Middle East Journal of Agriculture Research
ISSN 2077-4605
Volume : 07 | Issue : 01 | Jan.-Mar. | 2018
Pages:34-40

Response of olive trees (cv. Koroneiki) to algae extract sprays and its impact on growth and productivity under saline conditions

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Received: 14 Nov. 2017 / Accepted: 17 Jan. 2018 / Publication date: 25 Jan. 2018

ABSTRACT

The objective of the current work was to evaluate the effects of different concentration of algae extract foliar application on growth, yield and fruit quality of olive trees C.V. koroneiki grown in a sandy calcareous soil under saline condition. This work was carried out in an olive farm is located in Nekhl Center, Sinai on a 5 years old olive trees. The trees were almost uniform spaced 3x5 m under drip irrigation system. This work included four treatments (concentrations) as follows:- Control 0.0% algae extract (T1), 0.05% algae extract (T2), 075% algae extract (T3) and 0.1 % algae extract (T4). The obtained results showed that all algae extract concentrations spray improved the most of morphological characters and yield components compared with the control in both seasons. In this respect, the higher algae extract, the higher vegetative growth and productivity parameters.

The results of this study clearly concluded that spraying 0.1 % algae extract Three times i.e. first at growth start, second at flowering and third after final fruit set be recommended for improving growth, yield, fruit quality and oil content of Koroneiki olive. Under middle Sinai conditions

Key words: Olive, Algae, Growth, Yield, Oil, Saline conditions

Introduction

Recently, climate change is the main cause of agricultural damage worldwide as a consequence of more flooding and drought and increased soil salinity. Soil salinity is a limiting factor decreases crop yield in the world under irrigated land (Porcel *et al., 2012*). Therefore, the utilization and enhancement of saline land has been a main challenge for scientists in the world.

Olive has been one of the most important sources of income for many civilizations throughout the history in the Mediterranean. The Egyptian government plans to cultivate 1 million olive trees which will be distributed in 79919.6 feddan (feddan = 4200 m^2) of Egyptian land are currently devoted to olive cultivation, 25 percent of which is located in the North Sinai governorate, according to the Central Administration for Agriculture Education.

The soils of North Sinai with emphasis to central Sinai are characterized by its salinity and the high percent of lime content. As well as, the soils are irrigated with underground water which is characterized by the water salinity.

The plane is dedicated to use organic fertilizers to the plants grown in Sinai. In plant cultivation, seaweed extracts recently are widely used as plant stimulants that can improve the growth and development of plants. However, algae extract mixture contain a wide range of active materials such as free amino acids, organic acids, phytohormons, vitamins and enzymes which react as growth promoters. In this respect, the high content of macro and micronutrients in addition the natural enzymes and hormones (Shaaban, 2001). Algae extracts contain cytokinins as well in which induce the physiological activities (for instance activating some enzymes that involved in photosynthesis) and increase the total chlorophyll in the plant this will positively Reflect on the activity of photosynthesis and the synthesized materials which will positively reflect on shoots characteristics (Thomas**,** 1996).

Abd El-Motty *et al.,* (2010), studied the effect of algae extract spry on mango they found that vegetative growth, yield and fruit quality were significantly improved by algae extract sprays as increasing the concentration of the algae extract in the spraying solution.

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Algae extract as a new bio-fertilizer containing macronutrients as well as micronutrients, some growth regulators polyamines, proteins and vitamins applied to improve nutritional status, vegetative growth, yield and fruit quality (Abdel-Maguid *et al.,* 2004 ; Abd El-Moniem and Abd-Allah, 2008).

The aim of the current research was to study the effects of a seaweed extract applied foliarly on the productivity, fruit growth, fruit maturation and leaf nutrient status as well as olive oil content and quality of the Greek olive cultivar Koroneiki.

Materials and Methods

This study was conducted in olive farm in Saini during 2016 / 2017 growing seasons to investigate the influence of seaweed extract spray on 5 year's old trees of "Peento" olive (c.v Koroneiki) cultivar. The olive grown in sandy calcareous soils, spaced 3x5 m under drip irrigation system. The trees were healthy, similar in vigor and subjected to the same horticultural practices adapted in the region (irrigation, fertilization and control of pests and diseases).

Soils and water analysis

A representative number of soil profiles were dug and soil samples were collected from the farm soils as well as the water for the irrigation sources of the farm (well). All the collected samples (soils and water) were subjected to a lab analysis for physical-chemical analysis.

Preparation of algae cells extract:

A fresh slurry of the microalga *Scenedesmus acutus* and *Coelastrum proboscideum* were cultivated in fresh water basins in open air at algae station , National Research Centre (contains about 10% water) was washed with distilled water, concentrated by centrifugation and freeze and then re-melted at room temperature. The melted slurry was then centrifuged at 5000 rpm to obtain a clear cell sap (El-Fouly *et al.* 1992).

The seaweed extract is fully soluble in water and is a potent mixture of three types of marine algae as seen in table (1):
Sour jasim: rich in alginic acid (increases water retention and increases growth).
Laminaria: rich in many sugars.
Ascofilm: raw algae containing a high concentration of natural growth regulators up to 600 ppm, which makes it a binary effect (green and flower), which is the main advantage of this alga.

Table 1: Major chemical composition of marine algae extract (Cytolan concentrated liquid) (El-Fouly *et al.* 1992)

Content	Concentration (%)
Marine algae extract	100%
Organic matter	45 - 55%
Phosphorus (P_2O_5)	5%
Potassium (K_2O)	18%
Magnesium	0.42%
Calcium	0.17%
Sulfur	2.2%
Iron	0.06%
Copper	0.001%
Alginic acid	10 - 12%
Growth regulators	600 ppm

Time of sprays:

This study included the following treatment: three levels of spraying of algae extract were sprayed, 50, 75 and 100 cm3/100 liter water. Treatments were replicated three times (i.e. first at mid-

February, second at mid-April and third at mid-June) at factorial experiment in a completely randomized block design.

The following parameters were determined in the two successive seasons: Leaves area (cm2), Shoot length, Shoot diameter, Number of new shoots and Number of leaves /shoot.
The impact of investigated treatments on olive trees was evaluated through determining the following parameters.

Vegetative growth:

In the first week of August of both seasons, the following parameters were measured:
Shoot length (cm) starting from the base, Shoot diameter (cm) 10cm from the base, No. of new shoots and No. of leaves /shoot(average number of one year old from twenty shoots representing the four direction of the tree , leaf area (cm^2):
At mid-July of each season, leaf area (cm^2) was determined as average of three leaves from the middle portion of the tagged shoots on each replicate tree according to Ahmed and Morsy,(1999), using the following equilibration: Leaf area = 0.53 (length × width) +1.66.

Yield:

At maturity stage (November), fruits of each replicate tree were separately harvested, then weighted and average yield as kg tree was estimated.

Fruit quality:

Samples of 20 fruits from each replicate tree i.e., 60 fruits from each of the applied treatments were picked randomly at harvest to determine:
Average Fruit weight (gm) Flesh weight (gm), Seed weight (gm), Flesh/fruit Ratio, Flesh oil %, according to A.O.A.C., (2000).

Data analysis:

All the obtained data during the two seasons were subjected to analysis of variance according to Snedecor and Cochran (1990). The differences between the mean values of various treatments were compared by Duncan's multiple range test (Duncan's, 1955).

Results

Chemical characteristics of the ground water:

Analysis of water from wells, illustrated that the concentrations of the cations, i.e. Na^+, K^+, Ca^{++}, and Mg^{++} are characterized by high sodium content (69.2 meq/l), where, the Ca and Mg reached to 33.5 meq/l. Due to that the SAR reached to about 17, this characteristics make the water quality for irrigation class from good to fair. The pH analysis of the ground water of the studied wells area is about 8.7, which illustrate the origin of the water may be derived from sandstone, shale and limestone, table (1).

Table 2: Some chemical parameters of the ground water of the study well

pH (1: 2.5)	EC dSm^{-1} (1:5)	Soluble cations (meq l^{-1})				Soluble anions (meq l^{-1})				SAR
		Ca^{++}	Mg^{++}	Na^+	K^+	$CO^{=}_3$	HCO^{-}_3	Cl^-	$SO^{=}_4$	
7.49	8.7	21.6	11.9	69.2	0.5	-	2.4	74.2	26.6	16.9082511

Classification of the ground water

Water quality assessment for irrigation purposes very important and is rather essential for any irrigation system construction. The important parameters used for its estimation are, the total soluble salts referred to by electrical conductivity (EC), sodium adsorption ratio (SAR) and some other parameters like boron toxicity and pH.

Ground water can be classified on the basis of chemical relation between Na, K and Cl for either meteoric water according to Sulin (1946). The orders of concentrations of cations and anions are arranged in the following order, sedimentary aquifers as the same order $Na^{+}>Ca^{++}>Mg^{++}>K^{+}$ according to cations and anions $Cl^{-}>SO_4^{--}> HCO_3^{-}$.

According to conductivity and SAR, water of the studied well have high salinity hazard and medium sodium hazard. Using these waters at least for irrigation purposes should entail growing highly salinity resistant plants while, sodium sensitive plants may suffer injury. The coarse texture of the soil and leaching requirement would account for using these water.

Soils of the farm

From the soil survey and data analysis of the soils it is shown that, the soils of the investigated area are highly calcareous, deep soils with a sandy to sandy loam textured soils, the soils are saline highly saline, where the upper and lower layers have a high salinity (8.1 and 9.5 dS/m respectively) while; the upper lower layer was non saline (0.82 dS/m). Nevertheless, the soils sometimes are deep has a salinity value in a moderate salinity along the profile, where the salinity value range from 1.83 to 2 dS/m.

The soil is very poor in fertility where the organic matter content is very poor as well as the content of N, P and K.

Table 3: Some chemical analysis of the soils samples

Profile No.	Sample No.	Depth cm	pH (1:2.5)	EC (1:5)dS/m	Cation (meq/l)				Anion (meq/l)			
					K+	Na^{+}	Mg^{++}	Ca^{++}	Cl-	SO_4^{--}	HCO_3-	CO_3^{--}
1	1	20-0	8.12	8.1	0.54	41.0	12.4	31.0	45.1	36.44	3.4	--
	2	45-20	7.85	9.5	0.35	30.0	23.0	40.0	40.0	49.45	3.9	--
	3	75-45	7.87	0.82	0.25	2.85	1.1	4.0	3.8	2.8	1.6	--
2	4	25-0	8.66	1.83	0.47	6.88	2.9	7.8	8.1	7.95	2.0	--
	5	65-25	8.45	2.0	0.76	6.3	5.0	8.4	5.8	12.36	2.3	--
	6	120-65	8.51	2.0	0.44	7.6	3.6	8.0	6.9	10.54	2.2	--
3	7	15-0	8.72	2.4	0.58	8.8	5.6	9.4	7.4	14.48	2.5	--
	8	80-15	8.35	2.5	0.46	9.2	5.2	10.7	10.9	11.56	3.1	--
	9	150-80	8.30	0.84	0.60	4.4	1.2	3.1	4.0	3.9	1.4	--

As shown in Table (3) revealed that the effect of sea algae extract on vegetative growth of Koroneiki olive trees namely shoot length (cm), shoot diameter (cm), number of new shoots, number of leaves/shoot and leaf revealed that all algae extract concentration increased shoot length compared with the control. Highest shoot length value was obtained from olive trees sprayed with algae extract at the high concentration (T4) recorded (85.20 cm) while the lowest shoot length value was obtained from the control (72.35 cm). Low and medium algae extract concentrations (T2 and T3) gave intermediate shoot length (cm) values (76.6 and 82.4 cm) respectively. Shoot length (cm) in the second season in Table (3) followed the same trend obtained in the first one.

Shoot diameter, as presented in Table (3), shoot diameter increased by algae extract especially at the medium and high concentrations. Shoot diameter values in the first season recorded 0.48, 0.49, 0.62 and 0.63 cm in T1, T2, T3 and T4 respectively.

Number of new shoots as presented in Table (2) increased by algae extract sprayed in all concentrations than the control, the values were 7.66, 8.00, 8.35, 9.60 and 7.00, 9.30, 9.35 and 10.16 in treatments T1, T2, T3 and T4 in the first and second seasons respectively.

Number of leaves per shoot as shown in Table (3) were increased by algae extracts concentrations. High values of number of leaves per shoot were obtained from T3 and T4 compared with the control T1 and algae extract at the low concentration T2. This was true in the first and second seasons.

Table 4: Effect of sea algae extract on vegetative growth of cv. Koroneiki Olive trees

Variables / Treatments	Shoot length (cm)	Shoot diameter (cm)	No. of new shoots	No. of leaves /shoot	Leaf area (cm^2)
First season					
T1= AE (0) control	72.35 bc	0.48 h	7.66 f	35.90 de	2.23 g
T2= AE (50 conc./100 L.W	76.60 b	0.49 h	8.00 ef	37.24 d	3.33 g
T3= AE (75 conc./100 L.W	82.40 ab	0.62 h	8.35 ef	42.18 cd	3.60 g
T2= AE (100 conc./100 L.W	85.20 a	0.63 h	9.60 e	43.65 c	4.00 fg
Second season					
T1= AE (0) control	75.60 bc	0.46 h	7.00 f	38.70 de	2.46 g
T2= AE (50 conc./100 L.W	77.25 b	0.58 h	9.30 ef	36.25 d	3.20 g
T3= AE (75 conc./100 L.W	80.33 ab	0.63 h	9.35 ef	42.32 cd	3.20 g
T2= AE (100 conc./100 L.W	83.00 a	0.67 h	10.16 e	43.30 c	3.76 fg

Values followed by the same letters are not significantly differed at (P=0.05)
AE = Algae extract, L.W. = Liters of water

Leaf area (cm^3) increased by algae extract sprayed at all concentrations used compared with the control in both seasons of study. The values recorded in cm3 2.23, 3.33, 3.60, 4.00 and 2.46, 3.20, 3.20 and 3.76 in T1, T2, T3 and T4 in seasons 2015 and 2016 respectively.

Yield:

Results in Table (4) revealed that foliar spray with algae extract at all concentrations increased olive yield than the control. The highest yield was obtained from olive trees sprayed with algae extract at 100 cm^3/100 L. water (T4), which attained 23.20 and 25.80 kg/tree compared with the control which recorded the lowest yield values which recorded 15.5 and 17.35 kg/tree in the first and second seasons respectively. In other words the increment in olive yield as kg/tree over the control reached 50% and 48.7% in the first and second seasons respectively. However, a particular trend was noticed in all studied parameters, that the higher algae extract concentration, the higher parameter value.

Fruit quality:

Fruit weight (g): Data in Table (5) showed that foliar application of algae extract at all slightly increased Fruit weight than the control. The Fruit weight values record between 1.63-1.78 gm and 1.65-1.81 gm in the first and second seasons respectively.

Flesh weight (gm): as shown in Table (5) results revealed that foliar spray of algae extract with different concentrations, in general increased Flesh weight than the control in both seasons of study. The Flesh weight values recorded between 1.15-1.30 gm and 1.22-1.32 gm in the first and second seasons respectively.

Seed weight (gm): results in Table (5) indicated that all algae extract sprayed increased Seed weight of olive fruit than the control, which recorded 0.48 and 0. 43 gm, while algae extract at the low concentration T2 detected the high seed weight values 0.56 and 0.53 in the first and second seasons respectively.

Flesh/fruit ratio: results in tables (5) indicated that algae extracts sprayed as general tended to decrease Flesh/fruit ratio than those of the control. Flesh/fruit ratio ranged between 66%-73% and 70-73% in the first and second seasons respectively.

Flesh oil %: Results in tables (5) proved that foliar algae extract spray increased flesh oil % in Koroneiki olive fruit than the control. The highest flesh oil was obtained from fruits of olive trees sprayed with algae extract at the high concentration T4 meanwhile the lowest flesh oil% was obtained from the control T1. This was true in the two seasons of study. Flesh oil% recorded 17.30%, 18.00%, 20.50%, 21.25% and 16.20%, 20.16%, 22.01% and 23.15 in T1, T2, T3 and T4 in the first and second

seasons respectively. Data revealed that flesh oil% increased by T4 compared with the control, the increment over the control attained 22.8% and 42.9% in the first and second seasons respectively.

Table 5: Effect of sea algae extract on yield and fruit quality of Koroneiki Olive trees

Variables / Treatments	Yield (Kg/tree)	Fruit weight (gm)	Flesh weight (gm)	Seed weight (gm)	Flesh/fruit Ratio	Flesh oil %
First season						
T1= AE (0) control	15.50 d	1.63 e	1.15 fg	0.48 f	0.70 g	17.30 c
T2= AE (50 conc./100 L.W	16.25 cd	1.66 e	1.10 fg	0.56 f	0.66 g	18.00 bc
T3= AE (75 conc./100 L.W	20.35 b	1.75 e	1.22 fg	0.53 f	0.69 g	20.50 b
T2= AE (100 conc./100 L.W	23.20 a	1.78 e	1.30 fg	0.48 f	0.73 g	21.25 ab
Second season						
T1= AE (0) control	17.35 d	1.65 e	1.22 ef	0.43 efg	0.73 f	16.20 d
T2= AE (50 conc./100 L.W	19.20 cd	1.78 e	1.25 ef	0.53 efg	0.70 f	20.16 c
T3= AE (75 conc./100 L.W	21.33 bc	1.80 e	1.30 ef	0.50 efg	0.72 f	22.01 bc
T2= AE (100 conc./100 L.W	25.80 a	1.81 e	1.32 ef	0.49 efg	0.72 f	23.15 b

Values followed by the same letters are not significantly differed at (P=0.05)
AE = Algae extract
L.W. = Liters of water

Generally, a particular trend was obviously noticed in the present study where, vegetative growth, yield, fruit quality studied parameters in Koroneiki olive tree respects increased gradually with increasing algae extract concentration In this respect, spraying sea algae extract at 100 cm^3/100 liter water 0nce at full bloom increased vegetative growth parameters as well as yield (Kg/tree) by about 50 and 30 % and flesh oil % by 20 and 30 % in the first and second season respectively.

Discussion

From the above mentioned results it is clear that foliar spray of algae extracts improved vegetative growth in term of shoot length, shoot diameter, number of new shoot, number of leaves/shoot and leaf area as well as enhancing fruit quality in term of fruit weight may be reflected on the increase in yield kg/tree resulted from algae extracts spray over the control. The beneficial effects algae extracts spray on vegetative growth namely shoot length, shoot diameter, number of new shoot, number of leaves/shoot and leaf area were mentioned by many in fruit tree.

It could be concluded that foliar spray of algae extracts sprays at 100 ml/100L water is recommended as a promising treatment for improving vegetative growth, yield and fruit oil content. It is thought that seaweed extracts enhance the endogenous synthesis of polyamines and slow their degradation (Khan *et al.,* 2009 ; Spinelli *et al.,* 2009) .

Foliar spray of algae extract at 100 cm^3/100L.water was found to be the optimum concentration to enhance vegetative growth, yield and oil content. However, algae extract spray on olive cv. Koroneiki was found to be useful and be recommended to enhance the studied parameters.

As mentioned in the above results it clear that algae extract spray at different concentrations used had a positive effects on cv. Koroneiki olives. However, the increases in shoots characteristics may be due to the contents of algae extract i.e. which positively reflect on the activity of photosynthesis and synthesized materials which will reflect on shoots parameters (Thomas, 1996). Moreover, olive transplants vegetative growth parameters were enhanced markedly broken cells of fresh green by algae extract as soil application (Abd El-Maguid, 2004). This similar trend was proved by Abd El-Moniem and Abd-Allah, (2008) who mentioned that foliar spray of green algae cells extract improved vegetative growth and yield of superior grapevine. Similar finding were confirmed by other investigators on fruit crops, Abd El-Motty *et al.* (2010) on mango, in this respect, the higher sea algae extract, the higher vegetative growth and productivity parameters.

The enhancement effect of algae extract on fruit quality properties are mainly through the physiological action of nutrients, vitamins, and growth regulators which reflected on fruit quality. Also, the increase in leaf total chlorophyll content was reflected in increasing rate of

photosynthesis rate and accumulation of carbohydrates reserves which lead to positive effect on fruit quality. (Abdel-Maguid *et al.,* 2004; Abd el Moniem *et al*., 2008).

From the abovementioned results, it is clearly noticed that all sea algae extract concentrations spray improved vegetative growth and productivity measurements compared with the control.

Conclusion

It could be concluded that spraying see algae extract at 0.1 % three times i.e. first at growth start, second at flowering and third after final fruit set be recommended for improving growth, yield, fruit quality and oil content of Koroneiki olive. Under middle Sinai conditions.

Acknowledgement

We would like to thank Science and Technology Development Fund (STDF) for funding this work through project ID. 5805.

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