (**Chandler, 1987**). Yield expressed in weight (kg.) and number of fruits per tree was recorded. Twenty fruits from each tree were taken randomly from the yield of each tree when each mango cv. reached maturity stage, then transferred to the pomology laboratory, Hort. Dept. Fac. of Agric. Minia Univ. for determining the following physical characteristics:

A- Physical characteristics:

- 1- Average fruit weight (g).
- 2- Average fruit height (cm.)
- 3- Average fruit diameter (cm.)
- 4- Average fruit thickness (cm.)
- 5- Average fruit firmness by using pressure tester.
- 6- Percentage of peel weight.
- 7- Percentage of pulp weight.
- 8- Percentage of seed weight.
- 9- The ratio between edible and non-edible portions (pulp: peel + seed).

B- Chemical characteristics:

The studied chemical characteristics of fruits included the following parameters:

1- Total soluble solids (T. S. S. %):

The fruit flesh was well minced with an electric blender and the paste was squeezed and the total soluble solids were determined by hand refractometer (according to **A.O.A.C., 2000**).

2- Sugar content:

The percentages of the total and reducing sugars were determined according to **Lane and Eynon (1965)** volumetric method that is outlined in (**A.O.A.C., 2000**). Non reducing sugars were then calculated.

3- Total acidity (%):

Twenty five grams of fresh fruit pulp were mixed with 100 ml distilled water by an electric blender, the extract was filtrated and twenty ml. of it were titrated against 0.1 N sodium hydroxide using phenolphthalein as an indicator according to the (**A.O.A.C., 2000**). Acidity was determined as g citric acid/ 100 g pulp.

4- Vitamin C:

The pulp content of vitamin C (mg ascorbic acid/ 100 g pulp) was determined by titration against 2,6-dichlorophenol indophenol dye according to (**A.O.A.C., 2000**).

5- Total fibre content:

Determination of crude content of fibre was achieved by boiling a 1.0 g sample of the fresh flesh

in a mixture of glacial acetic acid and nitric acid (10:1). After filtration, the weight of the precipitate on top of the filter paper was calculated as a percentage of the original sample weight according to the official methods described in (A.O.A.C., 2000).

All the obtained data were tabulated and statistically analyzed according to the procedure of **Steel and Torrie (1980)**. The treatment means were compared using new L.S.D. test at 5% (**Gomez and Gomez, 1984**).

3. Results

1- Effect of spraying salicylic acid and/ or seaweed extract on the yield per tree

Data in Table (4) show the effect of spraying salicylic acid and/ or seaweed extract on the yield expressed in number of fruits/ tree and weight (kg.) of mango cvs FagriKalan, Zebda and Alphonse grown under Minia region conditions during 2017 & 2018 seasons.

Yield / tree expressed in number of fruits / tree and weight (kg.) was significantly varied among the three mango cvs FagriKalan, Zebda and Alphonse. The maximum values were recorded on mango cv FagriKalan, Zebda and Alphonse, in descending order. The maximum and minimum yield were recorded on mango cv. FagriKalan and Alphonse, respectively. These results were true during both seasons.

It is obvious from the obtained data that single and combined applications of SA at 50 to 200 ppm and seaweed extract at 0.05 to 0.2% had significant promotion on the yield expressed in weight and number of fruits / tree relative to the control. There was a gradual promotion on the yield/ tree with increasing concentrations of SA from 50 to 200 ppm and seaweed extract from 0.05 to 0.2%. Significant differences on the yield were observed between the two materials and their concentrations except among the higher two concentrations of SA (100 and 200 ppm) and seaweed extract (0.1 & 0.2%). Therefore, from economical point of view it is recommended to use the medium concentration of SA namely 100 ppm and seaweed extract namely 0.1% for obtaining an economical yield. Treating the trees three times with seaweed extract at 0.05 to 0.2% significantly was preferable than using SA at 50 to 200 ppm in improving the yield. Yield was significantly higher with the application of SA and seaweed extract together compared to using each material alone. The best results from economical point of view were obtained due to treating the trees three times with a mixture of SA at 100 ppm plus seaweed extract at 0.1 %. Untreated trees produced the minimum values. These results were true during both seasons.

The interaction between different mango cvs and SA and seaweed extract treatments exhibited significant effect on the yield expressed in number of fruits / tree and weight (kg). The recommended treatment was the use of SA at 100 ppm plus seaweed extract at 0.1% in mango cv. FagriKalan. Under such promised treatment, yield/ tree reached 260.39 kg and 270.36 kg during both seasons, respectively. The highest yield of mango cv. Zebda (208.15 & 216.0 kg) and Alphonse (190.56 & 204.82 kg) were recorded on the trees treated with SA at 100 ppm and seaweed extract at 0.1 % during both seasons, respectively. The untreated trees of mango cv Alphonse gave the minimum values of yield during both seasons. These results were true during both seasons.

2- Effect of spraying salicylic acid and/ or seaweed extract on both physical and chemical characteristics of the fruits

Data in Tables (5 to 12) show the effect of spraying salicylic acid and/ or seaweed extract on fruit characteristics namely weight, height, diameter, thickness and firmness of fruit, percentages of pulp, peels and seed weights of fruits, edible to non edible portions of fruit, T.S.S./, titratable acidity %, total, reducing and non – reducing sugars %, vitamin C and total crude fibre in the fruits of mango cvs FagriKalan, Zebda and Alphonse grown under Minia region conditions during 2017 & 2018 seasons.

Most physical and chemical characteristics of the fruits were significantly varied among the three mango cvs. The highest values of weight, height, diameter, thickness and fruit pulp%, edible to non edible portions, total acidity %, total fibre % and the lowest values of fruit firmness, fruit peel %, T.S.S., total reducing and non reducing sugars and vitamin C were recorded on the mango cv Alphonse. The vice versa was detected on mango cv. FagriKalan. These results were true during seasons.

Treating mango trees three times with SA at 50 to 200 ppm and/ or seaweed extract at 0.05 to 0.2% was significantly very effective in improving fruit characteristics in terms of increasing weight, height, diameter and thickness of fruit, fruit pulp%, edible to non- edible portions of the fruits, T.S.S., total, reducing and non – reducing sugars % and vitamin C content and decreasing percentages of peel and seeds in the fruit, titratable acidity % and total crude fibre relative to the control treatment. The present treatments had no significant effect on fruit firmness. There was a gradual promotion on both physical and chemical characteristics of the fruits with increasing concentrations of both SA and seaweed extract. No significant promotion on fruit quality parameters was observed among the higher two concentrations (100

& 200 ppm for SA and 0.1 & 0.2% for seaweed extract). Using seaweed extract was significantly preferable than using SAS on improving fruit quality.

Combined applications of SA and seaweed extract was significantly superior than using each one alone in this connection. From economical point of view, the best results with regard to quality parameters were obtained due to treating the trees three times with a mixture of SA at 100 ppm and seaweed extract at 0.1% (since no significant differences were observed among the higher two concentrations of SA and seaweed extract). The untreated trees produced unacceptable quality

parameters of the fruits. These results were true during both seasons.

Both physical and chemical characteristics of the fruits were significantly affected by the interaction between mango cvs and single and combined application of SA and seaweed extract. The best results with regard to physical characteristics were obtained due to treating Alphonse mango trees with a mixture of SA at 100 ppm and seaweed extract at 0.1. Treating Fagrikalan mango trees with the same mixture gave the best results with regard to chemical quality characteristics. Similar trend was noticed during both seasons.

Table (4): Effect of spaying salicylic acid and/ or seaweed extract on yield expressed in weight (kg.) and number of fruits / tree of mango cvs Fagrikalan, Zebda and Alphonse during 2017 & 2018 seasons.

Salicylic acid and seaweed extract treatments (B)	No. of fruits / tree								Yield tree (kg.)							
	2017				2018				2017				2018			
	Mango cvs (A)															
	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)
b ₁ Control	600	470	410	493.3	581	461	410	484.0	210	166.85	147.19	174.68	202.19	163.19	147.60	170.99
b ₂ Salicylic acid at 50 ppm	615	480	425	506.7	621	487	431	512.3	218.33	173.28	154.70	182.10	221.08	176.06	159.90	185.68
b ₃ Salicylic acid at 100 ppm	625	490	440	518.3	631	497	446	524.7	225	179.34	163.24	189.19	227.79	183.89	168.59	193.42
b ₄ Salicylic acid at 200 ppm	626	491	441	519.3	632	498	447	525.7	226	180.20	163.61	189.93	228.15	184.76	169.41	194.11
b ₅ Seaweed extract at 0.05%	641	500	456	532.3	647	509	462	539.3	235.25	185.00	171.00	197.08	239.39	190.88	179.72	203.33
b ₆ Seaweed extract at 0.1%	655	512	464	543.7	661	521	470	550.7	245.63	194.56	179.10	206.43	250.52	201.63	186.59	212.91
b ₇ Seaweed extract at 0.2%	656	513	465	544.7	662	522	471	551.7	246.66	195.45	179.96	207.35	251.56	202.54	187.93	214.01
b ₈ Both at low conc.	664	522	471	552.3	671	530	480	560.31	253.65	202.01	184.16	213.27	261.69	208.82	195.84	222.12
b ₈ Both at mid conc.	671	531	480	560.7	681	540	491	570.3	260.35	208.15	190.56	219.69	270.36	216.0	204.82	230.39
b ₈ Both at high conc.	672	532	481	561.7	683	541	492	572.0	261.41	209.08	191.44	220.64	271.83	216.94	206.04	231.80
Mean (A)	642.5	504.1	453.3		647	510.4	460		238.22	189.39	172.50		242.46	194.47	180.70	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	11.0	10.0	17.3		11.0	11.0	15.0		8.01	6.91	11.99		10.01	6.62	11.45	

Table (5): Effect of spaying salicylic acid and/ or seaweed extract on the averages fruit weight (g.) and fruit height (cm) of mango cvs Fagrikalan, Zebda and Alphonse during 2017 & 2018 seasons.

Salicylic acid and seaweed extract treatments (B)	Av. Fruit weight (g.)								Av. Fruit height (cm.)							
	2017				2018				2017				2018			
	Mango cvs (A)															
	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)
b ₁ Control	350	355	359	354.7	348	354	360	354.0	15.0	15.2	15.5	15.2	14.9	15.1	15.4	15.1
b ₂ Salicylic acid at 50 ppm	355	361	364	360.0	356	363	371	363.3	15.5	15.6	15.9	15.7	15.6	15.9	16.3	15.9
b ₃ Salicylic acid at 100 ppm	360	366	371	365.7	361	370	378	369.7	15.8	16.0	16.3	16.0	15.9	16.2	16.6	16.2
b ₄ Salicylic acid at 200 ppm	361	367	371	366.3	361	371	379	370.3	15.9	16.1	16.4	16.1	16.0	16.3	16.7	16.3
b ₅ Seaweed extract at 0.05%	367	370	375	370.7	370	375	389	378.0	16.3	16.6	16.9	16.6	16.6	17.0	17.4	17.0
b ₆ Seaweed extract at 0.1%	375	380	386	380.3	379	387	397	387.7	16.6	16.9	17.2	16.9	16.9	17.4	17.7	17.3
b ₇ Seaweed extract at 0.2%	376	381	387	381.3	380	388	399	389.0	16.7	17.0	17.3	17.0	17.0	17.5	17.8	17.4
b ₈ Both at low conc.	382	387	391	386.7	390	394	408	397.3	17.0	17.3	17.6	17.3	17.3	17.7	18.1	17.7
b ₈ Both at mid conc.	388	392	397	392.3	397	400	418	405.0	17.3	17.5	18.0	17.6	17.6	18.0	18.9	18.2
b ₈ Both at high conc.	389	393	398	393.3	398	401	420	406.3	17.4	17.6	18.1	17.7	17.7	18.0	18.3	18.0
Mean (A)	370	375	380		374	380	392		16.4	16.6	16.9		16.6	16.9	17.3	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	4.1	3.9	6.7		5.0	4.9	8.5		0.2	0.2	0.3		0.3	0.3	0.5	

Table (6): Effect of spaying salicylic acid and/ or seaweed extract on averages fruit diameter (cm) and thickness (cm) of mango cvsFagrikalan, Zebda and Alphonse during 2017 & 2018 seasons.

Salicylic acid and seaweed extract treatments (B)	Av. Fruit diameter (cm)								Av. Fruit thickness (cm)							
	2017				2018				2017				2018			
	Mango cvs (A)															
	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)
b ₁ Control	9.3	9.5	9.6	9.5	9.0	9.2	9.6	9.3	7.2	7.3	7.4	7.3	7.1	7.3	7.5	7.3
b ₂ Salicylic acid at 50 ppm	9.5	9.7	9.8	9.7	9.3	9.4	9.8	9.5	7.5	7.6	7.7	7.6	7.3	7.7	7.8	7.6
b ₃ Salicylic acid at 100 ppm	9.7	9.9	10.1	9.9	9.5	9.7	10.1	9.8	7.7	7.9	8.0	7.9	7.6	8.0	8.0	7.9
b ₄ Salicylic acid at 200 ppm	9.7	9.9	10.1	9.9	9.6	9.8	10.1	9.8	7.7	8.0	8.0	7.9	7.7	8.0	8.1	7.9
b ₅ Seaweed extract at 0.05%	9.9	10.1	10.3	10.1	10.0	10.2	10.5	10.2	7.9	8.2	8.3	8.1	7.9	8.2	8.5	8.2
b ₆ Seaweed extract at 0.1%	10.1	10.3	10.5	10.3	10.3	10.4	10.7	10.5	8.1	8.4	8.6	8.4	8.1	8.5	8.8	8.5
b ₇ Seaweed extract at 0.2%	10.1	10.4	10.6	10.4	10.6	10.5	10.8	10.6	8.1	8.4	8.7	8.4	8.2	8.5	8.9	8.5
b ₈ Both at low conc.	10.3	10.7	10.8	10.6	10.7	10.9	11.2	10.9	8.3	8.6	8.7	8.5	8.5	8.7	9.1	8.8
b ₈ Both at mid conc.	10.5	11.0	11.0	10.8	10.9	11.0	11.5	11.1	8.5	8.7	8.9	8.7	8.7	9.0	9.3	9.0
b ₈ Both at high conc.	10.6	11.0	11.0	10.9	11.0	11.0	11.6	11.2	8.5	8.7	8.9	8.7	8.8	9.0	9.3	9.0
Mean (A)	10.0	10.3	10.4		10.1	10.2	10.6		8.0	8.2	8.3		8	8.3	8.5	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	0.3	0.2	0.3		0.2	0.2	0.3		0.2	0.2	0.3		0.2	0.2	0.3	

Table (7): Effect of spaying salicylic acid and/ or seaweed extract on fruit firmness and fruit pulp weight % of mango cvsFagrikalan, Zebda and Alphonse during 2017 & 2018 seasons.

Salicylic acid and seaweed extract treatments (B)	Fruit firmness (lb/ inch ²)								Fruit pulp weight %							
	2017				2018				2017				2018			
	Mango cvs (A)															
	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)
b ₁ Control	19.8	22.0	15.1	19.00	19.9	21.9	15.2	19.0	79.0	79.9	80.0	79.6	78.5	80.0	80	79.5
b ₂ Salicylic acid at 50 ppm	19.9	22.1	15.2	19.07	20.0	22.0	15.2	19.07	80.5	81.5	81.8	81.3	80.7	81.0	81.3	81.0
b ₃ Salicylic acid at 100 ppm	19.9	22.2	15.3	19.13	20.0	22.0	15.3	19.10	82.0	83.0	83.3	82.8	81.9	83.0	83.3	82.7
b ₄ Salicylic acid at 200 ppm	19.9	22.2	15.3	19.13	20.0	22.1	15.3	19.13	82.5	83.5	83.4	83.1	82.0	83.4	83.4	82.9
b ₅ Seaweed extract at 0.05%	20.0	22.2	15.3	19.17	20.1	22.1	15.3	19.17	84.0	84.5	84.7	84.4	84.0	85.5	85.6	85.0
b ₆ Seaweed extract at 0.1%	20.0	22.2	15.3	19.17	20.2	22.1	15.3	19.20	86.0	86.4	86.6	86.3	85.9	87.0	87.3	86.7
b ₇ Seaweed extract at 0.2%	20.0	22.2	15.3	19.17	20.2	22.2	15.3	19.23	86.1	86.5	86.7	86.4	86.0	87.1	87.4	86.8
b ₈ Both at low conc.	20.0	22.3	15.3	19.20	20.2	22.3	15.3	19.27	88.0	88.9	89.0	88.6	87.9	89.0	89.3	88.7
b ₈ Both at mid conc.	20.0	22.3	15.3	19.20	20.2	22.4	15.4	19.33	88.9	90.0	89.5	89.5	89.0	90.4	90.5	90.0
b ₈ Both at high conc.	20.0	22.3	15.3	19.20	20.2	22.5	15.3	19.33	89.0	90.0	90.0	89.7	89.1	90.5	90.6	90.1
Mean (A)	20.0	22.2	15.3		20.1	22.2	15.3		84.6	85.4	85.5		84.5	85.7	85.9	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	1.7	NS	2.1		1.6	NS	1.9		0.8	0.7	1.2		0.7	0.9	1.6	

Table (8): Effect of spaying salicylic acid and/ or seaweed extract on fruit peel weight % and fruit seed weight % of mango cvsFagrikalan, Zebda and Alphonse during 2017 & 2018 seasons.

Salicylic acid and seaweed extract treatments (B)	Fruit peel weight %								Fruit seed weight %							
	2017				2018				2017				2018			
	Mango cvs (A)															
	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)
b ₁ Control	6.4	6.2	6.0	6.2	6.3	6.0	5.8	6.0	14.6	13.9	14.0	14.2	15.2	14.0	14.2	14.5
b ₂ Salicylic acid at 50 ppm	6.2	6.0	5.8	6.0	6.0	5.8	5.6	5.8	13.3	12.5	12.4	12.7	13.3	13.2	13.1	13.2
b ₃ Salicylic acid at 100 ppm	6.0	5.8	5.6	5.8	5.9	5.6	5.5	5.7	12.0	11.2	11.1	11.4	12.2	11.4	11.2	11.6
b ₄ Salicylic acid at 200 ppm	6.0	5.8	5.5	5.8	5.9	5.5	5.4	5.6	11.5	10.7	11.1	11.1	12.1	11.1	11.2	11.5
b ₅ Seaweed extract at 0.05%	5.7	5.6	5.3	5.5	5.6	5.5	5.4	5.5	10.3	9.9	10.0	10.1	10.4	9.0	9.0	9.5
b ₆ Seaweed extract at 0.1%	5.5	5.4	5.2	5.4	5.5	5.3	5.2	5.3	8.50	8.2	8.2	8.3	8.6	7.7	7.5	7.9
b ₇ Seaweed extract at 0.2%	5.5	5.4	5.2	5.4	5.4	5.3	5.1	5.3	8.40	8.1	8.1	8.2	8.6	7.6	7.5	7.9
b ₈ Both at low conc.	5.3	5.2	5.0	5.2	5.4	5.3	5.1	5.3	6.70	5.9	6.0	6.2	6.7	5.7	5.6	6.0
b ₈ Both at mid conc.	5.1	5.0	4.9	5.0	5.2	5.0	4.9	5.0	6.0	5.0	5.6	5.5	5.8	4.6	4.6	5.0
b ₈ Both at high conc.	5.1	5.0	4.9	5.0	5.1	5.0	4.8	5.0	5.9	5.0	5.10	5.3	5.8	4.5	4.6	5.0
Mean (A)	5.7	5.5	5.3		5.6	5.4	5.3		9.7	9.0	9.2		9.9	8.9	8.9	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	0.2	0.2	0.3		0.2	0.2	0.3		0.2	0.2	0.3		0.3	0.2	0.3	

Table (9): Effect of spaying salicylic acid and/ or seaweed extract on edible to non edible portions of the fruits and percentage of total soluble solids of mango cvsFagrikalan, Zebda and Alphonse during 2017 & 2018 seasons.

Salicylic acid and seaweed extract treatments (B)	Edible to non edible portions of the fruits								T.S.S. %							
	2017				2018				2017				2018			
	Mango cvs (A)															
	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)
b ₁ Control	3.76	3.98	4.00	3.91	3.65	4.00	4.00	3.88	16.5	16.0	15.9	16.1	16.6	16.3	16.0	16.3
b ₂ Salicylic acid at 50 ppm	4.13	4.41	4.49	4.34	4.18	4.26	4.35	4.26	17.0	16.5	16.4	16.6	17.1	16.4	16.3	16.6
b ₃ Salicylic acid at 100 ppm	4.56	4.88	4.99	4.81	4.52	4.88	4.99	4.80	17.4	16.9	16.8	17.0	17.5	16.6	16.6	16.9
b ₄ Salicylic acid at 200 ppm	4.71	5.06	5.02	4.93	4.56	5.02	5.02	4.87	17.5	17.0	16.9	17.1	17.5	16.7	16.7	17.0
b ₅ Seaweed extract at 0.05%	5.25	5.45	5.54	5.41	5.25	5.90	5.94	5.70	18.0	17.4	17.3	17.6	18.1	17.8	17.0	17.5
b ₆ Seaweed extract at 0.1%	6.14	6.35	6.46	6.32	6.09	6.69	6.87	6.55	18.6	17.8	17.6	18.0	18.7	18.0	17.3	18.0
b ₇ Seaweed extract at 0.2%	6.19	6.41	6.52	6.37	6.14	6.75	6.94	6.61	18.7	17.9	17.7	18.1	18.8	18.0	17.4	18.0
b ₈ Both at low conc.	7.33	8.01	8.09	7.81	7.26	8.09	8.35	7.90	19.0	18.3	18.0	18.4	19.1	18.3	17.8	18.7
b ₈ Both at mid conc.	8.01	9.00	8.52	8.51	8.09	9.42	9.53	9.01	19.5	18.7	18.3	18.8	19.6	18.6	18.2	18.8
b ₈ Both at high conc.	8.09	9.00	9.00	8.70	8.17	9.53	9.64	9.11	19.6	18.8	18.3	18.8	19.6	18.7	18.3	18.4
Mean (A)	5.82	6.25	6.26		5.79	6.45	6.56		18.2	17.5	17.3		18.3	17.5	17.2	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	0.35	0.33	0.57		0.31	0.33	0.57		0.2	0.2	0.3		0.2	0.2	0.3	

Table (10): Effect of spaying salicylic acid and/ or seaweed extract on the titratable acidity % and total sugars % of mango cvsFagrikalan, Zebda and Alphonse during 2017 & 2018 seasons.

Salicylic acid and seaweed extract treatments (B)	Titratable acidity %								Total sugars %							
	2017				2018				2017				2018			
	Mango cvs (A)															
	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)
b ₁ Control	0.341	0.400	0.421	0.389	0.341	0.399	0.423	0.388	14.1	13.9	13.6	13.9	14.0	13.9	13.6	13.8
b ₂ Salicylic acid at 50 ppm	0.311	0.371	0.411	0.364	0.311	0.370	0.411	0.364	14.4	14.2	13.9	14.2	14.5	14.3	14.1	14.3
b ₃ Salicylic acid at 100 ppm	0.290	0.341	0.380	0.337	0.291	0.341	0.379	0.337	14.8	14.5	14.2	14.5	14.9	14.7	14.3	14.6
b ₄ Salicylic acid at 200 ppm	0.288	0.340	0.377	0.335	0.288	0.339	0.375	0.334	14.9	14.5	14.3	14.6	15.0	14.8	14.4	14.7
b ₅ Seaweed extract at 0.05%	0.255	0.310	0.343	0.303	0.255	0.309	0.340	0.301	15.2	14.7	14.4	14.8	15.0	14.7	14.6	14.8
b ₆ Seaweed extract at 0.1%	0.235	0.290	0.330	0.285	0.240	0.288	0.329	0.286	15.6	15.0	14.7	15.1	15.7	15.8	14.9	15.5
b ₇ Seaweed extract at 0.2%	0.231	0.288	0.327	0.282	0.236	0.288	0.327	0.284	15.7	15.0	14.8	15.2	15.9	15.9	15.0	15.6
b ₈ Both at low conc.	0.210	0.250	0.305	0.255	0.209	0.250	0.301	0.253	16.1	15.5	15.2	15.6	16.0	16.3	15.5	15.9
b ₈ Both at mid conc.	0.200	0.220	0.285	0.235	0.199	0.220	0.285	0.235	16.6	15.8	15.5	16.0	16.3	16.6	15.8	16.2
b ₈ Both at high conc.	0.199	0.218	0.282	0.233	0.198	0.219	0.283	0.233	16.7	15.9	15.6	16.1	16.4	16.7	15.9	16.3
Mean (A)	0.256	0.303	0.346		0.257	0.302	0.345		15.4	14.9	14.6		15.4	15.4	14.8	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	0.30	0.21	0.36		0.29	0.18	0.31		0.3	0.2	0.3		0.3	0.2	0.3	

Table (11): Effect of spaying salicylic acid and/ or seaweed extract on the percentages of reducing and non-reducing in the fruits of mango cvs Fagrikalan, Zebda and Alphonse during 2017 & 2018 seasons.

Salicylic acid and seaweed extract treatments (B)	Reducing sugars %								Non-reducing sugars %							
	2017				2018				2017				2018			
	Mango cvs (A)															
	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)
b ₁ Control	4.4	4.2	4.0	4.2	4.5	4.2	4.0	4.2	9.7	9.7	9.6	9.7	9.5	9.7	9.6	9.6
b ₂ Salicylic acid at 50 ppm	4.6	4.4	4.2	4.4	4.7	4.5	4.2	4.5	9.8	9.8	9.7	9.8	9.8	9.8	9.9	9.8
b ₃ Salicylic acid at 100 ppm	4.9	4.6	4.4	4.6	4.9	4.7	4.5	4.7	9.9	9.9	9.8	9.9	10.0	10.0	9.8	9.9
b ₄ Salicylic acid at 200 ppm	5.0	4.7	4.4	4.7	5.0	4.8	4.6	4.8	9.9	9.8	9.9	9.9	10.0	10.3	9.8	10.0
b ₅ Seaweed extract at 0.05%	5.3	5.1	4.6	5.0	5.2	5.0	4.8	5.0	9.9	9.6	9.8	9.8	9.8	9.7	9.8	9.8
b ₆ Seaweed extract at 0.1%	5.6	5.4	4.9	5.3	5.4	5.3	5.0	5.2	10.0	9.6	9.8	9.8	10.3	10.5	9.9	10.2
b ₇ Seaweed extract at 0.2%	5.7	5.5	5.0	5.4	5.5	5.4	5.1	5.3	10.0	9.5	9.8	9.8	10.4	10.5	9.9	10.3
b ₈ Both at low conc.	5.9	5.6	5.3	5.6	5.7	5.7	5.3	5.6	10.2	9.9	9.9	10.0	10.3	10.6	10.2	10.4
b ₈ Both at mid conc.	6.1	5.8	5.5	5.8	5.9	5.9	5.5	5.8	10.5	10.0	10.0	10.2	10.4	10.7	10.3	10.5
b ₈ Both at high conc.	6.2	5.8	5.5	5.8	6.0	6.0	5.6	5.9	10.5	10.1	10.1	10.2	10.4	10.7	10.3	10.5
Mean (A)	5.4	5.1	4.8		5.3	5.1	4.9		10.0	9.8	9.8		10.1	10.3	10.0	
New L.S.D. at 5%	A	B	AB		A	B	Bb		A	B	AB		A	B	AB	
	0.2	0.2	0.3		0.2	0.2	0.3		0.2	0.2	0.3		0.2	0.2	0.3	

Table (12): Effect of spaying salicylic acid and/ or seaweed extract on vitamin C content and percentage of total fibre in the fruits of mango cvs Fagrikalan, Zebda and Alphonse during 2017 & 2018 seasons.

Salicylic acid and seaweed extract treatments (B)	Vitamin C content (mg/ 10 g pulp)								Total crude fibre %							
	2017				2018				2017				2018			
	Mango cvs (A)															
	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)	a ₁ Fagri	a ₂ Zebda	a ₃ Alphonse	Mean (B)
b ₁ Control	55.0	49.0	44.4	49.5	55.0	49.1	44.5	49.5	0.41	0.61	0.69	0.57	0.41	0.59	0.70	0.57
b ₂ Salicylic acid at 50 ppm	57.0	51	46	51.3	56.9	50.8	46.1	51.3	0.36	0.55	0.65	0.52	0.34	0.53	0.66	0.51
b ₃ Salicylic acid at 100 ppm	60	52	47.5	53.2	59.8	51.9	47.6	53.1	0.30	0.50	0.60	0.47	0.28	0.48	0.60	0.45
b ₄ Salicylic acid at 200 ppm	60.5	52.5	48.0	53.7	60.0	52.9	48.1	53.7	0.29	0.49	0.59	0.46	0.27	0.47	0.58	0.44
b ₅ Seaweed extract at 0.05%	62	53.9	50.0	55.3	61.9	54.0	50.1	55.3	0.25	0.45	0.55	0.42	0.23	0.43	0.55	0.40
b ₆ Seaweed extract at 0.1%	63	56.0	52.0	57.0	62.8	55.9	52.0	56.9	0.20	0.40	0.40	0.33	0.18	0.40	0.40	0.33
b ₇ Seaweed extract at 0.2%	63.1	56.3	52.5	57.3	63.0	56.0	52.6	57.2	0.19	0.39	0.39	0.32	0.17	0.39	0.39	0.32
b ₈ Both at low conc.	66.0	58.0	54.5	59.5	65.9	58.0	54.6	59.5	0.19	0.35	0.45	0.33	0.17	0.35	0.45	0.32
b ₈ Both at mid conc.	68.0	59.9	56.9	61.6	68.3	60.0	57.0	61.8	0.16	0.30	0.40	0.29	0.14	0.30	0.40	0.28
b ₈ Both at high conc.	68.5	60	57.0	61.8	68.5	60.1	57.0	61.9	0.15	0.30	0.39	0.28	0.13	0.30	0.39	0.27
Mean (A)	62.3	54.9	50.9		62.2	54.9	51.0		0.25	0.43	0.51		0.23	0.42	0.51	
New L.S.D. at 5%	A	B	AB		A	B	AB		A	B	AB		A	B	AB	
	2.1	1.4	2.4		1.9	1.7	2.9		0.05	0.04	0.07		0.06	0.04	0.07	

4. Discussion

1- Effect of evaluation:

The great variation occurred among the three investigated mango cvs namely Fagrikalan, Zebda and Alphonse grown under Minia region conditions might be ascribed mainly to the degree of successful performance and these differences are governed by various genetic, cultural and environmental factors. The suitability of the various environmental conditions to each mango cv surely reflected the success of such mango cv in the different locations. The extent of acclimatization of each cv. Grown under different location to varying climatic and soil conditions largely aids in growing such mango cvs (Whiley and Schaffer, 1993, Devilliers, 1998 and Majumder *et al.*, 2001).

The great variation on yield and fruit characteristics among the three mango cvs cultivated under Minia region was supported by the results of Hammam (2000); El-Masry (2001); Mohamed (2001); Ragab *et al.*, (2002); Hassan *et al.*, (2004); Abd El-Hadi (2006) and Fahmy (2016).

2-Effect of salicylic acid:

The beneficial effects of salicylic acid on growth, photosynthetic pigments, nutrients, yield and fruit characteristics of mango cv. Fagrikalan, Zebda and Alphonse might be attributed to its effect on promoting cell division, photosynthetic process, uptake and translocation of nutrients, the tolerance of the trees to biotic and abiotic stresses, expression of genes and accumulation of proline, uptake of sugars and amino acids and building of natural hormones such as IAA and GA₃ as well as is responsible for reducing the sensitivity of fruit crops to biotic and abiotic stresses and oxidative stresses, promoting the antioxidative capacity and protective compounds such as polymines and changing the leaf anatomy and chloroplast structure. It was found that salicylic acid is involved in endogenous signaling mediating in plant defense against pathogens and inducing the production of pathogenesis related proteins. Also, they are gave good evidence that salicylic acid is considered a potent inhibitor of hem containing enzymes such as catalase and ascorbate peroxidase that capable of stimulating reactive oxygen species accumulation during stress conditions and a potent inducer of NADPH oxidase and an inhibitor of alternative oxidase that able to indirect regulation of the redox status of plant cells (Janda *et al.*, 2007).

The promoting effects of salicylic acid on yield and fruit characteristics of mango cvs Fagrikalan, Zebda and Alphonse are in harmony with these obtained by Saied (2011), Ahmed (2011), Masoud and El- Sehrawy (2012), Ahmed *et al.* (2013b), Ahmed *et al.* (2014) and Mohamed (2014).

3-Effect of seaweed extract:

The beneficial effects of seaweed on yield and fruit characteristics might be attributed to its own from natural hormones, which are responsible for promoting growth and delaying leaf aging. It contains glutathione, lecithin, adenylic acid, enzymes, co-enzymes, vitamin B2, and B6, different nutrients, proteins, vitamins, antioxidants, amino acids especially glycine. Also, it is very essential for the synthesis of protoporphyrin the precursor of photosynthetic pigments and photosynthesis through enhancing the release of CO₂ (Norric *et al.*, 2002; Planes- Leyva *et al.*, 2003 and Aziz *et al.*, 2003).

These results regarding the effect of seaweed extract on yield and fruit quality of the investigated mango cvs are in harmony with those obtained by Irizar- Garza *et al.*, (2003); Ebeid- Sanaa (2007); Mouftah (2007); Mohamed and El- Sehrawy (2013), Ahmed *et al.*, (2013a) and Oraby (2013).

Conclusion

Carrying out three sprays (growth start, just after fruit setting and after one month later) of a mixture of Salicylic acid at 100 ppm and seaweed extract at 0.1 % was responsible for promoting the yield of mango cvs Fagrikalan, Zebda and Alphonse. The best mango cvs grown successfully under Minia region conditions were Fagrikalan, Zebda and Alphonse according to their higher yield, in descending order.

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