Effect of Seaweed Extract on Fruiting of Hindy Bisinnara Mango Trees

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Abstract*:* Yield quantitatively and qualitatively of "Hindy Bisinnara" mango trees in response to foliar application of seaweed extract (SWE) twice, thrice or four times at 0.0, 0.1, 0.2 and 0.4 % were investigated during 2010 and 2011 seasons.Results showed that using seaweed extract(SWE) spraying at 0.1 to 0.4 % twice, thrice or four times was essential in enhancing growth, different nutrients, yield as well as some physical and chemical characteristics of the fruits rather than non-application. The promotion was associated with increasing concentrations and frequencies. No major differences were observed among the higher two concentrations and frequencies.The best results with regard to yield and quality of "Hindy Bisinnara" mango trees were obtained with spraying seaweed extract (SWE) three times (growth start, just after fruit setting and 21 days later) at 0.2 %.
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1. Introduction

Owing to the fact that the world's population increases, demand for horticultural products is great. New insights and techniques are required in order to achieve sufficient and sustainable yields to meet global food demand and prevent world hunger.Therefore, Research in this field is strongly oriented towards searching and testing the effectiveness and efficiency of new products. One such approach is the use of biostimulants that can enhance the effectiveness of conventional mineral fertilizers **(Frankenberger and Arshad, 1995).**The biostimulants are loosely defined as non-fertilizer products which have beneficial effects on plant growth and didn't contain any chemicals or synthetic plants growth regulators **(Russo and Berlyn, 1990).**Some 15 million metric tons of seaweed products are produced annually (FAO, 2006), a considerable portion of which is used for nutrient supplements and as biostimulants or biofertilizers to increase plant growth and yield. Seaweed extract (SWE) have been used for several decades to enhance plant growth and productivity; by the development of non- pollution organic biostimulants which increase plant growth, vigor, crop yield and quality through increasing efficiency of nutrients and water uptake.Seaweed products exhibit growth-stimulating activities, and the use of seaweed formulations as biostimulants in crop production is well established. Biostimulants are defined as ‘‘materials, other than fertilizers, that promote plant growth when applied in small quantities’’ and are also referred to as ‘‘metabolic enhancers’’**(Zhang and Schmidt, 1997)**.Seaweed extract(SWE)contains essential nutrients, several organic compounds, enzymes, vitamins and natural hormones **(Verkleij, 1992)**.Seaweed products contain growth regulators(auxins, cytokinins and gibberellins), betain, amino acids and low concentrations of inorganic elements that influence cell growth and division cycle, expansion, nutrition and maturity **(Williams *et al.*,1981;Whapman *et al.*,1993; and Zodape,2001)**.Furthermore, the wide range of growth responses induced by seaweed extracts implies the presence of more than one group of plant growth-promoting substances/hormones **(Tay *et al.*,1985; Crouch and van Staden,1993)**.The ability of liquefied Seaweed extract(SWE)to maintain enriched metal mixtures (Cu, Co, Zn, Mn, Fe, Ni as well as Mo and B) in a soluble form for application to soil or use as foliar sprays was clearly understood**(Milton, 1962)**.The other beneficial effects included the promotion of yield, uptake of nutrients, and resistance of plants to most stresses and the incidence of fungal and insect attack **(Berlyn and Russo, 1990)**.Seaweed extract(SWE) being organic and biodegradable is important in sustainable agriculture **(Cassan *et al.*, 1992).**

The mechanisms by which Seaweed extract(SWE) affect cell metabolism are mainly through the physiological action of major and minor nutrients, amino acids, vitamins, and also cytokinins, auxin, and absicisic acid (ABA)-like growth substances affect cellular metabolism in treated plants leading to enhanced growth and crop yield **(Crouch*et al.*, 1992; Crouch and van Staden, 1993; Reitz and Trumble, 1996; Durand *et al.*, 2003;Stirk*et al.*, 2003;Ördög *et al.*, 2004)**. Therefore, their effect is a result of many components that may work synergistically at different concentrations, although the mode of action of seaweed extracts still remains quite unknown (**Fornes et al., 2002; Vernieri*et al.*, 2005)**.

The promotive effect of seaweed extract(SWE) on fruiting of fruit crops was previously mentioned **(Gobara, 2004; El- Sawy, 2005; Hegab *et al.*, 2005; Gamal, 2006; Ebeid-Sanaa, 2007;Hassan-**

Hoda, 2008; Khan *et al*., 2009; Abd El- Motty-Elham *et al*., 2010 and El- Sayed- Esraa, 2010).

This study aimed to throw some light of the prospective on the use of a seaweed extract (SWE) to promote the yield quantitatively and qualitatively of "Hindy Bisinnara" mango trees.

2. Materials and Methods

This study was carried on 36 trees(18 year's old) of mango "Hindy Bisinnara" grafted on mango seedling rootstock during the two consecutive seasons of 2010 and 2011 in a private orchard located at West Samalout, Minia Governorate, Egypt. The soil of the orchard is sandy, well drained and with water table depth not less than two meters. The chosen trees were planted at 7 x 7 meters apart. Surface irrigation system was followed. Normal horticultural practices were carried out as usual except those dealing with the application of seaweed extract (SWE) spraying. The experiment involved two factors (A&B).The first factor (A) consisted from four concentrations of seaweed extracts spraying namely: a_1= 0.0 %, a_2= 0.1 %, a_3= 0.2 % and a_4= 0.4 %.The second factor (B) contained three applications of using seaweed extract(SWE) spraying namely: b_1= twice at growth start and just after fruit setting, b_2= thrice at the same two previous dates and at 21 days later and b_3= four times at the same three previous dates and at 21 days later. Therefore, the experiment involved twelve treatments. Each treatment was replicated three times, one tree per each. Triton B as a wetting agent at 0.05 % was added to all seaweed extract (SWE) solutions before spraying. The trees were covered completely with mentioned concentrations of seaweed extracts spraying till runoff (50 L/ tree). The control treatment was sprayed with water containing Triton B at 0.05 %.

This experiment was set up in a completely randomized block design (CRBD) in split plot arrangement where the four concentrations and the three applications of seaweed extract (SWE) spraying ranked the main and subplots, respectively.

Sixteen new shoots/tree from "spring growth cycle" were chosen on four labeled branches for measuring the leaf area according to the equation given by **Ahmed and Morsy (1999)**. Fifty mature leaves/tree from non-fruiting shoots in the spring growth cycle **(summer, 1985)** were taken for determination of N, P, K and Mg as percentages, Zn, Fe and Mn as (ppm) according to the procedures that described by **Wilde *et al*. (1985).**

Percentage of fruit retention was estimated by dividing the number of fruits retained on each tree just before harvesting by total number of flowers and multiplying the product by 100. Harvesting was carried out at the last week of July in both seasons. Yield expressed in weight (kg) per tree was recorded. In addition, fruit weight (g.), total soluble solids %, total and reducing sugars %, total acidity % (as g citric acid/100 ml juice)and ascorbic acid content in the juice(as mg/100 ml juice) were determined according to the procedures that outlined in **A.O.A.C (1995).**

All the obtained data were tabulated and statistically analyzed using new L.S.D parameter at 5 % for all comparisons among different treatments means according to **Mead *et al*. (1993).**

3. Results and Discussion

1- Effect of seaweed extract on the leaf area and its content of N, P, K, Mg, Zn, Fe and Mn:

It is clear from the obtained data in Tables (1, 2 & 3) that application of seaweed extract(SWE) spraying via leaves at 0.1 to 0.4 % significantly was accompanied with stimulating the leaf area and its content of N, P, K, Mg, Zn, Fe and Mn rather than non- application. The promotion was significantly associated with increasing seaweed extracts concentrations. Significant differences on the leaf area and its content from these nutrients were observed among all concentrations except among the higher two concentrations namely 0.2 and 0.4 %. The maximum values were recorded on the trees that sprayed with seaweed extract (SWE) at 0.4 %. Control trees had the lowest values. These results were true during the two seasons and agreement with those found by **Jeannin *et al*.(1991)** as increasing root development and mineral absorption of maize affecting by aqueous seaweed sprays.An improved root system could be influenced by endogenous auxins as well as other compounds in the extracts **(Crouch *et al*., 1992).** Seaweed extracts improve nutrient uptake by roots **(Crouch *et al*.,1990)**, resulting in root systems with improved water and nutrient efficiency, thereby causing enhanced general plant growth and vigor. Seaweeds and seaweed products enhance plant chlorophyll content **(Blunden *et al*.,1997**). Application of a low concentration of ***Ascophyllum nodosum*** extract to soil or on foliage of tomatoes produced leaves with higher chlorophyll content than those of untreated controls. This increase in chlorophyll content was a result of reduction in chlorophyll degradation, which might be caused in part by betaines in the seaweed extract **(Whapham *et al*., 1993).**

Varying number of adding sprays (frequencies) of seaweed extract (SWE) caused significant differences on the leaf area and its content of these nutrients. There was a gradual promotion on the leaf area and its content of these nutrients with increasing number of adding sprays (frequencies) from twice to four times. No significant promotion was observed on the leaf area and these nutrients with increasing frequencies from three to four times. Carrying out four sprays of seaweed extract (SWE) at 0.4 % gave the maximum values. Similar trend was noticed during both seasons.

A proprietary marine extract has been shown to improve the leaf content of macronutrients, promote growth, and impart resistance to drought stress in grapes **(Mancuso *et al*.,2006)**. Also,K, Fe, and Cu

concentrations were increased in the leaves of olive trees sprayed with the additional application of seaweed extract (SWE)**, Chouliaras *et al.*(2009).**Moreover, **Turan and Köse (2004)** reported that SWE sprays increased K, Fe and Cu concentrations in leaves of grapevines.It is suggested that the influence of (SWE) on Cu uptake could be due to increasing membrane permeability of cells and hormone-like activities of the SWE through their involvement in cell respiration, photosynthesis and various enzymatic reactions **(Verkleij, 1992)**.

The higher own content of seaweed extract from essential nutrients, organic compounds, enzymes, vitamins and natural hormones **(Verkleij, 1992)** could explain the present results. The beneficial effect of seaweed extract (SWE) on uptake of nutrients, resistance of plants to most stresses and the incidence of fungal and insect attack **(Cassan *et al.*, 1992)** give another explanation.

These results are in agreement with those obtained by **Gobara (2004); El-Sawy (2005); Hegab *et al.* (2005);Spinelli *et al.* (2009); Abd El-Motty- Elham *et al.* (2010); and El- Sayed- Esraa (2010).**

2- Effect of seaweed extract on fruit retention and yield:

Data in Tables (3& 4) clearly show that foliar application of seaweed extract (SWE) spraying at 0.1 to 0.4 % significantly improved fruit retention % and yield comparing with non- application. There was a gradual promotion on fruit retention % and yield with increasing concentrations and number of adding sprays (frequencies) of seaweed extracts.Increasing concentrations from 0.2 to 0.4 % as well as frequencies from three to four times have no significant stimulation on such two parameters.

From economical point of view treating the trees three times with seaweed extract(SWE) at 0.2 % gave the best results with regard to yield. Under such promised treatment, yield reached 205 and 211 kg/tree during both seasons respectively. The minimum yield (151 and 152 kg/ tree during both seasons) was observed on untreated trees. These results were true during both seasons.

Seaweed concentrates triggers early flowering and fruit set in a number of crop plants **(Abetz and Young 1983;Featonby-Smith and van Staden 1987; Arthur *et al.*, 2003).**In many crops yield is associated with the number of flowers at maturity. As the onset and development of flowering and the number of flowers produced are linked to the developmental stage of plants, seaweed extracts probably encourage flowering by initiating robust plant growth. Yield increases in seaweed-treated plants are thought to be associated with the hormonal substances present in the extracts, especially cytokinins **(Featonby-Smith and vanStaden 1983a, b, 1984).** Cytokinins in vegetative plant organs are associated with nutrient partitioning, whereas in reproductive organs, high levels of cytokinins may be linked with nutrient mobilization. Fruit ripening generally causes an increase in transport of nutrient resources within the developing plant **(Hutton and van Staden 1984, Adams-Phillips *et al.*, 2004)** and the fruits have the capacity to serve as strong sinks for nutrients **(Varga and Bruinsma, 1974; Adams-Phillips *et al.*, 2004).** Photosynthetic distribution could be shifted, perhaps markedly, moving from vegetative parts (roots, stem, and young leaves) to the developing fruit, to be utilized in fruit development **(Nooden and Leopold, 1978).**Tomato Fruits treated with seaweed extracts had higher concentrations of cytokinins compared to untreated ones **(Featonby-Smith and van Staden, 1984)**.Cytokinins have been implicated in nutrient mobilization in vegetative plant organs**(Gersani and Kende,1982**)as well as reproductive organs**(Davey and van Staden, 1978)**. Such a response indicates that seaweedextracts are involved either in enhancing the mobilization of cytokinins from the roots to the developing fruit, or, more likely, by improving the amount or synthesis of endogenous fruit cytokinins **(Hahn *et al.*, 1974).**

So, increasing yield by seaweed extract (SWE) spraying may be due to association with its hormonal substances present especially cytokinins (better mobilization photosynthesis).

The promoting effect of seaweed extract (SWE) on growth and nutritional status of the trees surely reflected on making C/N ratio in favor of producing more fruits.

These results are in agreement with those obtained by **Crouch *et al.* (1992); Gobara (2004); El-Sawy(2005); Hegab *et al.* (2005); Abd El-Motty- Elham *et al.* (2010); and El- Sayed- Esraa (2010).**

3- Effect of seaweed extract on some physical and chemical characteristics of the fruits:

It is evident from the data in Tables (4& 5) that treating the trees with seaweed extract(SWE) at 0.1 to 0.4 % twice, thrice or four times significantly improved both physical and chemical characteristics of the fruits of "Hindy Bisinnara" mango in terms of increasing fruit weight, T.S.S. %, total and reducing sugars % and vitamin C content ,whereas they decreasing total acidity % in relative to the check treatment. The promotion on fruit quality was associated with increasing concentration and frequencies of spraying seaweed extracts. Negligible promotion was recorded with increasing concentrations from 0.2 to 0.4 % and a frequency from three to four times, therefore the recommended treatment is consisted from using seaweed extracts at 0.2 % three times. Unfavorable effects on fruit quality were revealed on untreated trees. Similar results were announced during both seasons.

Table (1): Effect of different concentrations and frequencies of seaweed extract on the leaf area (cm^2) of spring growth cycle and percentages of N and P in the leaves of "Hindy Bisinnara" mango trees during 2010 and 2011 seasons.

Concentrations of seaweed extract (A)	Leaf area (cm^2)								Leaf N %								Leaf P %							
	2010				2011				2010				2011				2010				2011			
	Frequencies of seaweed extract (B)																							
	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)
a_1 0.0 %	109.0	114.0	114.2	112.4	111.0	118.0	118.4	115.8	1.61	1.71	1.72	1.68	1.66	1.81	1.81	1.76	0.14	0.20	0.21	0.18	0.14	0.22	0.23	0.19
a_2 0.1 %	111.0	117.2	117.3	115.2	113.5	122.0	122.1	119.2	1.79	1.92	1.93	1.88	1.85	1.99	1.99	1.94	0.19	0.26	0.26	0.24	0.22	0.29	0.30	0.27
a_3 0.2 %	112.0	120.0	120.2	117.4	115.0	126.0	126.1	122.4	1.94	2.05	2.06	2.02	1.99	2.19	2.20	2.13	0.24	0.32	0.32	0.29	0.25	0.33	0.33	0.30
a_4 0.4 %	112.2	120.6	121.0	117.9	115.4	126.0	126.2	122.5	1.95	2.06	2.07	2.03	2.00	2.20	2.21	2.14	0.25	0.32	0.33	0.30	0.25	0.34	0.35	0.31
Mean (B)	**111.1**	**117.9**	**118.2**		**113.7**	**123.0**	**123.2**		**1.82**	**1.93**	**1.94**		**1.87**	**2.05**	**2.05**		**0.20**	**0.27**	**0.28**		**0.21**	**0.29**	**0.30**	
New L.S.D at 5 %	**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**	
	1.0	**0.9**	**1.8**		**1.0**	**0.9**	**1.8**		**0.06**	**0.05**	**0.10**		**0.05**	**0.05**	**0.10**		**0.03**	**0.02**	**0.04**		**0.03**	**0.02**	**0.04**	

Table (2): Effect of different concentrations and frequencies of seaweed extract on the leaf content of K & Mg as percentages and Zn as ppm of "Hindy Bisinnara" mango trees during 2010 and 2011 seasons.

Concentrations of seaweed extract (A)	Leaf K %								Leaf Mg %								Leaf Zn content (ppm)							
	2010				2011				2010				2011				2010				2011			
	Frequencies of seaweed extract (B)																							
	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)
a_1 0.0 %	1.60	1.71	1.72	1.67	1.69	1.82	1.83	1.78	0.30	0.36	0.37	0.34	0.40	0.47	0.48	0.45	55.1	60.1	60.5	58.5	57.0	64.0	64.3	61.7
a_2 0.1 %	1.74	1.85	1.86	1.82	1.85	1.90	1.90	1.88	0.36	0.49	0.50	0.45	0.46	0.60	0.61	0.55	61.1	71.1	71.2	67.8	64.1	82.2	82.5	76.2
a_3 0.2 %	1.90	2.11	2.11	2.04	2.01	2.15	2.15	2.10	0.42	0.66	0.67	0.58	0.52	0.77	0.78	0.69	69.2	82.0	82.5	77.9	71.0	90.0	91.0	84
a_4 0.4 %	1.90	2.12	2.12	2.05	2.02	2.16	2.17	2.12	0.43	0.67	0.68	0.59	0.53	0.78	0.79	0.7	70.0	82.5	83.0	78.5	71.5	90.6	90.9	84.3
Mean (B)	**1.78**	**1.95**	**1.95**		**1.89**	**2.00**	**2.01**		**0.37**	**0.54**	**0.55**		**0.47**	**0.65**	**0.66**		**63.8**	**73.9**	**74.3**		**65.9**	**81.7**	**82.1**	
New L.S.D at 5 %	**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**	
	0.06	**0.05**	**0.10**		**0.06**	**0.05**	**0.10**		**0.03**	**0.03**	**0.06**		**0.03**	**0.03**	**0.6**		**2.9**	**2.7**	**5.4**		**3.0**	**2.9**	**5.8**	

Table (3): Effect of different concentrations and frequencies of seaweed extract on the leaf content of Fe & Mn as ppm and percentage of fruit retention of "Hindy Bisinnara" mango trees during 2010 and 2011 seasons.

Concentrations of seaweed extract (A)	Leaf Fe (ppm)								Leaf Mn (ppm)								Fruit retention %							
	2010				2011				2010				2011				2010				2011			
	Frequencies of seaweed extract (B)																							
	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)
a_1 0.0 %	50.1	59.0	60.0	56.4	51.2	60.9	61.0	57.7	61.0	71.0	71.6	67.9	63.0	73.0	73.0	69.7	0.41	0.48	0.50	0.46	0.42	0.51	0.52	0.48
a_2 0.1 %	56.0	66.0	66.0	62.7	57.3	69.0	69.3	65.2	71.0	82.0	82.5	78.5	73.3	84.0	85.0	80.8	0.48	0.59	0.60	0.56	0.50	0.66	0.67	0.61
a_3 0.2 %	79.6	91.0	91.5	87.4	82.5	94.0	94.2	90.2	81.0	92.0	92.5	88.5	84.0	95.0	95.6	91.5	0.59	0.71	0.71	0.67	0.61	0.75	0.76	0.71
a_4 0.4 %	81.0	91.0	92.0	88.0	82.7	94.0	94.5	90.4	82.0	92.6	93.0	89.2	84.0	95.5	96.0	91.8	0.60	0.72	0.72	0.68	0.62	0.76	0.77	0.72
Mean (B)	**66.7**	**76.8**	**77.4**		**68.4**	**79.5**	**79.8**		**73.8**	**84.4**	**84.9**		**76.1**	**86.9**	**87.4**		**0.52**	**0.63**	**0.63**		**0.54**	**0.67**	**0.68**	
New L.S.D at 5 %	**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**	
	3.0	**2.7**	**5.4**		**3.3**	**3.0**	**6.0**		**2.6**	**2.5**	**5.0**		**2.9**	**2.7**	**5.4**		**0.03**	**0.02**	**0.04**		**0.03**	**0.02**	**0.04**	

Table (4): Effect of different concentrations and frequencies of seaweed extract on the yield/tree (kg.), fruit weight (g.) and percentage of total soluble solids in the fruits of "Hindy Bisinnara" mango trees during 2010 and 2011 seasons.

Concentrations of seaweed extract (A)	Yield/ tree (kg.)								Fruit weight (g.)								T.S.S %							
	2010				2011				2010				2011				2010				2011			
	Frequencies of seaweed extract (B)																							
	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)
a_1 0.0 %	151.0	161.0	162.0	158.0	152.0	166.0	167.0	161.7	140	155	156	150	142	159	160	153	17.2	17.9	18.0	17.7	18.0	19.0	19.0	18.7
a_2 0.1 %	159.0	171.0	171.5	167.2	162.5	179.0	180.0	173.8	155	180	181	172	157	185	186	176	18.1	19.0	19.0	18.7	19.0	20.2	20.3	19.8
a_3 0.2 %	169.0	205.0	206.0	193.3	174.0	211.0	212.0	199.0	171	187	188	182	175	191	192	186	19.0	20.2	20.2	19.8	20.0	21.5	21.6	21.0
a_4 0.4 %	171.0	206.0	207.0	194.7	175.0	212.0	213.0	200.0	172	189	190	184	176	192	193	187	19.1	20.3	20.3	19.9	20.1	21.6	21.7	21.1
Mean (B)	**162.5**	**185.8**	**186.7**		**167.0**	**192.0**	**193.0**		**159**	**178**	**179**		**163**	**182**	**183**		**18.4**	**19.4**	**19.4**		**19.3**	**20.6**	**20.7**	
New L.S.D at 5 %	**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**	
	2.5	**2.1**	**4.2**		**3.0**	**2.8**	**5.6**		**11.0**	**10.0**	**20.0**		**11.5**	**11.0**	**22.0**		**0.3**	**0.2**	**0.4**		**0.3**	**0.2**	**0.4**	

Table (5): Effect of different concentrations and frequencies of seaweed extract on some chemical characteristics of the fruits of Hindy Bisinnara mango trees during 2010 and 2011 seasons.

Concentrations of seaweed extract (A)	Total acidity %								Total sugars %								Vitamin C content (mg/ 100 ml juice)							
	2010				2011				2010				2011				2010				2011			
	Frequencies of seaweed extract (B)																							
	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)	b_1 twice	b_2 thrice	b_3 four	Mean (A)
a_1 0.0 %	0.410	0.340	0.339	0.363	0.415	0.330	0.325	0.357	13.1	13.8	14.0	13.6	13.1	14.0	14.0	13.7	44.1	49.0	49.5	47.5	45.0	51.0	51.0	49.0
a_2 0.1 %	0.371	0.300	0.297	0.323	0.361	0.271	0.270	0.301	14.1	15.0	15.2	14.8	14.2	15.2	15.2	14.9	48.0	51.0	51.5	50.2	49.0	52.0	52.0	51.0
a_3 0.2 %	0.355	0.241	0.240	0.279	0.341	0.210	0.205	0.252	15.1	16.1	16.2	15.8	15.2	16.6	16.6	16.1	50.1	56.0	56.3	54.1	51.0	57.0	57.0	55.0
a_4 0.4 %	0.351	0.240	0.239	0.277	0.340	0.209	0.201	0.250	15.2	16.2	16.3	15.9	15.2	16.7	16.8	16.2	50.6	56.6	57.0	54.7	52.0	57.0	57.0	55.3
Mean (B)	**0.372**	**0.280**	**0.279**		**0.364**	**0.255**	**0.250**		**14.4**	**15.3**	**15.4**		**14.4**	**15.6**	**15.7**		**48.2**	**53.2**	**53.6**		**49.3**	**54.3**	**54.3**	
New L.S.D at 5 %	**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**		**A**	**B**	**AB**	
	0.012	**0.011**	**0.022**		**0.014**	**0.11**	**0.022**		**0.4**	**0.3**	**0.6**		**0.3**	**0.2**	**0.4**		**1.9**	**1.7**	**3.4**		**2.2**	**2.0**	**4.0**	

The higher own content of seaweed extract(SWE) from Mg, K and B surely reflected in enhancing the biosynthesis and movement of carbohydrates that were responsible for advancing maturity and improving fruit quality.

A significant improvement in the size of olives and quality of olive oil in the trees sprayed with seaweed extract (SWE) fortified with added nitrogen and boron **(Chouliaras, 2009).Norrie and Keathley(2006)**have reported that *A. nodosum* extracts showed positive effects on the yield of 'Thompson seedless' grape *(Vitis vinifera L.) consistently over a 3-yearperiod. They observed that the A. nodosum*-treatedplantsalways outperformed (in terms of berries per bunch, berrysize, berry weight, rachis length, and the number of primarybunches per plant) the controls maintained under theregular crop management program, and resulted improved fruit size (13% increase), weight (39% increase),and yields (60.4% increase over the control).Also, seaweed extract increased fruit yield when sprayed on tomato plants during the vegetative stage, producing large sized fruits (30% increase in fresh fruit weight over the controls) with superior quality (**Crouch and van Staden,1992).**Moreover, foliar application of seaweed liquid extract (Kelpak 66)enhanced bean yield by 24%**(Nelson and van Staden,1984).**

These results are in agreement with those obtained by **Crouch *et al*. (1992); Gobara (2004); El- Sawy (2005); Hegab *et al*. (2005); Spinelli *et al*. (2009); Abd El- Motty- Elham *et al*. (2010); and El- Sayed- Esraa (2010).**

As a conclusion, the best results from economical point of view on yield and quality were obtained with treating the trees three times at growth start, fruit setting and 21 days later with seaweed extract(SWE) at 0.2 %.Seaweeds and seaweed products are increasingly used in crop production. However, the mechanism(s) of actions of seaweed extract-elicited physiological responses are largely unknown. The recent challenges to food production due to the increasing occurrence of biotic and abiotic stresses is likely due to climate change and will further reduce yields and/or will have an impact on crops in the 21st century (IPCC, 2007). Therefore, research into developing sustainable methods to alleviate these stresses should be a priority. Recent studies have shown that seaweed extracts protect plants against a number of biotic and abiotic stresses and offers potential for field application. Further, seaweed extracts are considered an organic farm input as they are environmentally benign and safe for the health of animals and humans.

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