Effect of Spraying Fish Oil and Glutathione on Fruiting of Ewaise Mango Trees Grown under Sandy Soil

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Abstract: This study was established during 2017 and 2018 seasons to test the effect of single and combined applications of fish oil and glutathione each at 0.5 to 2% on some vegetative growth aspects, photosynthetic pigments, flowering and fruit setting behavior, N, P, K, Mg, Ca (as %), Zn, Fe, Mn and Cu (as ppm), yield and both physical and chemical characteristics of the fruits in mango cv. Ewaise grown under sandy soil. The trees received three sprays at growth start, just after fruit setting and at 30 days later. Single and combined applications of fish oil and glutathione each at 0.5 to 2% had substantial promotion on shoot length and thickness, number of leaves/shoot, leaf area (in the spring growth cycle), photosynthetic pigments (chlorophylls a & b, total chlorophylls and total carotenoids), N, P, K, Mg, Ca (as %), Zn, Fe, Mn and Cu (as ppm), panicle length, number of panicles/tree, perfect flowers %, percentages of initial and fruit retention, yield and fruit quality characteristics over the control. Using glutathione was reasonably superior than using fish oil in enhancing all the studied parameters. Companied applications were materially favourable than using each material alone. In all cases negligible effect was observed on these parameters among the higher two concentrations of each material (1 & 2%). The best results with regard to growth, tree, nutritional status, flowering, fruit setting, yield and fruit quality were obtained due to treating Ewaise mango trees grown under sandy soil thrice (growth start, just after setting and at one month later) with a mixture of fish oil and glutathione each at 1%.

Keywords: Fish oil, glutathione, Ewaise mangoes, growth traits, flowering and fruit setting, photosynthetic pigments, yield, fruit quality

INTRODUCTION

It is well known that any effort is directed towards enhancing the production of Ewaise mangoes in our country will result in a promotion in our national income.

Under biotic and abiotic stresses, yield of Ewaise mangoes was greatly declined. This is due to the great release of reactive oxygen species (ROS) that are responsible to trees damage. Many attempts were accomplished for controlling ROS by using recent antioxidants such as fish oil and glutathione (Hultin and Jafan, 1991; Szala *et al*., 2008).

Glutathione (GSH) (molecular formula C_{10}-$H_{17}O_{65}$) is a tripeptide. It can be synthesized from the three amino acids namely cysteine, glutamic acid and glycine. It is essential in S metabolism and defense against all stresses, S uptake, gen expression and cell division (Jorge *et al*., 1993; Foyer *et al*., 1997; Noctor and Foyer, 1998; Koesy *et al*., 2001; Grill *et al*., 2001; Mulleineaux and Rausch, 2005; Pastimak *et al*., 2007; Rouhier *et al*., 2008).

Fish oil contains two types of fatty acids (omega 3-fatty acids namely Docosahexaenoic acid (DHA), eosapentaenotic acid (EPA), Tocopherls, Fe, Cu, P and carotenoids (Hultin and Jafan, 1991). It is considered an important source of antioxidants.

Recently, most studies gave good evidence for the important role of using glutathione and fish oil for preventing the cell damage caused by ROS and protecting the trees from aging. In addition, such two materials, one responsible for enhancing the idea of organic farming and reducing environment pollution.

Using fish oils was responsible for promoting growth tree nutritional status, yield and fruit quality of different horticultural crops (Olma *et al*., 1981; Osnaya and Schlasser, 1998; Mc-Arthey *et al*., 2006; Yoder *et al*., 2009; Masoud and Abou-Zaid-Eman, 2017).

Subjecting most fruit crops with glutathione at different concentrations and frequencies of application had positive effects on yield and fruit quality (Abdelaal *et al*., 2012; Gad El-Kareem, 2012; Ahmed *et al.,* 2013; El-Khawaga and Mansour, 2014; Madany, 2017).

This study was established to recognize the impact of using fish oil and glutathione applied via foliage on growth, tree nutritional status, yield and fruit quality of Ewaise mango trees grown under sandy soil.

MATERIALS AND METHODS

This investigation was conducted during the two consecutive seasons of 2017 and 2018 on thirty 10-years old Ewaise mango trees onto succary mango rootstock. The trees are grown in a private mango orchard located at west Samalout district, Samalout Minia Governorate. The uniform in vigour trees of Ewaise mango (30 trees) were planted at 7 × 7 meter apart.

The soil texture of the tested orchard is sandy clay well drained with a water table depth not less than two meters. Surface irrigation system was applied with water Nile.

The results of orchard soil analysis (Black, 1965; Black *et al.,* 1965; Wilde *et al.,* 1985) are shown in Table (1)

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

Particle size distribution:	
Sand %	56.7
Silt %	6.2
Clay %	37.1
Texture	Sandy clay
pH (1:2.5 extract)	7.35
EC (1: 2.5 extract) (mmhos/Icm/25°C)	1.59
O.M. %	0.21
$CaCO_3$ %	3.11
Total N %	0.009
Available P (ppm, Olsen)	1.2
Available K (ppm/ammonium acetate)	5.01
Available Mg (ppm)	21.0
Available S (ppm)	3.2
Available EDTA extractable micronutrients (ppm)	
Zn	1.49
Fe	1.11
Mn	1.22

The selected trees received a basal recommended fertilizer including the application of 20 m^3 farmyard manure (0.35% N, 0.45 % P_2O_5 and 1.2% K_2O) added in early December, 200 kg/fed/mono calcium superphosphate (15.5% P_2O_5) 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 sulpate (48% K_2O) 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, pests and weed control.

This experiment included the following ten treatments from single and combined applications of fish oil and glutathione each at 0.5 to 2.0%.

1) Control
2) Spraying Fish oil at 0.5%
3) Spraying Fish oil at 1.0%
4) Spraying Fish oil at 2.0%
5) Spraying Glutathione at 0.5%
6) Spraying Glutathione at 1.0%
7) Spraying Glutathione at 2.0%
8) Spraying Fish oil + Glutathione at 0.5%
9) Spraying Fish oil + Glutathione at 1.0%
10) Spraying Fish oil + Glutathione at 2.0%

Each treatment was replicated three times, one tree per each. Spraying of glutathione and fish oil was done three times at growth start (last week of Feb.), just after fruit setting (1st week of Apr.) and at one month later (1st week of May). Triton B as a wetting agent at 0.05% was added to all spraying solutions (each tree needs about 25 L solution). Spraying was done till runoff. The untreated trees sprayed with water containing triton B.

This study was statistically analyzed using Randomized complete block design (RCBD) in which the experiment included ten treatments and each treatment was replicated three times, tree per each.

Generally, the following measurements were recorded

Four branches for each tree were labelled (1st of Mar.) for measuring shoot length, number of leaves / shoot, shoot thickness (cm.) and leaf area in spring growth flush.

Twenty leaves below panicles in the spring growth cycle according to summer (1985) were taken in the first week of July for measuring the leaf area (cm^2) using the following equation as reported by Ahmed and Morsy (1999).

$$LA = 0.70 (L \times W) - 1.06$$

where LA = leaf area (cm^2)
L = Maximum length of leaf (cm.)
W = Maximum width of leaf (cm.)

Samples of five mature and fresh leaves from spring growth cycle per each replicate were taken. The leaves were cut into small pieces, homogenated and extracted by 25% acetone in the presence of a little amount of Na_2CO_3 and silica quartz then filtered through central glass funnel G_4.

The optical density of the filtrate was determined using Carl-Zeis spectrophotometer at the wave length of 662, 644 and 440 nm to determine chlorophylls (a and b) and carotenoides, respectively, Content of each pigments was calculated by using the following equations (according to Fadl and Seri El-Deen, 1978; Hiscox and Isralstam, 1979).

Chl. A = (9.784 x E 662) – (0.99 x E 644) = mg/L
Chl. B = (21.426 x E 644) – (4.65 x E 662) = mg/L
Total Carotenoides = (4.965 x E 440 – 0.268
(chlorophyll a + chlorophyll b)
E = Optical density at a given wave length.

The chlorophylls a and b as well as total carotenoides were calculated as mg/100g fresh weight of leaves.

The same previous leaves taken for measuring leaf area were well washed with running tap water followed by twice distilled water, dried in oven at 70°C for 24 hours and ground in stainless steel mill. Wet digestion was done by using concentrated sulphoric acid for overnight. Digestion was boiled and cooked with using H_2O_2 till colourless (Summer, 1985). In the digestion, the leaf content of N, P, K, Mg, Zn, Cu, Fe and Mn were determined as follows on dry weight basis (Piper, 1950; Peach and Tracey, 1968).

1- Nitrogen % was determined by modified micro Kjeldahi method as described by Pregel (1934).
2- Phosphorus % was determined by using spekol spectrophotometer (Cottenie *et al.,* 1982).
3- Potassium % was determined by using Flame photometer according to the procedure reported by Brown and Lilleland (1946).
4- Magnesium % and calcium was determined by using Varsen method (Chapman and Pratt, 1965).

5- Micronurteienst namely Zn, Fe, Mn and Cu (in ppm) were measured using atomic absorption spectrophotometer Perkin Elmer model 5000 according to Evenhuis and Deward (1980).

Number of hermaphrodite flowers on the twelve labeled shoots (three shoots for each directions) was counted periodically at five day intervals starting at the second week of March in both seasons till completed of fruit setting stage (1st week of April). Then, the number of fruitlettes was counted and the percentage of initial fruit setting was calculated by dividing the number of fruitlettes by total number of flowers and multiplying the product × 100. Percentage of fruits retention was calculated by counting the number of fruits just before harvesting and dividing the number of fruits by number of setted fruits and multiplying the product × 100, panicle length, number of panicles/trees and percentages of perfect flowers.

Harvesting was achieved during the regular commercial harvesting time under Aswan Governorate conditions (first week of July) in both seasons when the flesh becomes yellowish (Hulme, 1971). The yield expressed weight and number of fruits per tree was recorded.

Twenty fruits were taken randomly from the yield of each tree then transferred to the laboratory for determining the following physical and chemical properties of the fruits.

1- Physical properties of the fruits:

a- Average fruit weight (g.).
b- Averages fruit dimensions (in cm) (length, width and thickness by vernier caliper).
c- Percentages of flesh.
d- Ratio of edible to non edible portions by dividing pulp weight (edible) by weights of peel and seed (non-edible).

2- Chemical properties of the fruits:

The studied chemical characteristics of fruits included the following parameters.

a- Total soluble solids (TSS %):

The flesh of fruit was well minced with an electric blender and the paste was squeezed and the total soluble solids were determined by using hand refractometer.

b- Sugars content:

The percentages of the total and reducing sugars were determined according to Lane and Eynon (1965) volumetric method that outlined in (AOAC, 2000).

c- Total acidity (%):

Twenty five grams of flesh were blended 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 phenolphthalene as an indicator according to the (AOAC, 2000). Acidity was determined as g citric acid/ 100 g pulp.

d- Vitamin C:

The pulp content of vitamin C (mg. Ascorbic acid/100 g pulp) was determined by titration with 2, 6 dichlorophenol indophenol according to (AOAC, 2000).

e- **Total fibre %:**

Total fibre % was determined according to AOAC (2000).

All the obtained data were statistically analyzed and the differences between various treatments were compared using new L.S.D. at 5% according to Mead *et al.* (1993).

RESULTS

Vegetative growth aspects:

Data in Table (2) clearly show that spraying fish oil and/or glutathione each at 0.5 to 2% three times had significant stimulation on the four growth aspects (length and thickness of shoot, number of leaves/shoot and leaf area) in the spring growth cycle rather than non-application. The promotion on theses growth aspects was in proportional to the increase in concentrations of each material from 0.5 to 2%. Increasing concentrations from 1 to 2% for each material had no significant promotion on these growth aspects. Treating the trees with glutathione at 0.5 to 2% was significantly more than using fish oil in enhancing these growth aspects. The use of both materials together each at 0.5 to 2% significantly improved these growth aspects relative to using each material alone. The maximum values were recorded on the trees treated with fish oil plus glutathione each at 2%. The untreated trees produced the lowest values. These results were true during both seasons.

1- Leaf chemical components:

It is evident from the data in Tables (3 and 4) that subjecting Ewaise mango trees three times to fish oil and/or glutathione each at 0.5 to 2% resulted in significant promotion on photosynthetic pigments (total chlorophylls and total carotenoids), percentages of N, P, K, Mg an Ca and leaf content of Zn, Fe, Mn and Cu (as ppm) relative to the check treatment. There was a gradual promotion on photosynthetic pigments and different nutrients in the leaves with increasing concentrations of both fish oil and glutathione from 0.5 to 2%. Negligible promotion on these pigments and nutrients was observed among the higher two concentrations of each material namely (1 and 2%). Using both materials together significantly associated with maximizing these parameters than using each material alone. Treating the trees thrice with a mixture of fish oil and glutathione each at 2% gave the maximum values. The lowest values were recorded on the trees that did not receive any materials. Similar results were announced during 2016 and 2017 seasons.

2- Flowering and fruit setting aspects:

Table (5) shows that flowering aspects (panicle length, number of panicles/trees and percentages of perfect flowers), and initial fruit setting and fruit retention were significantly improved in response to treating the trees thrice with fish oil and glutathione each at 0.5 to 2% either applied alone or in combinations relative to the control treatment. Male

Table (2): Effect of single and combined applications of fish oil and glutathione on vegetative growth and chlorophylls a and b in the leaves of Ewaise mango trees during 2016 and 2017 seasons

Treatments	Shoot length (cm)		No. leaves/shoot		Shoot thickness (cm)		Leaf area $(cm)^2$		Chlorophyll a (mg/g F.W)		Chlorophyll a (mg/g F.W)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	9.0	8.7	5.0	5.0	0.69	0.68	71.0	70.9	4.11	4.14	1.14	1.11
Spraying fish oil at 0.5 %	10.3	10.0	6.0	6.0	0.75	0.74	72.5	72.4	4.22	4.25	1.21	1.22
Spraying fish oil at 1.0 %	12.0	11.7	7.0	7.0	0.81	0.80	74.0	73.9	4.39	4.36	1.29	1.30
Spraying fish oil at 2.0 %	12.1	11.8	7.5	7.0	0.82	0.81	74.3	74.2	4.40	4.38	1.30	1.30
Spraying glutathione at 0.5 %	13.3	12.9	8.5	9.0	0.88	0.86	75.7	75.6	4.55	4.55	1.40	1.39
Spraying glutathione at 1.0 %	15.0	14.7	9.5	10.0	0.94	0.91	77.0	77.0	4.71	4.71	1.46	1.45
Spraying glutathione at 2.0 %	15.1	14.8	10.0	10.0	0.95	0.92	77.3	77.2	4.73	4.72	1.47	1.46
Spraying fish oil + glutathione at 0.5 %	16.2	15.9	11.0	11.0	1.00	0.98	79.0	78.8	4.90	4.92	1.58	1.60
Spraying fish oil + glutathione at 1.0 %	17.3	17.4	12.0	12.0	1.05	1.04	80.2	81.0	5.11	5.15	1.64	1.65
Spraying fish oil + glutathione at 2.0 %	17.4	17.5	12.0	12.0	1.06	1.05	80.5	81.3	5.12	5.16	1.65	1.66
New L.S.D. at 5 %	**1.1**	**1.4**	**1.0**	**1.0**	**0.05**	**0.06**	**1.1**	**1.3**	**0.06**	**0.05**	**0.04**	**0.03**

Table (3): Effect of single and combined applications of fish oil and glutathione on total chlorophylls, total carotenoids and percentages of N, P, K and Mg in the leaves of Ewaise mango trees during 2016 and 2017 seasons

Treatments	Total chlorophylls (mg/g F.W)		Total carotenoids (mg/g F.W)		Leaf N %		Leaf P %		Leaf K %		Leaf Mg %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	5.25	5.25	1.15	1.18	1.58	1.60	0.119	0.125	1.11	1.09	0.51	0.49
Spraying fish oil at 0.5 %	5.43	5.47	1.21	1.26	1.68	1.69	0.130	0.136	1.18	1.20	0.55	0.54
Spraying fish oil at 1.0 %	5.68	5.66	1.28	1.33	1.79	1.79	0.140	0.145	1.25	1.27	0.60	0.59
Spraying fish oil at 2.0 %	5.70	5.68	1.29	1.34	1.80	1.82	0.141	0.147	1.26	1.27	0.61	0.60
Spraying glutathione at 0.5 %	5.95	5.94	1.40	1.47	1.88	1.93	0.151	0.158	1.34	1.37	0.66	0.68
Spraying glutathione at 1.0 %	6.17	6.16	1.47	1.55	1.95	1.99	0.161	0.167	1.40	1.43	0.72	0.73
Spraying glutathione at 2.0 %	6.20	6.18	1.48	1.56	1.96	2.00	0.162	0.168	1.41	1.44	0.73	0.74
Spraying fish oil + glutathione at 0.5 %	6.48	6.52	1.59	1.64	2.05	2.06	0.179	0.185	1.48	1.51	0.80	0.80
Spraying fish oil + glutathione at 1.0 %	6.75	7.29	1.71	1.70	2.15	2.13	0.190	0.196	1.55	1.59	0.84	0.85
Spraying fish oil + glutathione at 2.0 %	6.77	7.82	1.72	1.71	2.16	2.14	0.191	0.197	1.57	1.60	0.85	0.86
New L.S.D. at 5 %	**0.05**	**0.06**	**0.03**	**0.04**	**0.05**	**0.06**	**0.004**	**0.005**	**0.05**	**0.04**	**0.03**	**0.04**

Table (4): Effect of single and combined applications of fish oil and glutathione on the percentages of Ca and Zn, Fe, Mn and Cu in the leaves of Ewaise mango trees during 2016 and 2017 seasons

Treatments	Leaf Ca %		Leaf Zn (ppm)		Leaf Fe (ppm)		Leaf Mn (ppm)		Leaf Cu (ppm	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	2.11	2.09	46.3	47.0	49.0	49.3	51.1	51.0	1.09	1.11
Spraying fish oil at 0.5 %	2.22	2.25	48.5	49.2	51.5	51.4	53.9	54.0	1.12	1.17
Spraying fish oil at 1.0 %	2.33	2.36	51.0	51.7	53.0	52.9	58.0	58.0	1.16	1.21
Spraying fish oil at 2.0 %	2.35	2.38	51.3	52.0	53.3	53.2	58.3	58.4	1.17	1.22
Spraying glutathione at 0.5 %	2.50	2.52	54.0	54.8	56.0	55.9	61.9	62.0	1.21	1.27
Spraying glutathione at 1.0 %	2.65	2.68	56.0	56.7	58.9	59.0	64.9	65.0	1.25	1.31
Spraying glutathione at 2.0 %	2.66	2.69	56.3	57.0	59.0	59.1	65.0	65.3	1.26	1.32
Spraying fish oil + glutathione at 0.5 %	2.80	2.82	59.9	60.6	61.9	62.0	67.1	67.2	1.30	1.40
Spraying fish oil + glutathione at 1.0 %	2.87	2.90	62.0	62.8	65.9	66.0	70.0	70.4	1.35	1.44
Spraying fish oil + glutathione at 2.0 %	2.88	2.91	62.3	63.0	66.0	66.1	70.2	70.5	1.36	1.45
New L.S.D. at 5 %	**0.07**	**0.08**	**1.8**	**1.9**	**1.9**	**1.9**	**1.8**	**1.8**	**0.02**	**0.02**

Table (5): Effect of single and combined applications of fish oil and glutathione on some flowering aspects and percentages of initial fruit setting and fruit retention of Ewaise mango trees during 2016 and 2017 seasons

Treatments	Panicle length (cm)		No. of panicles/tree		Male flowers %		Perfect flowers %		Initial fruit sett %		Fruit retention %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	15.1	14.9	99.0	100	70.0	70.1	30.0	29.9	1.7	1.6	0.22	0.18
Spraying fish oil at 0.5 %	16.1	16.0	102	104	68.0	69.1	32.0	31.9	2.1	2.0	0.30	0.29
Spraying fish oil at 1.0 %	17.2	17.1	105	107	66.0	67.2	34.0	33.8	2.6	2.4	0.37	0.36
Spraying fish oil at 2.0 %	17.3	17.3	106	108	65.0	67.1	34.5	33.9	2.7	2.5	0.38	0.36
Spraying glutathione at 0.5 %	18.5	18.5	111	112	64.0	64.1	36.0	35.9	3.1	3.0	0.45	0.44
Spraying glutathione at 1.0 %	19.6	19.6	116	118	61.1	61.0	38.9	39.0	3.6	3.5	0.51	0.50
Spraying glutathione at 2.0 %	19.7	19.7	117	119	60.0	60.1	40.0	39.9	3.7	3.6	0.52	0.51
Spraying fish oil + glutathione at 0.5 %	20.9	21.1	122	124	56.0	55.7	44.0	44.3	4.0	3.9	0.59	0.60
Spraying fish oil + glutathione at 1.0 %	23.1	22.3	130	132	54.0	53.5	46.0	46.7	4.3	4.4	0.66	0.67
Spraying fish oil + glutathione at 2.0 %	23.2	22.5	131	133	53.7	53.0	46.3	47.0	4.4	4.5	0.67	0.68
New L.S.D. at 5 %	**0.9**	**1.0**	**2.0**	**2.0**	**1.2**	**1.3**	**1.9**	**1.7**	**0.3**	**0.3**	**0.06**	**0.05**

Table (6): Effect of single and combined applications of fish oil and glutathione on the yield and some physical characteristics of the fruits of Ewaise mango trees during 2016 and 2017 seasons

Treatments	Yield/tree (kg)		No. fruits/tree		Fruit weight (g.)		Fruit height (cm)		Fruit diameter (cm)		Fruit thickness (cm)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	39.8	40.0	201	200	198	200	8.11	8.12	6.29	6.30	4.81	4.79
Spraying fish oil at 0.5 %	42.4	43.7	211	213	201	205	8.21	8.23	6.39	6.40	4.87	4.90
Spraying fish oil at 1.0 %	45.7	46.8	222	225	206	208	8.32	8.34	6.47	6.49	4.93	4.96
Spraying fish oil at 2.0 %	46.1	47.1	223	226	206.5	208.5	8.33	8.35	6.48	6.50	4.94	4.97
Spraying glutathione at 0.5 %	48.7	49.9	231	233	211	214	8.50	8.51	6.56	6.57	5.00	5.04
Spraying glutathione at 1.0 %	51.2	52.1	237	239	216	218	8.61	8.71	6.64	6.65	5.10	5.11
Spraying glutathione at 2.0 %	51.7	52.7	238	241	217	218.5	8.62	8.72	6.65	6.66	5.11	5.12
Spraying fish oil + glutathione at 0.5 %	56.5	57.2	251	252	225	227	8.71	8.85	6.71	6.72	5.16	5.20
Spraying fish oil + glutathione at 1.0 %	60.8	61.8	261	263.5	233	235	8.83	8.96	6.81	6.83	5.22	5.26
Spraying fish oil + glutathione at 2.0 %	61.3	62.0	262	264	234	232.5	8.84	8.97	6.82	6.84	5.23	5.27
New L.S.D. at 5 %	**1.8**	**1.9**	**5.0**	**5.0**	**2.6**	**2.4**	**0.09**	**0.09**	**0.07**	**0.06**	**0.05**	**0.06**

Table (7): Effect of single and combined applications of fish oil and glutathione on some physical and chemical characteristics of the fruits of Ewaise mango trees during 2016 and 2017 seasons

Treatments	Fruit flesh %		Fruit seeds and peels %		Edible to non-edible portion of fruit		T.S.S. %		Total sugars %		Reducing sugars %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	68.0	67.9	32.0	32.1	2.13	2.12	15.5	15.9	14.1	14.0	5.9	5.8
Spraying fish oil at 0.5 %	69.9	70.0	30.1	30.0	2.32	2.33	16.2	16.4	14.4	14.5	6.3	6.4
Spraying fish oil at 1.0 %	72.1	72.0	27.9	28.0	2.59	2.57	16.6	16.7	14.8	14.9	6.6	6.7
Spraying fish oil at 2.0 %	72.2	72.1	27.8	27.9	2.60	2.58	16.7	16.8	14.9	15.0	6.7	6.8
Spraying glutathione at 0.5 %	74.0	73.9	26.0	26.1	2.85	2.83	17.1	17.2	15.3	15.5	7.1	7.1
Spraying glutathione at 1.0 %	76.0	75.8	24.0	24.2	3.17	3.13	17.5	17.6	15.6	15.9	7.6	7.4
Spraying glutathione at 2.0 %	76.4	75.9	23.5	24.1	3.24	3.15	17.6	17.7	15.7	16.0	7.7	7.5
Spraying fish oil + glutathione at 0.5 %	78.8	79.0	21.2	21.0	3.72	3.76	18.1	18.3	16.1	16.4	8.2	7.8
Spraying fish oil + glutathione at 1.0 %	80.9	81.0	19.1	19.0	4.24	4.26	18.7	18.7	16.4	16.8	8.5	8.1
Spraying fish oil + glutathione at 2.0 %	81.0	81.6	19.0	18.4	4.26	4.43	18.8	18.5	16.5	16.9	8.5	8.2
New L.S.D. at 5 %	**1.4**	**1.2**	**1.4**	**1.2**	**0.16**	**0.18**	**0.4**	**0.3**	**0.2**	**0.3**	**0.3**	**0.2**

Table (8): Effect of single and combined applications of fish oil and glutathione on some chemical characteristics of the fruits of Ewaise mango trees during 2016 and 2017 seasons

Treatments	Non-reducing sugars %		Total acidity %		Vitamin C (mg/100 pulp)		Total fibre crude %		T.S.S./acid	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	9.9	10.1	0.315	0.318	46.0	45.9	1.11	1.15	50.2	50.0
Spraying fish oil at 0.5 %	9.9	10.0	0.301	0.300	48.0	47.8	1.05	1.06	53.8	54.7
Spraying fish oil at 1.0 %	10.0	10.0	0.280	0.281	49.9	49.9	0.99	1.01	59.3	59.4
Spraying fish oil at 2.0 %	10.0	10.0	0.279	0.280	50.0	49.9	0.98	0.99	59.9	60.0
Spraying glutathione at 0.5 %	10.0	10.1	0.277	0.260	52.0	51.9	0.91	0.90	61.7	66.2
Spraying glutathione at 1.0 %	9.9	10.2	0.263	0.245	54.0	53.8	0.85	0.83	66.5	71.8
Spraying glutathione at 2.0 %	10.1	10.2	0.262	0.244	54.0	54.0	0.84	0.82	67.2	72.5
Spraying fish oil + glutathione at 0.5 %	10.1	10.5	0.249	0.230	55.0	55.6	0.74	0.71	72.7	79.6
Spraying fish oil + glutathione at 1.0 %	10.2	10.6	0.230	0.216	56.9	57.7	0.68	0.64	81.3	86.6
Spraying fish oil + glutathione at 2.0 %	10.3	10.3	0.228	0.215	57.0	57.8	0.67	0.63	82.5	86.1
New L.S.D. at 5 %	**NS**	**NS**	**0.011**	**0.012**	**1.4**	**1.5**	**0.05**	**0.06**	**2.1**	**1.9**

flowers % was significantly reduced with the present treatments. There was a progressive promotion on these parameters with increasing concentrations of each material from 0.5 to 2%. Significant differences on these parameters were observed among all concentrations except between the higher two concentrations namely 1 and 2%. Combined applications were significantly favourable than using each materials alone in improving flowering and fruit setting aspects except male %. Using glutathione was significantly preferable than using fish oil in this respect. From economical point of view the maximum panicle length (23.1 & 22.3 cm), number of panicle/tree (130 & 132 panicle/tree), prefect flowers % (46.0 & 46.7%), initial fruit setting (4.3 & 4.4%) and fruit retention (0.66 & 0.67%) were recorded on the trees received both material together at 1% (since no significant differences were observed among 1 and 2%). The lowest values were recorded on untreated trees. These results were true during both seasons.

3- Yield/tree:

It is noticed from the data in Table (6) that subjecting Ewaise mango tree thrice to fish oil and/or glutathione each at 0.5 to 2% had significant promotion on the yield expressed in weight and number of fruits/tree over the control. There was a progressive promotion on the yield with increasing concentrations of both fish oil and glutathione from 0.5 to 2%. Significant difference on the yield was observed with varying concentrations of fish oil and glutathione except among the higher two concentrations namely 1 and 2%. Using glutathione at 0.5 to 2% significantly was more than using fish oil at the same concentration in improving the yield. Combined applications were preferable than using each material alone in this respect. Since no significant promotion on the yield among the higher two concentrations namely 1 and 2%, from each materiel it is advised to use a mixture of fish oil and glutathione each at the medium concentration (1%). Under such promised treatment, yield/tree reached 60.8 & 61.8 kg compared to the yield of untreated trees that reached 39.8 & 40.0 kg during both seasons, respectively. The percentage of increment on the yield due to using the previous promised treatment (fish oil + glutathione at 1%) over the concentrations reached 52.8 and 54.5% during both seasons, respectively. These results were true during both seasons.

4- Fruit characteristics:

Data in Tables (6 and 8) measurably reveal that spraying Ewaise mango trees three times with fish oil and/or glutathione each at 0.5 to 2% was significantly very effective in improving fruit quality in terms of increasing weight, height, diameter and thickness of fruit flesh % edible to non-edible portions of fruits, T.S.S., total and reducing sugars, vitamin C and T.S.S./acid and decreasing percentages of seeds and peels of fruit, total acidity % and total fiber % relative to the control. The promotion on fruit quality was related to the increase in concentrations of both materials. Increasing concentrations for each material from 1 to 2% failed to show significant promotion on these quality parameters. Using glutathione was significantly favorable than using fish oil in enhancing fruit quality characteristics. Combined applications were significantly preferable in improving fruit quality parameters than using each material alone. The best results from economical point of view were obtained due to treating the trees three times with fish oil + glutathione each at 1% (since no significant promotion was occurred on fruit quality among 1% and 2% concentrations. Percentage of non reducing sugars was significantly unaffected with the present treatments. These results were true during both seasons.

DISCUSSION

1- Effect of glutathione:

The positive action of glutathione on growth, tree nutritional status, yield and fruit quality of Ewaise mango trees might be discussed on the light of the impact of glutathione (GSH) in controlling the reactive oxygen species (ROS) that enhanced by abiotic stresses. As a component of the ascorbate - glutathione pathway, it takes part in the removal of excess H_2O_2 in a reaction in which GSH is oxidized. The high ratio of GSH to its oxidized form, glutathione disulfide (GSSG), occurring under optimal growth conditions can be restarted by means of higher glutathione reductase (GR) activity, increased GSH synthesis, decreased GSH degradation on the transport of GSH and GSSG (Foyer *et al.,* 1997; Szala *et al.,* 2008). Besides the control of ROS levels, GSG takes part in the regulation of growth, development, the cell cycle, gene expression and protein activity due to its effect on the redox state of the cells (Rennenberg, 1982; Meister and Anderson, 1983). It is also involved in the transfer and storage of sulphur (Meister and Anderson, 1983) and in the detoxifications of heavy metal, which form complexes from GSH- derived phytochelatins. Glutathione may also be involved in redox control of cell division and enhanced growth of the trees (Jorge *et al.,* 1993). In this concern Meister and Anderson (1983) reported that the amino acid cysteine is a component of the antioxidant glutathione. The influence of cysteine availability on glutathione levels reflects the importance of glutathione as a reservoir of reduced sulphur. It is also responsible in enhancing storage pool for excess cysteine and principal form in which organic sulphur is transported. The effects of glutathione on chemical components might be ascribed to it's a crucial role in controlling and maintaining the intercullar redox system as well as chloroplast metabolism in which it provides the redox buffering capacity vital for efficient photosynthesis and is involved in processing the oxidizing that are inevitably formed as a result of light capture and subsequent electron transport (Koesy *et al.,* 2001; Mulleineaux and Raucsh, 2008).

Thus, the promoting effect of glutathione on growth and nutritional status surely reflected on enhancing fruit retention, yield and fruit quality.

These results are in the same line to the results obtained by Abdelaal *et al.* (2012), Gad El-Kareem

(2012) on Taimour mango trees, Ahmed *et al.* (2013) on Zaghloul date palms. These results are nearly in agreement with those obtained by El-Khawaga and Mansour (2014) on Washington Navel orange trees.

2- Effect of fish oil:

Fish oil contains two types of fatty acids (omega 3-fatty acids namely Docosahexaenoic acid (DHA), eosapentaenotic acid (EPA), Tocopherols, Fe, Cu, P and carotenoids (Hultin and Jafan, 1991). It is considered an important source of antioxidants. Recently, most studies gave good evidence for the important role of using glutathione and fish oil for preventing the cell damage caused by ROS and protecting the trees from aging.

These results regarding the beneficial effects of fish oil on growth and fruiting of Ewaise mango are in harmony with (Olmo *et al*., 1981; Osnaya and Schlasser, 1998; Mc-Arthey *et al*., 2006; Yoder *et al*., 2009; Masoud and Abou-Zaid-Eman, 2017).

CONCLUSION

The best results with regard to growth, tree, nutritional status, flowering, fruit setting, yield and fruit quality were obtained due to treating Ewaise mango trees grown under sandy soil thrice (growth start, just after setting and at one month later) with a mixture of fish oil and glutathione each at 1%.

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تأثير الرش بزيت السمك والجلوتاثيون علي الإثمار في صنف المانجو العويس النامية في الأراضي الرملية

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أجريت هذه الدراسة خلال موسمي ٢٠١٧، ٢٠١٨ وذلك لاختبار تأثير الاستخدام الفردي والمشترك لزيت السمك والجلوتاثيون بتركيز ٠.٥ إلي ٢ % لكلا منهما علي بعض الصفات الخضرية وصبغات البناء الضوئي (كلوروفيل أ، ب، والكلوروفيل الكلى والكاروتينات الكلية) وعناصر النيتروجين والفوسفور والبوتاسيوم والماغنسيوم والكالسيوم (كنسبة مئوية) وعناصر الزنك والحديد والمنجنيز والنحاس (كجزء في المليون) وسلوك الأزهار وعقد الثمار وكمية محصول الشجرة والخصائص الطبيعية والكيميائية للثمار صنف المانجو العويس النامي في التربة الرملية. ولقد تم رش الأشجار ثلاث مرات في بداية النمو الخضري وبعد مرحلة عقد الثمار مباشرة وبعد ثلاثين يوما من هذه المرحلة. أشارت نتائج الدراسة إلي أن الاستخدام الفردي والمشترك لزيت السمك والجلوتاثيون بتركيز من ٠.٥ إلي ٢% لكل منهما قد أعطى تحسنا واضحا في طول الفرخ وسمكه وعدد الأوراق التي عليه ومساحة الورقة وذلك في دورة نمو الربيع. وصبغات التمثيل الضوئي (الكلوروفيل الكلى والكاروتينات) والنيتروجين والفوسفور والبوتاسيوم والكالسيوم (كنسبة مئوية) والزنك والحديد والمنجنيز والنحاس (كجزء في المليون) وطول النورة وعدد النورات علي الشجرة والنسبة المئوية للأزهار الخنثى والعقد الأولى والعقد النهائي وكمية محصول الشجرة وخصائص الجودة بالثمار وذلك عند المقارنة بالكونترول. ولقد تفوق استخدام مركب الجلوتاثيون عن زيت السمك في تحسين جميع الصفات تحت الدراسة كما تفوق الاستخدام المشترك لهاتين المادتين عن الاستخدام الفردي لهما وفى كل الأحوال كانت الفروق طفيفة علي هذه الصفات ما بين التركيزين الأعلى لكل مادة (١، ٢%). أمكن الحصول علي أفضل النتائج بخصوص خصائص النمو والحالة الغذائية للأشجار والأزهار وعقد الثمار وكمية المحصول وخصائص الجودة للثمار عند رش أشجار المانجو العويس النامية في التربة الرملية ثلاث مرات (في بداية النمو، بعد مرحلة عقد الثمار مباشرة، وبعدها بشهر) بمخلوط يتكون من زيت السمك والجلوتاثيون بتركيز ١% لكل منهما.

الكلمات الدالة: زيت السمك – الجلوتاثيون – المانجو العويس – صفات النمو الخضري – الأزهار – عقد الثمار – صبغات البناء الضوئي – العناصر الكبرى والصغرى – كمية المحصول – خصائص الجودة.