Annals of Agricultural Science, Moshtohor (ASSJM)
https://assjm.journals.ekb.eg/
www.fagr.bu.edu.eg
© 2023, Faculty of Agriculture, Benha University, Egypt. ISSN:1110-0419
Original Article Vol. 62(4) (2024), 13 – 20 DOI: 10.21608/assjm.2025.317626.1314

Response of Olive Trees Irrigated with Sewage Water to Foliar Spray with Salicylic Acid, Chitosan and Algae Extract

Zewail, R. M.Y[1]., Mady, M.A.[1], El-Desoky, S. A.[1], Elgohary, A.A.[2]
[1] Botany department, Faculty of Agriculture, Benha University, 13736, Egypt.
[2] Seawage water treatments Egabal Alsfar, Abozabal, Qalubia, Egypt.
Corresponding author: - reda.zewail@fagr.bu.edu.eg

Abstract

This work amid to investigate the beneficial effects of the biostimulating treatments under treated Sewage water. Foliar spraying of salicylic acid at 0.5 and 1 g^{-1}, chitosan 2 and 4 ml^{-1} and alage extract at 2 and 4 ml^{-1} start at June and repeated 8 times on growth, flowering and fruit quality of olive trees grown under treated sewage water applications. Results indicated that chitosan at 4 ml^{-1} significantly increased growth parameters fresh weight of leaves/branch g, dry weight of leaves/branch and total leaf area/branch cm^2. Flowering characteristics i.e., date of full bloom, flowering density, total number of flower/inflorescence. In addition, fruit yield/tree, fruit yield /faddan (ton), fruit weight g, fruit width (cm), fruit length, seed weight, flesh weight, percentage flesh/fruit weight. Also, fruit chemical quality i.e., fruit moisture %, fruit oil content and refractive index, were increased with chitosan at 4 ml^{-1} during both seasons. Meanwhile, peroxide value and acid value % were decreased with the same application during both seasons. Using chitosan is best superior for increasing olive growth and yield under treated sewage irrigation water.

Key words: Olive, biostimulating fruit yield, oil content,

Introduction

Olive tree (*Olea europaea* L.) is one of the oldest and emblematic cash crops of the Mediterranean Basin, being cultivated mostly under rained production systems. Although the species can tolerate harsh conditions, the sector is under threat by the current adverse environmental circumstances and even more by the future scenarios of climate change **PCC., (2013)** Agricultural yield losses due to environmental stresses are well documented and many studies have shown that is crucial to increase the efforts in adapting measures to help the plants to cope with such adverse conditions **Wang and Frei.,(2011**). The limited water resources associated with the rugged topography of traditional olive growing areas hinder the implementation of irrigation systems, and/or make it economically unsustainable. Alternatively, the exogenous application of salicylic acid (SA), Chitosan and algae extract can be adequate short-term solutions to attenuate the adverse effects of summer-associated stresses **Glenn and Puterka,. (2004)** and Salicylic acid is an active secondary metabolite that occurs in plants and its derivatives are synthesized from chorismate (derived from shikimate pathway). Salicylic acid or ortho-hydroxybenzoic acid belongs to a varied group of phenolic compounds well known in the plant kingdom. Salicylic acid is present in plants as a free phenolic acid and as a conjugate form, which may be generated by glucosylation, methylation or hydroxylation of the aromatic ring Salicylic acid is considered an important phytohormone that regulates various aspects of plant growth, environmental stress (**Lefevere *et al.*, 2020).**and SA is a signaling phytohormones with diverse regulatory roles in plant metabolism and abiotic stress tolerance **Khan *et al.*, (2015**). Salicylic acid (SA), as a strong signaling molecule in plants, regulates physiological and biochemical functions effective in defense mechanisms and also boosts biological and non-biological factors involved in augmenting plants.. The major roles of SA in drought-stressed plants are as follows: activation of antioxidant defense system, production of secondary metabolites, synthesis of osmolytes, optimization of mineral status and maintenance of proper balance between plant photosynthesis and growth **(Azizifar *et al.*, 2022**).However, the influence of these substances on crop quality has received less attention than the influence on yield, possibly because they are more difficult to detect and sometimes are not consensual. The application of SA increased the yield of olive **Abd El-Razek *et al.*, (2013**) and **Khalil *et al.*, (2012**). Chitosan is a natural, biocompatible, non-toxic polymer with intrinsic antimicrobial activity. A wide range of applications has been proposed .Chitosan can be used as an encapsulating agent to produce slow-release fertilizer **Hidangmayum and**

Dwivedi (2022). and as a material with the ability to alleviate abiotic stress in plants, by means of salinity control and the alleviation of drought stress **Mujtaba *et al.*, (2021**). Chitosan is widely used itself as a plant growth promoter, thanks to its positive nature, resulting in an increased affinity to the plant cell membrane and, thus, an enhanced reactivity **Balusamy *et al.*, (2022**). Moreover, CTNPs have found large application as a soil conditioner to complex toxic metals and their removal in polluted soil **Sathiyabama and Manikandan (2021).**

Seaweed extracts (SWE) are widely used in agriculture for their beneficial effects on plant growth and tolerance enhancement to biotic and abiotic stresses and used as supplements of nutrients, In agriculture and horticulture, bio stimulants or bio fertilizers To boost the growth and yield of plants **Sangha *et al., (*2014).** The seaweed extract has been found to contain growth stimulators such as auxins, gibberellins and cytokinin (**Begum *et al.*,2018).** The extract also comprises growth promoting hormones (IAA and IBA), trace elements, vitamins and amino acids and have been reported to stimulate the growth and yield of plants, develop tolerance to environmental stress, increase nutrient uptake and enhance antioxidant properties (**Pramanick *et al.*,2013 and Mohanty *et al.*,2013).** Seaweed extracts are used as nutrient supplements, biostimulants, or biofertilizers in agriculture and horticulture to increase plant growth and yield **(Nabti *et al.*,2017).** Modern agriculture is searching for new biotechnologies that would allow for a reduction in the use of chemical inputs without negatively affecting crop yield or the farmers' income. In recent years, the use of natural seaweed as fertilizer has allowed for partial substitution of conventional synthetic fertilizer (**Zodape *et al.*,2011 and Hernández-Herrera *et al.*,2014).**Thus, the main objective of this investigation was directed towards improving olive trees vegetative growth, nutritional Status and oil quality and quantity by using salicylic acid, chitosan and Seaweed extract under regular and wast irrigation water.

Material and methods

Two field experiments were carried out at Al Jabal Al-Asfar sewage treatment station farm during 2022 and 2023 seasons. To study the effects of salicylic acid 0.5, 1 g-1, Chitosan 2 and 4 ml^{-1} and Algae 2 and 4 ml^{-1}(since all of these are acting as antioxidants for oxygen free radicals scavengers) under treated sewage irrigation water on the morphological, physiological and metabolic features of olive trees (*Olea europaea* L.). In addition, the possibility of using such treatments for maximizing its growth, productivity, fruit quality, and improving the oil ratio of fruits.

Physical and chemical properties of the experimental soil during 2021 and 2022 seasons. **Soluble cations and anions (mmole. L^{-1}) Ca^{++}** 13.5, **Mg^{++}**9.50, **K^{+}**0.65, **Na^{+}**18.90, **Cl^{-}**21.5, **HCO_3^{-}**2.5, **So_4^{2-}**17.55, **E.C* (dSm^{-1})** 2.08, **PH**8.05, **Sp**27, **Particle size distribution (Mechanical analysis) Find Sand %** 60.5, **Silt %35, Clay %4.5, Soil texture** Sandy loam.

Mean chemical properties of treated sewage irrigation water. Total dissolved salts, EC (ds/m) 1.52, P.P.M 972, PH 7.53, Anions (mEq/L) CO_3^{-} 0.00, HCO_3^{-} 4.80, Cl 9.75, $SO_4^{=}$0.64, Ca^{++}3.33, Na^{+}9.63, Mg^{++}1.98, k^{+}0.25, Residual sodium carbonate 0.00, Absorbable sodium percentage(SAR) 5.91.

The olive trees have been treated (*Olea europaea* L.) plants were done as the recommended methods from the Egyptian ministry of agriculture. All other practical managements (fertilization, irrigation, pest control and etc….) were applied as recommended according to the Ministry of Agriculture in Egypt.

Through plant growth and development trees were sprayed 8 times with different assigned treatments, the first one was at first of march and repeated each 15 days intervals until the end of June, the spraying solution volume was spraying until the solution runoff from the plant. All other cultural practices were performed as recommended. The chosen trees were uniform in shape and had undergone standard horticultural procedures.

Sampling and collecting data: Different morphological characteristics of olive trees at 15th June during first and second seasons, were collected to measure and calculate each of the following characteristics. Fresh weight of leaves (g)/branch, Dry weight of leaves/branch (g),Total leaf area /branch cm^2 using the disk method according to **Derieux *et al.*, (1973),**Date of full bloom, Flowering Density, Total No. of flowers / inflorescence, inflorescence Length (cm),Fruit set (%). The samples of each treatment were taken for growth measurements, then, dried in oven at 70 oC for 48 hours till weight stability, leaves were estimated.

Photosynthetic pigments: Chlorophyll a, b, and carotenoids were colorimetrically determined in the olive trees during both seasons according to the methods described by **Wettstein (1957)** and calculated as mg/g fresh weight.

Fruit yield and yield components: Fruits yield /tree/kg: The fresh weight of all harvested fruits per treatment divided by the number of plants in the same treatment.

Fruit chemical quality analysis:- Fruit moisture (%), Fruit oil (%), Refractive index. Peroxide value (meq/kg oil): The peroxide value was determined according to **Jacobs (1959)** by dissolving 5 g of the oil in a mixture consisting of 60% glacial acetic acid + 40% chloroform. The solution was treated with approximately 0.5 ml of saturated solution of potassium iodide in a glass Stoppard flask. The flask was shaken in rotary for exactly two

minutes, after which 30 ml of distilled water was added, and the liberated iodine was titrated with 0.01 N sodium thiosulfate using 1% of starch solution as an external indicator. The results were calculated in mill moles per kilogram of oil according to the following equation.

$$\text{Peroxide value} = \frac{0.5 \times N \times V \times 100}{\text{Weight of sample}}$$

Where, N = Normality of sodium thiosulfate solution V = Volume in ml. of sod. Thiosulfate needed for titration

Acid value (%): It was determined according to **Deffenbacker and Pocklingon** (1992), since five grams of oil were accurately weighed in 250 ml dry conical flask with about 100 ml of neutralized 50% ethanol+ 50% petroleum ether to dissolve the oily sample. Acidity of the sample was determined by titration with 0.1 N of potassium hydroxide solution in the presence of phenolphthalein as an indicator. The acid value was calculated according to the following equation.

$$\text{Acid value} = \frac{V \times N \times 5.61 \times 100}{\text{Weight of sample}}$$

Where, V = Volume of KOH solution N = Normality of potassium hydroxide solution

Percentages of N, P, K, Iron mg^{-1} and Zinc mg^{-1} in the leaves (**Summer, 1985 and Wilde et al., 1985)**. A suitable sample (0.5 g) was taken from each dried leaf and wet digested using a mixture of perchloric acid: sulphuric acid (1:4 v/v) (**Piper, 1950**) and Iron , Zinc by using the atomic absorption spectrophotometer.

Statistical analysis:

All data of the present investigation were subjected to analysis of variance and significant differences among means were determined according to (**Snedecor and Cochran, 1990**). In addition, significant differences among means were differentiated according to the Duncan, s, multiple test range (**Duncan, 1955**).

Results and discussion

I-Effect of growth stimulant treatments and treated sewage water on growth characteristics of olive trees

Data presented in Table 1 show the effects of growth stimulant treatments i.e., (salicylic acid 0.5 and 1 g l^{-1}, chitosan 2 and 4 ml l^{-1}, algae extract 2 and 4 ml l^{-1}) under treated sewage irrigation water /or regular water on fresh weight of leaves /branch (g), Dry weight of leaves/branch and Total leaf area/branch cm^2 during 2022 and 2023 season. The results showed increased in growth characteristics by using growth stimulants material with sewage water during both seasons. Chitosan at 4 ml L^{-1} gave the highest value of this trait during both seasons with regular water, chitosan 2 ml 1^{-1} followed the heights treatment under treated sewage water during both seasons. In the same time salicylic acid at 0.5 and 1 g^{-1} and algae extract at 2 and 4 ml^{-1} increased this trait during both seasons but not reached the highest treatment when compared with control under regular irrigation water during first and second seasons. Meanwhile, foliar applications of growth stimulants treatment under treated sewage irrigation water increased fresh weight of leaves (g)/branch during 2022 and 2023 growing seasons. Salicylic acid at 1 g^{-1} gave the highest value of fresh weight of leaves (g)/branch under treated sewage irrigation water when compared with control during first and second seasons. The followed increased for these traits is chitosan 4 ml^{-1} , algae 4 ml^{-1} " chitosan 2 ml^{-1}, followed by algae 2 ml^{-1}, salicylic acid at 05 g^{-1} when compared with control during both seasons. In this respect, the obtained increased of these traits could be attributed to the application of chitosan and other biostimulating growth materials, salicylic acid and algae extract to increased plant growth and development.

Plants can develop faster because chitosan, which stimulates a variety of growth factors including nutrient uptake, cell division, and elongation. It has also been observed that the exogenous chitosan supply either induces or increases the production of phytohormones. In addition to supporting plant growth, phytohormones overexpression also helps activate plant defense mechanisms against various biotic and abiotic stressors. For example, compared to the controls, seeds primed with 2.5 mg/mL of chitosan somewhat increased the phytohormones content in primed plants. Plants treated with chitosan demonstrated a noteworthy synthesis of various phytohormones, specifically 1-naphthol acetic acid, indole acetic acid, and benzylaminopurine **(Jogaiag *et al.*, 2020).** Numerous genes that code for plant hormones are upregulated because of chitosan treatment. It has been observed that treating Arabidopsis with chitosan oligosaccharides increases the expression of PR1, a gene related to defense that is recognized as a marker of the salicylic acid signaling pathway **(Jia *et al.*, 2016).**

II-Effect of growth stimulant treatments and treated swage water on flowering characteristics of olive trees:-

Concerning full bloom date, Flowering density, Total No. of flowers / inflorescence, Inflorescence length (cm) and Fruit set percentage of the different olive trees were affected by the application of biostimulating materials i.e., (salicylic acid 0.5 and 1 g l^{-1}, chitosan 2 and 4 ml l^{-1}, algae extract 2 and 4 ml l^{-1}) under treated sewage water /or regular water data in Table (2) revealed that full bloom started from April 8th till April 20th in 2022 season and from April 7st till April 21th in 2023season and all other traits was affected by the applications of biostimulating

treatments during both seasons. The earliest treatments in all the above mentioned traits was the chitosan at 2 ml^{-1} in both seasons, meanwhile, the latest treatment in this respect was the control in both seasons under wast irrigation water. These observations were previously noticed **El-sayed *et al.*, (2006).** The determination of blooming dates of different treatments may be of great importance when establishing olive growth with chitosan and other biostimulating treatments.

Table 1. Effect of growth stimulant treatments under water types on growth characteristics of Olive trees during 2022 and 2023 seasons

Treatments	**characteristics**	**Fresh weight of leaves (g)/branch**	**Dry weight of leaves/branch (g)**	**Total leaf area /branch cm^2**
			First season	
Treated Sewage water	**Salicylic 0.5g L^{-1}**	20.01b	7.21e	**48.03e**
	Salicylic 1g L^{-1}	21.00a	9.65a	**64.33a**
	Chitosan 2 ml L^{-1}	18.76d	9.56b	**58.53c**
	Chitosan 4 ml L^{-1}	19.37c	8.49c	**62.12b**
	Algae 2 ml L^{-1}	19.13c	9.19c	**57.41c**
	Algae 4 ml L^{-1}	11.17f	9.03b	**60.17b**
	Control	17.97e	5.57f	**41.78f**
			Second Season	
Treated Sewage water	**Salicylic 0.5g L^{-1}**	15.30e	7.28e	**38.29e**
	Salicylic 1g L^{-1}	20.35b	10.03a	**51.85a**
	Chitosan 2 ml L^{-1}	21.35a	9.66b	**49.94b**
	Chitosan 4 ml L^{-1}	19.05d	8.51d	**46.39**
	Algae 2 ml L^{-1}	19.46b	9.26b	**42.07d**
	Algae 4 ml L^{-1}	19.22c	9.12c	**47.15c**
	Control	11.26f	5.65f	**29.22f**

Table 2. Effect of growth stimulants treatment under water types on flowering characteristics of Olive trees during 2022 and 2023 seasons

Treatments	characteristics	Date of full bloom		Flowering Density		Total No. of flowers / inflorescence	
		2022	**2023**	**2022**	**2023**	**2022**	2023
Treated Sewage water	**Salicylic 0.5g L^{-1}**	12.4c	13.4c	77.33c	78.6c	18.17c	**19.17c**
	Salicylic 1g L^{-1}	8.4a	12.4a	74.65c	74.65c	19.68c	**19.68c**
	Chitosan 2 ml L^{-1}	8.4a	10.4a	132.6a	130.83a	28.03a	**28.55a**
	Chitosan 4 ml L^{-1}	8.4a	12.4a	132.4a	138.38a	27.87a	**26.87a**
	Algae 2 ml L^{-1}	9.4b	11.4b	75.47b	78.47b	19.30c	**19.80c**
	Algae 4 ml L^{-1}	9.4b	11.4b	78.38b	77.49b	19.33c	**20.23c**
	Control	20.4f	21.4f	60.83f	62.35f	15.27g	**16.25g**
		Inflorescence Length (cm)		Fruit set (%)			
		2022	**2023**	**2022**	2023		
	Salicylic 0.5g L^{-1}	2.47b	3.67b	32.37c	**35.37c**		
	Salicylic 1g L^{-1}	3.30b	3.47b	35.98c	**36.88c**		
	Chitosan 2 ml L^{-1}	3.79a	3.80a	43.64a	**44.82a**		
	Chitosan 4 ml L^{-1}	3.67a	3.81a	42.43a	**43.33a**		
	Algae 2 ml L^{-1}	3.16c	2.71c	33.23c	**34.15c**		
	Algae 4 ml L^{-1}	3.25c	3.26c	35.23c	**36.21c**		
	Control	2.15f	2.25f	25.23g	**26.25g**		

III-Effect of growth stimulant treatments under irrigation with sewage water on yield and yield characteristics of olive trees

Dealing with the yield expressed as (kg/tree), **Fruit yield /faddan (ton), Fruit weight (g), Fruit width (cm), Fruit length (cm), Seed weight (g), Flesh weight (g) and Flesh/ Fruit weight** of the

studied olive traits under wast irrigation water and biostimulating treatments., data presented in **Tables (3 and 4)** showed that there were noticeable significant differences in fruit yield which varied greatly according to the studied olive with biostimulating treatments under treated sewage water. Fruit yield ranged from (96.83 to 130.17 kg/tree) in the 1st season and from (101.31 to 133.00 kg/tree) in the 2nd season. The highest value of these traits was recorded with chitosan at $4ml^{-1}$. On the other hand, the least values of fruit yield were detected with control (untreated treatments with treated sewage water in both seasons. The same results were observed by **El-Said *et al*., (2006) and Essa *et al*., (2006).Badran and Ahmed, 2009,**

In this respect, the obtained increased of olive yield and yield components with the applications of salicylic acid, chitosan and algae could be attributed to Many substances, such as chitosan, which is a naturally occurring substance with no negative effects on human health, can be added to plants to increase their resistance to harsh conditions like pathological injuries, climatic changes, increased growth of vegetables and fruits, and fruit quality **(Blevius and Lukaszweski, 1998)**. It may also be involved in signaling during abiotic stressors, according to recent research.

Chitosan has been shown to mitigate the harmful effects of a variety of stress factors in plants, such as heavy metals, high temperatures, chilling, or salinity **(Szepesi et al., 2009),** by inducing a wide range of processes involved in stress tolerance mechanisms. These findings suggest that chitosan may be a promising compound for the reduction of abiotic stress sensitivity in plants. Numerous physiological processes are impacted by chitosan, including as stomatal conductance, photosynthetic rate, ion uptake and transport, and flowering **(Raskin, 1992).** According to earlier research **(Ahmed et al., 2003; Gobara, 2004; Ahmed et al., 2007 and Badran and Ahmed, 2009)**, using chitosan, a significant antioxidant, was crucial for enhancing development and fruiting in a variety of evergreen fruit crops.

Table 3. Effect of growth stimulant treatments under treated sewage water on yield and yield characteristics of Olive trees during 2022 and 2023 season

Treatments	characteristics	Fruits yield /tree/kg		Fruit yield/faddan (ton)		Fruit weight (g)		Fruit width (cm)	
		2022	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	2023
Treated Sewage water	**Salicylic 0.5g L^{-1}**	117.17c	119.17c	21.09c	21.19c	8.49c	8.49c	2.65c	**2.58c**
	Salicylic 1g L^{-1}	113.06c	113.22c	20.35c	20.38c	9.47c	9.47c	2.19c	**2.15c**
	Chitosan 2 ml L^{-1}	124.56a	126.72a	22.06a	22.81a	10.53a	11.53a	2.67a	**2.79a**
	Chitosan 4 ml L^{-1}	130.17a	129.06a	23.43a	23.23a	11.60a	12.60a	2.86a	**2.93a**
	Algae 2 ml L^{-1}	123.83b	120.94b	21.29b	21.77b	8.48c	8.48c	2.12c	**1.97c**
	Algae 4 ml L^{-1}	121.94b	121.28b	21.95b	21.83b	8.61c	8.61c	2.53c	**2.23c**
	Control	100.00f	103.39f	18,06g	18.61g	5.84g	6.84g	2.0f	**1.92f**

Table 4. Effect of growth stimulant treatments under treated sewage water on yield and yield characteristics of Olive trees during 2022 and 2023 seasons

Treatments	characteristics	Fruit length cm		Seed weight (g)		Flesh weight (g)		% Flesh/ Fruit weight	
		2022	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	2023
Treated Sewage water	**Salicylic 0.5g L^{-1}**	3.26c	3.57c	0.84c	0.82c	7.65c	7.67c	90.11c	**90.34c**
	Salicylic 1g L^{-1}	2.61c	2.80c	0.87c	0.75c	8.60c	8.72c	90.81c	**92.08c**
	Chitosan 2 ml L^{-1}	3.73a	3.60a	0.63a	0.89a	9.90a	10.64a	94.02a	**92.28a**
	Chitosan 4 ml L^{-1}	3.83a	3.93a	0.53a	0.52a	10.87a	12.08a	93.71a	**95.87a**
	Algae 2 ml L^{-1}	2.60c	2.68c	0.86c	0.77c	7.15c	6.92c	90.28c	**88.13c**
	Algae 4 ml L^{-1}	2.87c	2.78c	0.88c	0.88c	7.73c	7.73c	89.78c	**89.78c**
	Control	2.00g	1.94g	0.96f	0.91f	4.88g	5.93g	83.56f	**86.70f**

Iv- Fruit chemical properties

Regarding fruit moisture content, fruit oil content, refractive index, Peroxide value refers to the probability of oil oxidation and subsequently conversely with oil quality and acid value of the studied olive treatments, data presented in **Table (5)** showed that the differences among the different studied treatments were significant Control treatment had the highest values for moisture content and peroxide value under treated sewage water in the 1st and the 2nd seasons. Meanwhile, chitosan at 2 ml^{-1} gave the least fruit moisture percent and peroxide value for treated sewage water in both seasons of the experimental study. Besides, both the other fruit moisture contents and peroxide value were in between. In this concern all other traits (i.e., fruit oil content, refractive index, and acid value increased with the applications of biostimulating treatments especially chitosan at $4ml^{-1}$ during both seasons under treated sewage water. Meanwhile control treatment gave the latest increased in the above-mentioned traits during first and second seasons. All other treatments were in between.

In this respect, Chitosan molecules are crucial for developmental processes, and certain of them are essential for the mechanisms that lead to environmental acclimatization. It has long been recognized that chitosan functions as a signaling molecule to trigger defense mechanisms in plants **(Shah, 2003).**

Numerous physiological processes, such as blooming, ion uptake and transport, photosynthetic rate, and stomatal conductance, are influenced by chitosan **(Raskin, 1992).**Prior research demonstrated that adding chitosan, a significant antioxidant, was crucial for enhancing the growth and fruiting of certain evergreen fruit crops **(Badran and Ahmed, 2009).**

In horticulture and agriculture, seaweed resources are heavily used to boost harvest quantity and quality as well as to enhance plant development and output **Brito et al. (2018)**. The influence can be explained by the presence of chemicals in the algal extract that promote plant growth, such as auxin, gibberellins, cytokinins, ethylene, polyamines, and betaines. Seaweeds are a valuable source of nutrients and organic materials for fertilizer **Abd-El-Rhman and Attia (2016)**. Utilized in agriculture as plant stimulants or soil conditioners. When used as foliar spray, they can promote plant development, increasing crop output and productivity (**Khan et al. 2012).**

Table 5. Effect of growth stimulant treatments under Treated Sewage water on fruit chemical properties of Olive fruits during 2022 and 2023 seasons

Treatments	characteristics	Fruit moisture (%)		Fruit oil (%)		Refractive index		Peroxide value (meq/kg oil)		Acid value (%)	
		2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
Treated Sewage water	Salicylic 0.5g L^{-1}	68.81c	68.51c	41.48c	41.88c	1.469d	1.469d	3.45c	3.65c	0.25c	0.22c
	Salicylic 1g L^{-1}	56.07d	56.47c	45.42c	45.92c	1.469d	1.469d	3.21c	3.41c	0.22c	0.24c
	Chitosan 2 ml L^{-1}	55.03d	55.23d	57.08a	58.18a	1.469d	1.469d	2.30a	2.39a	0.18a	0.18a
	Chitosan 4 ml L^{-1}	55.20c	55.32d	59.25a	59.35a	1.469d	1.469d	2.53a	2.58a	0.15a	0.15a
	Algae 2 ml L^{-1}	58.37d	58.34d	49.49c	48.59c	1.469d	1.469d	3.89c	3.79c	0.17b	0.17b
	Algae 4 ml L^{-1}	65.24c	66.29c	46.28c	47.18c	1.469d	1.465d	3.55c	3.25c	0.18b	0.19b
	Control	70.25b	71.00b	35.47f	35.48f	1.469d	1.465d	4.54f	4.47f	0.35f	0.36f

Conclusion

Spraying olive trees 8 times starts from first of March and repeated each 15 days until end of June with chitosan at 4 ml^{-1} under Treated Sewage water is the best for fruit yield, fruit oil % and fruit quality of Eggazi cv.

References

Abd El-Razek, E., Hassan, H. S. A., & Gamal El-Din, K. M. (2013). Effect of foliar application with salicylic acid, benzyladenine and gibberellic acid on flowering, yield and fruit quality of olive trees (Olea europaea L.). Middle-east journal of scientific research, 14(11), 1401-1406.

Abd-El-Rhman IE, Attia MF (2016): Foliar spray with potassium nitrate and salicylic acid for improving growth, yield and nutrients uptake by olive trees under salinity stress conditions. Int J ChemTech Rese 9(12):230–245.

Ahmed, F.F.; A.Y. Mohamed and B.M. Abdalla (2007): The relation between using some antioxidants and productivity of Sewy date palms. Minia J. of Agric. Res.& Develop., 27 (4): 753–770.

Azizifar, S., Abdossi, V., Gholami, R., Ghavami, M., & Mohammadi Torkashvand, A. (2022).

Evaluation of the effects of kaolin and salicylic acid on yield and some physiological responses of olives under drought stress. *Journal of Horticultural Science*, *35*(4), 605-619.

Badran, M.A.F.M. and F.F. Ahmed (2009): The promotive effect of some antioxidants on the productivity of Taimour mango trees. Minia J. of Agric. Res.& Develop., 29 (2): 333–348.

Balusamy, S. R., Rahimi, S., Sukweenadhi, J., Sunderraj, S., Shanmugam, R., Thangavelu, L., ... & Perumalsamy, H. (2022). Chitosan, chitosan nanoparticles and modified chitosan biomaterials, a potential tool to combat salinity stress in plants. Carbohydrate Polymers, 284, 119189.

Begum, M; Bordoloi, B. C; Singha, D. D. and Ojha, N. J. (2018): Role of seaweed extract on growth, yield and quality of some agricultural crops: A review. Agricult. Revie., 39(4), 321-326.

Blevius, D.G. and K.M. Lukaszweski (1998): Boron in plant structure and function. Anna. Plant physio. Plant Mol.Biol.49: 481 Egypt. J. of Appl. Sci., 35 (12) 2020 11.

Brito C, Dinis L, Silva E, Gonçalves A, Matos C, Rodrigues MA, Moutinho-Pereiraa J, Barros A, Correia C **(2018):** Kaolin and salicylic acid foliar application modulate yield, quality and phytochemical composition of olive pulp and oil from rainfed trees. Sci Hortic 237:176–183.

Deffenbacher, J. L., & Stark, R. S. (1992). Relaxation and cognitive-relaxation treatments of general anger. *Journal of Counseling Psychology*, *39*(2), 158–167. https://doi.org/10.1037/0022-0167.39.2.158

Derieux, M; Kerrest, R. and Montalanty, Y. (1973): Etude de la surface foliaive et de lactivite photosynthetique chez kulkues hybrids de mais. Ann. Amelior plants, 23: 95-107.

Duncan, D. B. (1955): Multiple ranges and multiple F. test. Biometrics, 11: 1-42.

EL-Sayed, M. E. ; Gowda A. M. and Hassan M. A. (2006). Studies on Some olive cultivars under Beni suev Governorate Conditions. Alex. J. Agric. Res. (51):137-151.

Essa, k. B.; EL-iraqy M. A. and Soher E. Sharawy (2006). Evaluation of some olive cultivars under south tahrir region. J. Agric. Sci . Mansoura Univ., 31 (6):3815-3825.

Glenn, D.M., Puterka, G.J., 2004. Particle films: a new technology for agriculture. In: Janick, J. (Ed.), Horticultural Reviews. John Wiley & Sons, Inc, Oxford, UK. http:// dx.doi.org/10.1002/9780470650882.ch1. pp. 1-44

Gobara, A.A. (2004): Growth and fruiting of Washington Navel orange in relation to foliar application of some antioxidants. Minia J. of Agric. Res.& Develop., 24 (3): 581 – 600.

Hernández-Herrera, R. M; Santacruz-Ruvalcaba, F; Ruiz-López, M. A; Norrie, J. and Hernández-Carmona, G. (2014): Effect of liquid seaweed extracts on growth of tomato seedlings (*Solanum lycopersicum* L.). J. of appl. phycology, 26(1), 619-628.

Hidangmayum, A., & Dwivedi, P. (2022). Chitosan based nanoformulation for sustainable agriculture with special reference to abiotic stress: a review. Journal of Polymers and the Environment, 30(4), 1264-1283.

Jacobs, M.B. (1959). The chemical analysis of food and products. D.Van. Nostrand Company, Inc. New York, USA, pp. 380–381.

Jia H, Orbovic V, Jones JB, Wang N. 2016. Modification of the PthA4 effector binding elements in Type I Cs LOB 1 promoter using Cas9/sg RNA to produce transgenic Duncan grapefruit alleviating Xcc 1pthA4: dCs LOB 1.3 infection. Plant Biotechnology Journal 14:1291–1301 DOI 10.1111/pbi.12495.

Jogaiah, S., Satapute, P., De Britto, S., Konappa, N., Udayashankar, A.C., 2020. Exogenous priming of chitosan induces upregulation of phytohormones and resistance against cucumber powdery mildew disease is correlated with localized biosynthesis of defense enzymes. Int. J. Biol. Macromol. 162, 1825e1838.

Khalil, F., Qureshi, K. M., Khan, A., & Bibi, N. (2012). Effect of girdling and plant growth regulators on productivity in olive (Olea europaea). Pakistan Journal of Agricultural Research, 25(2).

Khan MIR, Fatma M, Per TS, Anjum NA, Khan NA (2015): Salicylic acid-induced abiotic stress tolerance and underlying mechanisms in plants. Front Plant Sci 6:462.

Lefevere, H; Bauters, L. and Gheysen, G. (2020): Salicylic acid biosynthesis in plants. Frontiers in plant science, 11, 338.

Mohanty, D; Adhikary, S. P. and Chattopadhyay, G. N. (2013): Seaweed liquid fertilizer (SLF) and its role in agriculture productivity. Ecoscan, 3, 147-155.

Mujtaba, M., Sharif, R., Ali, Q., Rehman, R., & Khawar, K. M. (2021). Biopolymer based nanofertilizers applications in abiotic stress (drought and salinity) control. In Advances in Nano-Fertilizers and Nano-Pesticides in Agriculture (pp. 85-110). Woodhead Publishing.

Nabti, E; Jha, B. and Hartmann, A. (2017): Impact of seaweeds on agricultural crop production as biofertilizer. Int. J. of Env. Sci.and Tech., 14(5), 1119-1134

PCC, 2013. Climate change 2013: the physical science basis. In: Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M. (Eds.), Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

Pramanick, B; Brahmachari, K. and Ghosh, A. (2013): Effect of seaweed saps on growth and yield improvement of green gram. African J. of Agri. Res., 8(13), 1180-1186.

Raskin, I. (1992): Role of salicylic acid in plants. Annu. Rev. Plant Physiol. Plant Mol. Bid., 43: 439 – 463.

Raskin, I. (1992): Role of salicylic acid in plants. Annu. Rev. Plant Physiol. Plant Mol. Bid., 43: 439 – 463.

Raskin, I. (1992): Role of salicylic acid in plants. Annu. Rev. Plant Physiol. Plant Mol. Bid., 43: 439 – 463.

Sangha, J. S; Kelloway, S; Critchley, A. T. and Prithiviraj, B. (2014): Seaweeds (macroalgae) and their extracts as contributors of plant productivity and quality: the current status of our understanding. Advances in botanical research, 71, 189-219.

Sathiyabama, M., & Manikandan, A. (2021). Foliar application of chitosan nanoparticle improves yield, mineral content and bostinnat immunity in finger millet plants. *Carbohydrate Polymers*, *258*, 117691.

Shah, J. (2003): The salicylic acid loop in plant defense. Curr opin Plant Biol 6: 365 – 371.

Snedecor, G. W. and W. G. Cochran (1990): Statistical Methods 7th Ed. The Iowa State Univ. Press, Ames.

Szepesi, A. ; J. Csiszar ; K. Genus ; E. Horvath ; F. Horvath ; M. I. Simon and I. Tari (2009): Salicylic acid improves acclimation to sall stress by stimulating abscisic aldehyde oxidase activity and abscisic acid accumulation and increases Na+ content in leaves without toxicity symptoms in solanum lycopersicum L. J. of Plant Physiol., 166: 914 – 925.

Wang, Y., & Frei, M. (2011). Stressed food–The impact of abiotic environmental stresses on crop quality. Agriculture, Ecosystems & Environment, 141(3-4), 271-286.

Wettstein, D. (1957): Chlorophyll, letal und der submicroskpische formmech sell-der-plastiden. Exptl. Cell. Res., 12: 427.

Zodape, S. T; Gupta, A; Bhandari, S. C; Rawat, U. S; Chaudhary, D. R; Eswaran, K. and Chikara, J. (2011): Foliar application of seaweed sap as biostimulant for enhancement of yieldand quality of tomato *(Lycopersicon esculentum* Mill.). J. of Sci. and Industrial Res., 70,215-219.

أستجابة أشجار الزيتون المرويه بمياه الصرف المعالج للرش الورقى بالساليك،الشيتوزان والطحالب

تهدف هذا الدراسه إلى دراسة التأثيرات المفيدة للمعاملات المشجعه حيوياً تحت تأثير الري بمياه الصرف المعالج. الرش الورقي بحمض الساليسيليك 0.5 و1 جم،/لتر والشيتيوزان 2 و4 مل/ لتر ومستخلص الطحالب 2 و4 مل/لتر وبدأ الرش في شهر يونيو وبتكرر 8 مرات على النمو والتزهير وجودة الثمار لنباتات الزيتون الصنف عجيزى المزروعة تحت مياه الصرف المعالج. أشارت النتائج إلى أن الشيتوزان بتركيز 4 مل/لتر أدى إلى زيادة معنوية في مؤشرات النمو، الوزن الطازج للأوراق/فرع جم، الوزن الجاف للأوراق/فرع ومساحة الاوراق الكلية/فرع سم2. خصائص التزهير، أي تاريخ الإزهار الكامل، وكثافة التزهير، والعدد الإجمالي للازهار/نوره. بالإضافة إلى ذلك، إنتاجية الثمار/شجرة، إنتاجية الثمار/فدان (طن)، وزن الثمرة جم، عرض الثمرة (سم)، طول الثمرة، وزن البذرة، وزن اللحم، نسبة اللحم / وزن الثمرة. كما أدت المعاملات الى زيادة الخصائص الكيميائية للثمار مثل النسبه المئويه لرطوبة الثمار ، محتوى زيت الثمار،كما قللت من معامل الانكسار، قيمة البيروكسيد وقيمة الحمض % مع الرش بالشيتوزان عند 4 مل /لتر خلال كلا موسمي النمو. يعد استخدام الشيتوزان أفضل وسيلة لزيادة نمو الزيتون الصنف عجيزى وإنتاجيته تحت الري بمياه بالصرف المعالج.