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Effect of Cultivated Distances and Some Stimulative Substances on the Growth, Flowering and Total Yield of Olive Trees cv. Toffahi in Saline Soil

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Abstract: This study carried out in two seasons 2021 and 2022 to study the effect of two types of cultivated distances (5×6 m and 3×5 m) and some chemical substances (Proline at 150 ppm, Fulvic acid at 50 ppm, Glutamic acid at 500 ppm, Nano- chitosan at 50 ppm and potassium Silicate at 1000 ppm) and their interactions on the growth, flowering and total yield of 21 years old of Toffahi olive trees grown in saline sandy soil and irrigated with a drip system in a private orchard located at Fayed city, Ismailia, Egypt. The results showed that spraying trees with nano-chitosan or proline recorded the highest productivity in both seasons. As for to the cultivated distance effect, it obviously superiority of normal plant density at 5 × 6 m which had a higher superiority of vegetative growth, leaf photosynthetic pigments, leaf mineral content, total carbohydrate and floral parameters compared to trees planted intensively at 3×5 m. The trees sprayed with potassium silicate gave highest number sprout growth/ branch, while olive trees sprayed glutamic or nano-chitosan recorded largest leaf area. Spraying nano-chitosan or porolin gained heaviest leaf fresh weight. Foliar spraying of porolin gave highest N%, while nano-chitosan and potassium silicate treatment gave highest K % and P% in the two seasons. The interaction between normal plant density at 5 × 6 m with glutamic recorded highest number of inflorescences / branch and sex ratio, also the interaction between normal plant density with potassium silicate gave highest number of flowers/ inflorescence, while the highest number of perfect flowers/inflorescence or number of set fruitlets / inflorescence were for the interaction between normal distant at 5 × 6 m with potassium silicate or with porolin. The trees were sprayed with porolin gave highest significantly fruit set percentage and also interaction it with plant destance at 5 × 6 m.

Key words: Olive, plant distance, stimulative substances, soil salinity.

1. Introduction

Olive (*Olea europaea* L.) has spread in the Mediterranean basin, which is still the major region of olive production. It considered one of the crops tolerant to different environmental conditions such as heat and drought, so its cultivation is widespread in most of the desert areas in Egypt.

The success of different agricultural systems in olive orchard depends on good management of irrigation and fertilization processes to control the strength of tree growth and productivity, in addition to choosing the appropriate cultivar for the planting distance used **(Rallo *et al.*, 2013 and Diez *et al.*, 2016)**. In spite of the fact that intensive cultivation of olives began decades ago, the research that dealt with the intensification of olive varieties used for table purposes is very rare.

Increasing of salt stress is one of the major problems in large areas of cultivated land in Egypt. The growth rates and productivity of plants in general and olive trees in particular are affected by high levels of salinity **(Abd El-Hady *et al*., 2003; Chartzoulakis, 2005 and Regni *et al.*, 2019).**

Stimulative substances are natural or synthetic substances applied to plants to enhance nutritional efficiency, abiotic stress tolerance and crop quality (**Carolina and Helena, 2020).** Moreover, the exogenous application of amino acids has been reported to modulate the growth, yield and fruit quality of pears and grapevine **(Ahmed and Abd El-Hameed, 2003 and Khan *et al*., 2012).**

Fulvic acid (FA) application has been documented to significantly enhance plant growth and nutrient uptake by improving nutrient availability, alleviating plant stress, activating enzymes, and regulating hormonal balance **(Pettit, 2004).**

Glutamic acid is an α-amino acid with formula C5H9 O4N. Its molecular structure could be idealized as HOOC-CH (NH2) 2 -(CH with two carboxyl groups-CooH and one amino group –NH2. Different Researches were done to evaluate the effect of glutamic acid in plant growth, yield and chemical constituents by **Liepman and Olsen, (2004); Forde and Lee, (2007).**

Chitosan is a polysaccharide containing randomly distributed beta 1-4 linked deacetylated unit and acetylated unit **(Rinaudo, 2006)**. Foliar application of chitosan decreased transpiration and increased water use efficiency, growth parameters and yield of many crops **(Chibu *et al*., 2003; Ahmed *et al.*, 2016; Sajid *et al*., 2020 and Khalil and Badr eldin, 2021).** The application of chitosan raises the enzymatic activity in the nitrogen metabolism and enhances the transportation of nitrogen in the functional leaves which increases plant growth and productivity **(Mondal *et al.*, 2013).**

Silicon is one of the abundant elements in the soil next to oxygen, comprises 27.2 % of soil weight and 3-17% in its solution **(Greenwood and Earnshaw, 1997 and Sommer *et al*., 2006).** Moreover, it plays an important role in increasing plant growth and enhancing withstanding of fruit crops to biotic and abiotic stresses, nutrient uptake, plant pigments, preserving plant water balance, sustaining photosynthetic activity, and maintaining erectness of plant leaves under high transpiration rates **(Mir *et al.*, 2022 and Xu *et al*., 2023).**

The objective of this work aims to study the effect cultivated distances and some stimulative substances via amino acid (Proline, Fulvic and Glutamic acids), Nano-chitozan and potassium silicate on growth, flowering and total yield of olive cv. Toffahi in saline soil.

2. Materials and Methods

This experiment was carried out during two successive seasons of 2021 and 2022 on thirty-six mature trees of Toffahi olive cultivar. The trees were 21 years old grown in a private orchard at Sarabium, Ismailia Governorate. Olive trees were cultivated at 5 x 6 and 3 x 5 m in sandy soil under drip irrigation. The selected trees received the normal horticulture practices. The experiment designed in a split plot design, consisted of 6 treatments. Every treatment contained 6 trees as replicates.

The physical and chemical properties of the experimental soil were tabulated according to **(Black *et al.*, 1975; Chapman and Pratt, 1975; Page *et al.*, 1982)** in Tables (1). The water analyses of main source supply (subterranean well) are given in Table 2.

Table (1). Mechanical and chemical properties of experimental farm soil (average of two seasons) before treatment

Mechanical analysis					
Depth cm	**Sand%**	**Clay%**	**Silt%**	**organic matter (%)**	
0-30 cm	95.60	1.60	2.80	0.23	
Chemical analysis					
Depth cm	**pH**	**Ece dS m-1**	**available N (Mg kg-1soil)**	**available P (Mg kg-1soil)**	**available K (Mg kg-1soil)**
0-30 cm	8.02	3.51	20.7	12.2	90.5

Table (2). The chemical analysis of the used irrigation water

Characters	EC dSm^{-1}	pH	Cations (meq/l)				Anions (meq/l)				SAR
			Ca^{2+}	Mg^{2+}	Na^{2+}	K^{2+}	CO_3^-	HCO_3^-	Cl^-	SO_4^{2-}	
Value	10.50	7.91	10.4	14.2	75.1	5.3	0.00	37.9	32.7	34.4	21.41

The selected trees received the following:

1) Control (water spray).
2) Foliar spray with proline at 150 ppm.
3) Foliar spray with fulvic acid at 50 ppm.
4) Foliar spray with glutamic acid at 500 ppm.
5) Foliar spray with nano- chitosan 50 ppm.
6) Foliar spray with potassium silicate at 1000 ppm.

The treatments were sprayed at full bloom and after 4 weeks. All chemicals sold from El-Gomhouria Company for chemicals.

The responses of the tested olive trees to treatments were evaluated through the following parameters:

2.1. Vegetative growth measurements

- Four non-fruiting branches were taken from the previous year's growth from each replicate, taken from four different directions of the tree in mid-August of each season, and calculated the average of each branch diameter (mm), branch length (cm), number of sprout growth/branch, and number of leaves/branch.

- Leaf area (cm^2): The average area of 20 leaves from each replicate was calculated from the previous year's growth from the middle of the semi-woody branches **(Ahmed and Morsy, 1999)** according to the equation:

$$\text{Leaf area} = 0.53\ (\text{length} \times \text{width}) + 1.66$$

- Leaf fresh weight and leaf dray weight: From each replicate 50 leaves were taken randomly from the middle of the semi-woody branches of the previous year's growth, and their fresh weight was measured. The leaves were left to dry naturally at laboratory temperature and their dry weight was measured.

2.2. Leaf chemical determinations: Leaf samples were collected from half shoots.

a- Leaf minerals contents

Dried samples (0.5 g) were digested using the H_2SO_4 and H_2O_2 to determine N, P, K, Zn, Mn and Fe contents according to the method described by **Cottenie et al. (1982).**

Nitrogen content was determined in the digested solution by the modified micro-kjeldahl method (Microkeldahelvelp scientific A UDK 129, Germany) as described by **Plummer (1971).**

K content was determined against a standard using flame-photometer (JEN way flame photometer) **(Piper, 1950).**

Phosphorus content (g/100g dry weight) was determined colorimetrically according to the method of Jackson (1958).

Micronutrients [Iron (Fe), Manganese (Mn), Zinc (Zn)] were determined by using Atomic Absorption Spectrophotometer, Pyeunican SP1900, according to **Brandifeld and Spincer (1965).**

b- Leaf photosynthetic pigments (mg/100 g F.W.)

The contents of chlorophyll and carotenoids were determined spectrophotometrically according to **Mitic *et al*. (2013)**. Absorbance of prepared mixtures was recorded at 662 nm (chl. a), 644 nm (chl. b) and 440 nm (carotene) using acetone as blank and pigment content was calculated using the formula of **Wetsttein (1957):**

$$\text{Chlorophyll a} = 9.784 \times E662 - 0.990 \times E644$$

$$\text{Chlorophyll b} = 21.426 \times E644 - 4.650 \times E662$$

$$\text{Carotenoids} = 4.695 \times E440 - 0.268 \times (a + b)$$

E = Optical density at a given wave length.

c- Total carbohydrates (%): Total carbohydrates (%) were estimated in leaves according to the method described by Association of Official Agricultural Chemists **(A.O.A.C., 2012).**

2.3. Floral aspects: Floral measurements were counted at Full bloom (med April).

- Four fruiting branches were taken from the previous year's growth at four different directions of the tree from each replicate and calculated the average number of inflorescences / branch.

- Four inflorescences were taken from each four fruiting branches per replicate and calculated the average number of flowers /inflorescence and also calculated the average number of perfect flowers/inflorescence.

- After fruit set, four inflorescences were taken from each four fruiting branches per replicate and calculated the average number of set fruitlets per inflorescence.

- Sex ratio % (sex expression): Sex ratio was calculated as percentage of perfect flowers to total tree flowers according to the following equation used by **Fouad *et al.* (1992):**

$$\text{Sex ratio \%} = \frac{\text{Number of perfect flower} \times 100}{\text{Total number of flowers}}$$

- Fruit set percentage: Fruit set was recorded after 75% of petal fall. Date tabulated as fruit set percentage of perfect flowers according to the following equation used by **Fouad et al. (1992):**

$$\text{Fruit set \%} = \frac{\text{Number of set fruitlets} \times 100}{\text{Number of perfect flowers at full bloom}}$$

2.4. Total yield: fruits of each tree were separately harvested at maturity stage (mid-September) and weighed yield as kg / tree and calculated per feddan.

2.5. Statistical analysis

All collected data will be analyzed with analysis of variance (ANOVA) procedure using the Co Stat Statistical Software. Differences between means were compared by using **Duncan (1958).**

3. Results and Discussion

3.1 .Vegetative growth measurements

Branch length (cm) and diameter (mm)

Data in Table (3) showed that the normal density at 5 x 6 m had a highest the branch length (37.12 and 40.26 cm) and diameter (2.86 and 3.21mm) than intensive planting at 3 x 5 m in the two seasons, respectively.

With respect to the effect of stimulative substance, porolin spraying treatment significantly increased branch length (35.55 and 39.25 cm) in the first and second seasons, respectively, compared with other treatments. While, the highest branch diameter was from foliar spraying of glutamic (2.74 mm) without differences with porolin (2.59 mm), Fulvic acid (2.65 mm) and potassium silicate (2.65 mm) in the first season, while in the second season the highest values of branch diameter were from foliar spraying of potassium silicate (3.21mm) and nano-chitosan (3.16 mm) without differences between them. The control treatment recorded the lowest values of branch length and diameter during two studied seasons.

Dealing with the interaction effect between plant density and stimulative substance, it was noticed that the interaction between normal plant distant and porolin recorded significantly the highest values of branch length (42.88 and 45.33 cm) in the first and second seasons, respectively. The interaction of control treatment with two-system cultivation normal and intensive recorded the lowest values of branch length (32.94 &34.44 and 26.05 & 29.99 cm) during two studied seasons, respectively. The tabulated data stated that interaction between normal plant distant and all treatments had nonsignificant values compared with control in the first season, while in the second season the highest values were from interaction between normal plant distant and treatments of potassium silicate (3.54 mm) and nano-chitosan (3.41mm) without differences between them.

Number of leaves/ branch

System of normal planting at 5 x 6 m recorded uppermost number of leaves/ branch (64.54 and 74.17) than intensive planting at 3 x 5 m in the two seasons, respectively (Table, 4).

With regard to the effects of simulative substances on number of leaves/branch, it was noticed that the uppermost number of leaves/ branch were obtained using fulvic acid, glutamic, nano-chitosan and potassium silicate without significant differences between them in the first season, while in the second season the highest number of leaves/ branch were obtained using potassium silicate. The least number of leaves/branch were from the control .

The interaction between the two factors of study indicated that, the highest values of leaves number/ branch were from interaction between normal plant distant and treatments of potassium silicate (75.33 and 88.10) in the two seasons, respectively. The least value of interaction between the two factors was from intensive distant with control (43.61 and 48.44) in the both seasons, respectively .

Table (3). Effect of cultivated distances and some stimulative substances on branch length and diameter of olive trees in saline soil (2021 and 2022 seasons)

Stimulative substances \ Cultivated distances	Branch length (cm)		mean	Branch diameter (mm)		mean
	5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m	
	First season 2021					
Control(water spray)	32.94 d	26.05 f	29.50 D	2.58bc	2.14 e	2.36 C
Porolin at 150 ppm	42.88 a	28.22 e	35.55 A	2.88 a	2.31de	2.59AB
Fulvic acid at 50 ppm	38.22 b	28.38 e	33.30 B	2.96 a	2.33 de	2.65AB
Glutamic at 500 ppm	37.11 bc	28.00 e	32.55BC	2.94 a	2.54 cd	2.74 A
Nano-chitosan at 50 ppm	36.16 c	28.22e	32.19BC	2.81ab	2.26 e	2.54 B
Potassium silicate at 1000 ppm	35.44 c	27.22 ef	31.33 C	2.97 a	2.34 de	2.65AB
Mean	37.12 A	27.68 B		2.86 A	2.32 B	
	Second season 2022					
Control(water spray)	34.44 c	29.99 e	32.22 D	2.83 e	2.46 f	2.65 E
Porolin at 150 ppm	45.33 a	33.16 cd	39.25A	3.24 bc	2.77 e	3.01CD
Fulvic acid at 50 ppm	40.22 b	31.99 d	36.11 C	3.02 d	2.75 e	2.89 D
Glutamic at 500 ppm	40.83 b	33.69 c	37.26 B	3.23 c	2.91 de	3.07 BC
Nano-chitosan at 50 ppm	39.89 b	32.72 cd	36.30BC	3.41 ab	2.91 de	3.16AB
Potassium silicate at 1000 ppm	40.88 b	32.83 cd	36.86BC	3.54 a	2.89 de	3.21 A
Mean	40.26 A	32.40 B		3.21 A	2.78 B	

Means with the same letters are not significantly different at $P < 0.05$.

No. sprout growth/ branch

The olive trees planted at normal density (5 x 6 m) achieved higher number sprout growth/ branch (7.42 and 8.93) than at intensive planting 3 x 5 m (5.23 and 6.25) in both seasons, respectively (Table, 4).

The trees sprayed with potassium silicate gave highest number sprout growth/ branch (7.53 and 9.30) in the two seasons, respectively, as well as, the trees sprayed with nano-chitosan in the first season only. The other foliar spraying treatments recorded intermediate values of sprout growth/ branch .

In terms of the effect of interaction, the results showed the interaction between the two factors of nano-chitosan or potassium silicate with normal plant distant recorded highest number sprout growth/ branch (8.467 &10.50 and 9.40 & 11.00) without significant differences between them in the first and second seasons, respectively. The lowermost values of interaction were for intensive distant with control (4.20 and 4.43) in the both seasons, respectively.

Table (4). Effect of cultivated distances and some stimulative substances on number leaves/ branch and number sprout growth / branch of olive trees in saline soil (2021 and 2022 seasons)

Cultivated distances / Stimulative substances	No. leaves/ branch		mean	No. sprout growth / branch		mean
	5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m	
	First season 2021					
Control(water spray)	54.00 cd	43.61 e	48.80 C	5.40 fg	4.20 h	4.80 D
Porolin at 150 ppm	56.77 c	52.88cd	54.83 B	7.60 bc	5.73 ef	6.67 B
Fulvic acid at 50 ppm	68.66 b	54.38cd	61.52 A	6.43 de	4.67 gh	5.55 C
Glutamic at 500 ppm	66.88 b	53.72cd	60.30 A	7.20 cd	5.63 efg	6.42 B
Nano-chitosan at 50 ppm	65.61 b	51.27cd	58.44 AB	8.467 ab	5.47 efg	6.97 AB
Potassium silicate at 1000 ppm	75.33 a	48.94 de	62.14 A	9.40 a	5.67 ef	7.53 A
Mean	64.54 A	50.80 B		7.42 A	5.23 B	
	Second season 2022					
Control(water spray)	61.16 e	48.44 f	54.80 E	6.63 e	4.43 g	5.53 E
Porolin at 150 ppm	68.63 d	60.72 e	64.68 D	9.20 b	6.83 de	8.02 C
Fulvic acid at 50 ppm	72.16 c	58.74 e	65.45CD	7.43 cd	5.33 f	6.38 D
Glutamic at 500 ppm	74.13 c	60.36 e	67.24 C	8.83 b	6.43 e	7.63 C
Nano-chitosan at 50 ppm	80.85 b	61.60 e	71.23 B	10.50 a	6.87 cde	8.68 B
Potassium silicate at 1000 ppm	88.10 a	61.44 e	74.77 A	11.00 a	7.60 c	9.30 A
Mean	74.17 A	58.55 B		8.93 A	6.25 B	

Means with the same letters are not significantly different at $P < 0.05$.

Leaf area (cm^2)

It is observed from Table (5) the trees planted at normal density 5 x 6 m recorded highest leaf area (5.47 and 6.43 cm^2) in both seasons, respectively.

In regard to the stimulative substance, the treatments of spraying glutamic or nano-chitosan recorded largest leaf area (5.40 & 6.26 and 5.30 & 6.40 cm^2) without significant differences between in the first and second seasons, respectively, as well as, the treatment of spraying porolin (5.53 cm^2) in the first season only. The least values of leaf area were for control treatment (4.37 and 4.85 cm2) in the both seasons, respectively. The other tested treatments recorded intermediate values of leaf area (cm^2).

Concerning to the interaction between planting density and stimulative substances, the tabulated data stated that glutamic or nano-chitosan under normal plant density achieved the highest leaf area (5.82 & 6.88 and 5.58 &6.95cm^2) in the first and second seasons, respectively, as well as, the interaction of porolin under normal plant density (5.94 cm^2) in the first season only. The interaction of control under intensive distant gave smallest leaf area (3.99 and 4.51 cm^2) in the both seasons. The other interactions recorded intermediate values of leaf area (cm^2) .

Leaf fresh and dry weights (g)

The trees planted at normal density at 5 x 6 m recorded higher leaf fresh (20.51and18.91 g) and dry (9.97 and 8.67 g) weights than at intensive density at 3 x 5 m in both seasons (Table, 5).

With respect to the effect of stimulative substance, the tested treatments of spraying nano-chitosan gained heaviest leaf fresh weight (20.43 &18.83) and leaf dry weight (10.10 and 8.82 g) in the first and second seasons, respectively without differences with porolin in leaf fresh weight during first season. The lightest leaf fresh and dry weights were for control treatment (17.75 and 16.15 g) in the two seasons, respectively. The other tested substances recorded intermediate values of leaf fresh and dry weights.

The interaction between normal plant distant (5 x 6 m) with nano-chitosan gained heaviest leaf fresh and dry weights (21.70 & 20.10 and 10.97 & 9.67 g) and also normal density at 5 x 6 m with porolin for leaf fresh weight (21.60 and 20.00g) in the two seasons, respectively. The lightest leaf fresh (16.53 & 14.93 and 17.10 &15.50 g) and dry (6.23 & 4.93 and 6.90 & 5.60 g) weights were for interaction of control or fulvic acid under intensive distant at 3 x 5 m in the both seasons, respectively. The other interactions between plant density and stimulative substance gave intermediate values of leaf fresh and weights in the two seasons.

Table (5). Effect of cultivated distances and some stimulative substances on leaf area, leaf fresh and leaf dry weights of olive trees in saline soil (2021 and 2022 seasons)

Cultivated distances / Stimulative substances	leaf area (cm2)		mean	Leaf fresh weight (g)		mean	Leaf dry weight (g)		mean
	5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m	
	First season 2021								
Control (water spray)	4.75 d	3.99 e	4.37 D	18.97cd	16.53 f	17.75 E	9.30 c	6.23 h	7.77 D
Porolin at 150 ppm	5.94 a	5.11cd	5.53 A	21.60 a	18.80 d	20.20AB	10.40 b	7.80 f	9.10 C
Fulvic acid at 50 ppm	5.55abc	4.79 d	5.17BC	19.60 c	17.10 f	18.35 D	8.67 d	6.90 g	7.78 D
Glutamic at 500 ppm	5.82 a	4.98 d	5.40AB	20.67 b	18.10 e	19.38 C	10.37 b	8.23 e	9.30BC
Nano-chitosan at 50 ppm	5.58 ab	5.02 d	5.30ABC	21.70 a	19.17cd	20.43 A	10.97 a	9.23 c	10.10A
Potassium silicate at 1000 ppm	5.17bcd	4.82 d	5.00 C	20.53 b	18.93 d	19.73BC	10.10 b	8.60 d	9.35 B
Mean	5.47 A	4.79 B		20.51A	18.11 B		9.97 A	7.83 B	
	First season 2022								
Control (water spray)	5.18 f	4.51 g	4.85 D	17.37 cd	14.93 f	16.15 E	8.00 d	4.93 i	6.47 D
Porolin at 150 ppm	6.70 b	5.61 e	6.16 B	20.00 a	17.20 d	18.60AB	9.10 b	6.50 g	7.80 C
Fulvic acid at 50 ppm	6.12 c	5.16 f	5.64 C	18.00 c	15.50 f	16.75 D	7.37 e	5.60 h	6.48 D
Glutamic at 500 ppm	6.88 ab	5.63de	6.26AB	19.07 b	16.50 e	17.78 C	9.07 bc	6.93 f	8.00BC
Nano-chitosan at 50 ppm	6.95 a	5.84 d	6.40 A	20.10 a	17.57cd	18.83 A	9.67 a	7.97 d	8.82 A
Potassium silicate at 1000 ppm	6.72 b	5.76de	6.24 B	18.93 b	17.33 d	18.13BC	8.80 c	7.30 e	8.05 B
Mean	6.43 A	5.42 B		18.91 A	16.51 B		8.67 A	6.54 B	

Means with the same letters are not significantly different at $P < 0.05$.

3.2. Leaf chemical constituents

a. Leaf photosynthetic pigments

As shown in Table (6) the effect plant density and simulative substances and their interaction on leaf photosynthetic pigments (i.e. chlorophyll a, b and carotene carotenoids) of olive trees was significantly affected in both seasons .

The system of normal density recorded highest leaf chlorophyll a (0.64 and 0.72 mg/g FW), chlorophyll b (0.56 and 0.54 mg/g FW) and carotenoids contents (0.48 and 0.48 mg/g FW) compared with intensive distant in the two seasons, respectively.

The treatments foliar spraying of potassium silicate increased chlorophyll a (0.62 mg/g FW), chlorophyll b (0.55 mg/g FW) and carotenoids contents (0.48 mg/g FW) in the first season only, while in the second season the treatments foliar spraying of potassium silicate increased chlorophyll b (0.53 mg/g FW) and carotenoids contents (0.46 mg/g FW) except highest value of chlorophyll a (0.71 mg/g FW) which was recorded from spraying nano-chitosan compared with control. The least values of chlorophyll a (0.54 and 0.57 mg/g FW) and carotenoids content (0.40 and 0.39 mg/g FW) were from control treatment in the two seasons, respectively. The lowest value of chlorophyll b was from control treatment (0.40 mg/g FW) in the first season, while in the second season the lowest value of chlorophyll b was from Glutamic (0.39 mg/g FW). The other treatments foliar spraying recorded medium values of chlorophyll a, b and carotenoids content in both seasons.

The interaction between normal plant distant and potassium silicate had uppermost values of chlorophyll b (0.66 mg/g FW) and carotenoids (0.52 mg/g FW) in the first season, while in the second season the interaction between normal plant distant and porolin had highest chlorophyll b (0.58 mg/g FW) and carotenoids (0.50 mg/g FW), and also the same interaction gained highest carotenoids content (0.51 mg/g FW) in the first season only. In regards to chlorophyll a, the highest values of it were from interaction between normal plant distant and fulvic acid (0.68 mg/g FW) in the first season, while in the second season were for the interaction between normal plant distant and nano-chitosan (0.77 mg/g FW). The least value of chlorophyll a was for interaction between intensive distant and fulvic acid in the first season, while in the second season were for the interaction between intensive distant and control. The interaction between intensive distant and glutamic gave lowest chlorophyll b (0.35 and 0.33 mg/g FW) in the two seasons, respectively. The lowermost carotenoids content was from the interaction between intensive distant and control (0.28 mg/g FW) in the first season, while in the second season were for the interaction between intensive distant and glutamic (0.35 mg/g FW). The other interactions between plant density and stimulative substance gave intermediate values of chlorophyll a, b and carotenoids content in the two seasons.

Table (6). Effect of cultivated distances and some stimulative substances on leaf photosynthetic pigments of olive trees in saline soil (2021 and 2022 seasons)

Cultivated distances / Stimulative substances	Chorophyll a (mg/g)			Chorophyll b (mg/g)			Carotenoids (mg/g)		
	5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m	
	First season 2021								
Control (water spray)	0.66 b	0.43 l	0.54 F	0.56 c	0.23 l	0.40 F	0.51 b	0.28 k	0.40 F
Porolin at 150 ppm	0.64 d	0.58 h	0.61 C	0.64 b	0.36 j	0.50 B	0.51 a	0.41 i	0.46 B
Fulvic acid at 50 ppm	0.68 a	0.55 k	0.61 B	0.53 e	0.41 h	0.47 C	0.47 c	0.42 g	0.45 C
Glutamic at 500 ppm	0.59 f	0.56 j	0.58 E	0.45 f	0.35 k	0.40 E	0.44 f	0.38 j	0.41 E
Nano-chitosan at 50 ppm	0.61 e	0.58 i	0.59 D	0.54 d	0.40 i	0.47 D	0.45 d	0.41 h	0.43 D

Potassium silicate at 1000 ppm	0.64 c	0.59 g	0.62 A	0.66 a	0.45 g	0.55 A	0.52 a	0.44 e	0.48 A
Mean	0.64 A	0.54 B		0.56 A	0.37 B		0.48 A	0.39 B	
	Second season 2022								
Control(water spray)	0.65 f	0.48 k	0.57 F	0.56 b	0.27 l	0.42 E	0.465 e	0.318 l	0.392 F
Porolin at 150 ppm	0.72 c	0.61 i	0.67 C	0.58 a	0.34 j	0.46 D	0.498 a	0.362 j	0.430 D
Fulvic acid at 50 ppm	0.70 d	0.63 h	0.67 D	0.56 c	0.38 i	0.47 C	0.481 c	0.385 i	0.433 C
Glutamic at 500 ppm	0.73 b	0.56 j	0.65 E	0.45 g	0.33 k	0.39 F	0.450 f	0.350 k	0.400 E
Nano-chitosan at 50 ppm	0.77 a	0.64 g	0.71 A	0.52 e	0.44 h	0.48 B	0.484 b	0.412 h	0.448 B
Potassium silicate at 1000 ppm	0.73 b	0.67 e	0.69 B	0.54 d	0.51 f	0.53 A	0.478 d	0.431 g	0.455 A
Mean	0.72 A	0.60 B		0.54 A	0.38 B		0.48 A	0.38 B	

Means with the same letters are not significantly different at P <0.05.

b. The leaf mineral content

Nitrogen percentage (N%

It quite evidence from Table (7) that the effect plant density and simulative substances and their interaction on leaf nitrogen percentage (N%) was significantly affected in both seasons.

The highest leaf N% was for normal plant density (1.98 and1.91%) in the first and second seasons, respectively .

Tabulated data demonstrate that, foliar spraying of porolin gave highest N% (2.21 and 2.23%) in the first and second season, respectively. The lowest percentage of nitrogen was for the control treatment (1.72 and 1.52%) in the two seasons, respectively. The other treatments of foliar spraying recorded medium values of leaf N % .

The interaction of intensive distant and porolin recorded uppermost percentage of nitrogen (2.32 %) in the first season, while in the second season the highest percentage of nitrogen for interaction between normal plant distant and porolin (2.42 %). The least percentage of nitrogen was for interaction between normal plant distant and control (1.53 %) in the first season, while in the second season the lowest percentage of nitrogen was for interaction between intensive distant and control (1.44%). The other interactions between plant density and stimulative substance gave intermediate values of leaf N .%

Phosphorus percentage (P%)

Table (7) illustrated that the effect plant density and simulative substances and their interaction on leaf phosphorus percentage (P%) was significantly affected in the two seasons.

The system of intensive plant density gained uppermost leaf phosphorus percentage (0.35 %) in the first season, while in the second season the system of normal density recorded highest P .(%۰،۳۸)

Foliar spraying of potassium silicate achieved highest P% (0.41 and 0.49 %) in the first and second season, respectively. The lowest P% (0.26 and 0.32%) was form control treatment in the first and second season, respectively. The other simulative substances foliar spraying recorded in between values of leaf P .%

Interaction between intensive distant and potassium silicate gained uppermost leaf P % (0.53 %) in the first season, while in the second season uppermost value was from interaction between normal plant distant and potassium silicate (0.50%). The lowermost P % was for interaction between intensive distant and control (0.22%) or normal plant distant and Glutamic (0.22%) in the first season, while in the second season the lowermost P% was for interaction between intensive distant and control (0.27%). The other interactions between plant density and stimulative substance gave intermediate values of P%.

Potassium percentage (K%)

It is observed from Table (7) the effect plant density and simulative substances and their interaction on leaf potassium percentage (K%) was significantly affected in both seasons.

The normal distant recorded higher K% (1.56 and 1.00 %) than intensive distant (1.23 and 0.97 %) in the first and second seasons, respectively.

The nano-chitosan treatment gave highest K % (1.46 and1.14%) in the two seasons, respectively, as well as potassium silicate (1.46 %) without significant differences with nano-chitosan treatment in the first season only. The lowermost potassium percentage of leaf was for control (1.31% and 0.82 %) in the first and second season, respectively. The other treatments recorded in between percentages of K % .

The interaction between intensive distant and potassium silicate achieved uppermost leaf K% (1.90%) in the first season, while in the second season uppermost value was from interaction between normal plant distant and nano-chitosan (1.44%). The lowest potassium percentage (1.01%) was from interaction between intensive distant and silicate potassium in the first season, while in the second season lowest value was from interaction between normal plant distant and control (0.71 %). The other interactions between plant density and stimulative substance gave mediate values of K. %.

Table (7). Effect of cultivated distances and some stimulative substances on leaf macro nutrients content (N, K, P%) of olive trees in saline soil (2021 and 2022 seasons)

Cultivated distances / Stimulative substances	N (%)		mean	P (%)		mean	K (%)		
	5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m	
	First season 2021								
Control(water spray)	1.53 l	1.91 h	1.72 F	0.29 e	0.22 i	0.26 F	1.37 e	1.25 h	1.31 D
Porolin at 150 ppm	2.10 d	2.32 a	2.21 A	0.32 d	0.29 e	0.31 C	1.46 d	1.30 f	1.38 B
Fulvic acid at 50 ppm	1.66 k	1.84 i	1.75 E	0.24 h	0.29 e	0.27 E	1.45 d	1.28 g	1.37 C
Glutamic at 500 ppm	2.06 e	1.94 f	2.00 D	0.22 i	0.35 c	0.29 D	1.48 c	1.28 fg	1.38 B
Nano-chitosan at 50 ppm	2.25 c	1.92 g	2.08 B	0.27 g	0.41 b	0.34 B	1.70 b	1.22 i	1.46 A
Potassium silicate at 1000 ppm	2.28 b	1.76 j	2.02 C	0.28 f	0.53 a	0.41 A	1.90 a	1.01 j	1.46 A
Mean	1.98 A	1.95 B		0.27 B	0.35 A		1.56A	1.23 B	
	Second season 2022								
Control(water spray)	1.60 k	1.44 l	1.52 F	0.37 f	0.27 k	0.32 E	0.71 i	0.93 e	0.82 F
Porolin at 150 ppm	2.42 a	2.05 c	2.23 A	0.30 j	0.43 c	0.37 C	0.84 g	1.18 d	1.01 C
Fulvic acid at 50 ppm	1.60 j	1.93 f	1.77 E	0.34 h	0.31 i	0.33 D	0.89 f	0.90 f	0.90 E
Glutamic at 500 ppm	1.87 g	1.94 e	1.91D	0.35 g	0.30 j	0.33 D	0.80 h	1.20 c	1.00 D
Nano-chitosan at 50 ppm	1.78 i	2.19 b	1.98 B	0.39 e	0.41 d	0.40 B	1.44 a	0.84 g	1.14 A
Potassium silicate at 1000 ppm	1.87 h	1.98 d	1.92 C	0.50 a	0.48 b	0.49 A	1.33 b	0.79 h	1.06 B
Mean	1.91 A	1.87 B		0.38 A	0.37 B		1.00A	0.97 B	

Means with the same letters are not significantly different at P <0.05.

Leaf micro nutrients content (Fe, Mn and Zn ppm)

Data concerning the effect of some stimulative substances and planting density on leaf Fe, Mn and Zn ppm of olive trees are presented in (Table,8).

Regarding the plant distance effect, results showed that the highest significant leaf micro nutrients content [(Fe 60.89 & 59.15 ppm), (Mn 4.90 &4.19 ppm) and (Zn 15.17 &16.25 ppm)] was for normal plant density in the both seasons, respectively.

Foliar spraying of nano-chitosan or potassium silicate gave uppermost values of Fe (71.61 & 68.93 and 72.96 & 70.43 ppm) in the two seasons, respectively without differences between them. The treatment of nano-chitosan achieved highest Mn (6.10 and 6.32 ppm) in the first and second seasons, respectively. The greatest value of Zn was for spraying with porolin (16.78 and 17.58 ppm) in the both seasons, respectively. The control treatment had the least values of Fe (42.28 & 40.35 ppm), Mn (3.55 & 3.04 ppm) and Zn (10.86 &11.49 ppm) in the first and second seasons, respectively. The other simulative substances foliar spraying gave in between values of leaf Fe, Mn and Zn ppm.

Table (8). Effect of cultivated distances and some stimulative substances on leaf micro nutrients content (Fe, Mn, Zn ppm) of olive trees in saline soil (2021 and 2022 seasons)

cultivated distances / stimulative substances	Fe (ppm)		mean	Mn (ppm)		mean	Zn (ppm)		mean
	5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m	
	First season 2021								
Control(water spray)	42.75 h	41.81h	42.28 E	3.89 h	3.69 k	3.55 F	9.88 l	11.83 j	10.86 F
Porolin at 150 ppm	51.98ef	83.92ab	67.95 B	4.04 f	5.44 d	4.74 C	18.79a	14.77e	16.78 A
Fulvic acid at 50 ppm	54.01ef	44.38gh	49.19 D	3.80 j	3.29 l	3.79 E	13.93h	13.31i	13.62 E
Glutamic at 500 ppm	65.88 c	50.24fg	58.06 C	4.78 e	3.95 g	4.37 D	16.91 c	11.18k	14.04 D
Nano-chitosan at 50 ppm	62.14cd	81.07 b	71.61AB	6.05 c	6.16 b	6.10 A	14.65 f	17.43b	16.04 B
Potassium silicate at 1000 ppm	88.58 a	57.34de	72.96 A	6.82 a	3.86 i	5.34 B	16.84d	14.26 g	15.55 C
Mean	60.89 A	59.79 B		4.90 A	4.40 B		13.80B	15.17A	
	Second season 2022								
Control(water spray)	35.00 d	54.68 c	44.84 C	2.59 k	3.50 f	3.04 F	10.65 l	12.32 k	11.49 F
Porolin at 150 ppm	65.68ab	54.46 c	60.07 B	4.31 d	2.93 i	3.62 C	19.86a	15.30 h	17.58 A
Fulvic acid at 50 ppm	37.35 d	43.35 d	40.35 C	3.43 h	2.73 j	3.08 E	14.73 i	15.45 f	15.09 E
Glutamic at 500 ppm	73.67 a	67.20ab	70.43 A	4.51 c	2.26 l	3.38 D	15.36 g	17.32 c	16.34 D
Nano-chitosan at 50 ppm	70.73ab	67.13ab	68.93 A	6.83 a	5.82 b	6.32 A	17.06 e	17.18 d	17.12 B
Potassium silicate at 1000 ppm	62.50bc	68.09ab	65.29AB	3.47 g	4.04 e	3.76 B	19.84 b	13.72 j	16.78 C
Mean	57.49 A	59.15 A		4.19 A	3.55 B		16.25 A	15.21 B	

Means with the same letters are not significantly different at P <0.05.

The interaction between normal or intensive distant and control gave lowest values of leaf Fe, Mn and Zn ppm in the both seasons, while the highest interaction was different between treatments with planting distance. The interaction between nano-chitosan or potassium silicate with normal plant density recorded highest values of Fe and Mn (ppm) in the both seasons, while highest value of Zn (ppm) was from interaction between normal distant with porolin in the two seasons.

c. Leaf total carbohydrate

It is clearly shown from the data in Table (9) that the effect plant density and simulative substances and their interaction on leaf total carbohydrate content was significantly affected in both seasons .

It is noticed from the obtained data that normal plant density recorded greatest values of leaf total carbohydrate (54.31 and 63.23 %) in the first and second seasons, respectively as compared with planting intensive.

Foliar spraying of potassium silicate gave highest value of leaf total carbohydrate content (59.24 and 57.96%) in both seasons, respectively, and also without significant differences with spraying of nano-chitosan in the second season only. The least total carbohydrate content was from the control treatment (42.85 and 50.13%) in the two seasons, respectively. The other stimulative substances gave values in between.

According to the interaction between planting density and stimulative substances, the interaction between normal planting density with stimulative substance porolin recorded highest leaf total carbohydrate content in the first season, but in the second season, the interaction between all stimulative substances except potassium silicate with normal planting density gained highest leaf total carbohydrate content. The lowest total carbohydrate content was from the interaction between intensive plant density and fulvic acid in both seasons.

Table (9). Effect of cultivated distances and some stimulative substances on leaf total carbohydrate of olive trees in saline soil (2021 and 2022 seasons)

cultivated distances / stimulative substances	Carbohydrate (%)		mean
	5 x 6 m	3 x 5 m	
	First season 2021		
Control(water spray)	42.12 k	43.59 h	42.85 F
Porolin at 150 ppm	60.08 a	42.13 j	51.11 C
Fulvic acid at 50 ppm	54.94 f	41.85 l	48.40 E
Glutamic at 500 ppm	54.57 g	42.70 i	48.63 D
Nano-chitosan at 50 ppm	55.07 e	56.11 d	55.59 B
Potassium silicate at 1000 ppm	59.08 c	59.40 b	59.24 A
Mean	54.31 A	47.63 B	
	Second season 2022		
Control(water spray)	56.61 c	43.66 de	50.13 D
Porolin at 150 ppm	65.45 ab	43.42 de	54.44 BC
Fulvic acid at 50 ppm	63.59 ab	41.69 e	52.64 C
Glutamic at 500 ppm	64.82 ab	43.49 de	54.16 BC
Nano-chitosan at 50 ppm	66.74 a	45.05 d	55.90 AB
Potassium silicate at 1000 ppm	62.20 b	53.72 c	57.96 A
Mean	63.23 A	45.17 B	

Means with the same letters are not significantly different at $P < 0.05$.

3.3. Floral aspect

Data in Tables (10 and 11) showed that, the effect plant density and simulative substances and their interaction on number of inflorescences / branch, number of flower/inflorescence, number of perfect flowers, No. set fruitlets / inflorescence, sex ratio and fruit set were significantly affected in both seasons .

Number of inflorescences/branch and number of flowers/ inflorescence

The trees cultivated in normal plant density at 5 x 6 m recorded highest number of inflorescences / branch (12.45 and 9.79) and number of flower/ inflorescence (21.74 and 20.59) in the first and second seasons, respectively, compared with intensive distant.

As for the effect of simulative substances, foliar spraying of glutamic recorded highest number of inflorescences / branch (13.00 and 10.43), while foliar spraying of potassium silicate gave highest number of flowers/ inflorescence (23.65 and 21.98) in the first and second seasons, respectively. The least number of inflorescences / branch (7.82 and 6.38) and number of flowers/ inflorescence (16.32 and 15.17) were for control treatment in the two seasons, respectively. The other substances gave values in between.

Table (10). Effect of cultivated distances and some stimulative substances on No. inflorescences/ branch, No. of flowers/ inflorescence and No. perfect flower/ inflorescence of olive trees in saline soil (2021 and 2022 seasons)

Cultivated distances / Stimulative substances	No. of inflorescences / branch		mean	No. of flowers/ inflorescence		mean	No. of perfect flower/ inflorescence		mean
	5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m	
	First season 2021								
Control (water spray)	9.10 de	6.53 f	7.82 D	16.63 i	16.00 i	16.32 E	15.10 f	14.17 g	14.63 E
Porolin at 150 ppm	13.90 b	8.40 de	11.15 B	22.70bc	19.63fg	21.17 C	20.27 c	17.60 e	18.93 C
Fulvic acid at 50 ppm	9.83 d	6.80 f	8.32 D	18.93 g	17.63 h	18.28 D	17.20 e	15.73 f	16.47 D
Glutamic at 500 ppm	16.40 a	9.60 d	13.00A	23.60 b	21.17de	22.38 B	21.63 b	19.27 d	20.45 B
Nano-chitosan at 50 ppm	13.37 b	8.77 de	11.07 B	23.20 b	20.37ef	21.78BC	21.43 b	18.63 d	20.03 B
Potassium silicate at 1000 ppm	12.10 c	7.83 e	9.97 C	25.37 a	21.93cd	23.65 A	23.43 a	20.40 c	21.92 A
Mean	12.45 A	7.99 B		21.74 A	19.46 B		19.84 A	17.63 B	
	Second season 2022								
Control(water spray)	6.93 h	5.83 i	6.38 D	16.10 f	14.23 g	15.17 E	14.50 e	13.10 f	13.80 F
Porolin at 150 ppm	10.63 b	8.33efg	9.48 B	21.07cd	18.17 e	19.62 C	18.90 c	16.90 d	17.90 D
Fulvic acid at 50 ppm	9.27cde	7.50 gh	8.38 C	18.20 e	15.60 f	16.90D	17.10 d	13.90 e	15.50 E
Glutamic at 500 ppm	11.93 a	8.93def	10.43 A	22.93ab	19.03 e	20.98 B	21.30 a	17.27 d	19.28 B
Nano-chitosan at 50 ppm	10.07 bc	8.40 efg	9.23 B	21.70 bc	18.00 e	19.85 C	20.27 b	16.63 d	18.45 C
Potassium silicate at 1000 ppm	9.93 bcd	7.90 fgh	8.92 BC	23.53 a	20.43 d	21.98 A	21.70 a	18.53 c	20.12 A
Mean	9.79 A	7.82 B		20.59 A	17.58 B		18.96 A	16.06 B	

Means with the same letters are not significantly different at P <0.05.

Similarly, the interaction between normal plant density at 5 x 6 m with glutamic recorded highest number of inflorescences / branch (16.40 and11.93) and also the interaction between normal plant density with potassium silicate gave highest number of flowers/ inflorescence (25.37 and 23.53) in both seasons, respectively .

Number of perfect flowers/ inflorescence

Relating to the effect of planting density, it is clear that normal distant at 5 x 6 m recorded highest significant number of perfect flowers/inflorescence (19.84 and 18.96) compared to intensive distant in the two seasons, respectively.

Concerning the effect of stimulative substances, the treatment of potassium silicate recorded highest number of perfect flowers/ inflorescence (21.92 and 20.12) compared to other treatments in the two seasons, respectively. The lowest number of perfect flowers/ inflorescence (14.63 and 13.80). The other tested treatments recorded intermediate number of perfect flowers in the both seasons .

In regard to the interaction between planting density and stimulative substances, highest number of perfect flowers/inflorescence were for the interaction between normal distant at 5 x 6 m with potassium silicate (23.43 and 21.70) in the two seasons, as well as the interaction between normal distant with glutamic (21.30) in the second season only. The lowest number of perfect flowers/inflorescence was for interaction between intensive plant density and control (14.17 and 13.10) in the two seasons, respectively. The other interactions gave values in between in the both seasons.

Number of set fruitlets / inflorescence

In terms of the effect of plant density, the trees cultivated at normal distant at 5 x 6 m gave highest number of set fruitlets / inflorescence (7.32 and 6.80) in the both seasons compared with intensive distant (Table,11).

With respect to the effect of stimulative substances, foliar spraying of porolin or potassium silicate gave uppermost number of set fruitlets / inflorescence (7.37 & 6.87 and 7.66 & 7.25) in the first and second seasons, respectively, compared to other tested treatments. The least number of set fruitlets / inflorescence was for control treatment (3.91 and 4.25) in the two seasons, respectively.

The uppermost values of number of set fruitlets / inflorescence were from the interaction between normal distant at 5 x 6 m with porolin or potassium silicate (9.16 &7.91 and 9.24 & 8.41) in the first and second seasons, respectively. The lowermost number of set fruitlets / inflorescence was for interaction between intensive plant density and control (3.58 and 3.58) in the two seasons, respectively .

Sex ratio

The trees cultivated at normal distant at 5 x 6 m gave highest sex ratio (91.24 and 92.10 %) compared with intensive distant (90.50 and 90.70%) in the both seasons, respectively.

Foliar spraying of potassium silicate or nano- chitosan recorded highest sex ratio (91.24 and 92.10 %) compared with other substances in the first season, meanwhile in the second season spraying of any simulative substances increased sex ratio % without significant differences between all substances compared to the control .

The interaction between normal distant at 5 x 6 m with glutamic or nano-chitosan or potassium silicate recorded highest sex ratio without significant differences between them in the two seasons and also normal distant with fulvic acid in the first season only. Similarly, intensive distant with nano-chitosan in the two seasons and also intensive distant with potassium silicate in the first season only, as well as intensive distant with porolin in the second season.

Fruit set percentage

It is observed from Table (11), the trees under normal distant cultivation at 5 x 6 m always had highest fruit set percentages (36.563 and 35.866 %) compared with intensive plant distant in the two seasons .

The trees were sprayed with porolin gave highest significantly fruit set percentages (38.485 and 38.188%) in the first and second seasons, respectively compared with other simulative substances. The lowermost values of fruit set percentages (26.767 and 30.657%) in both seasons. The other tested simulative substances recorded intermediate values of fruit set percentages in the two seasons.

As such, the interaction between normal plant distant at 5 x 6 m with porolin recorded highest fruit set percentages (45.263 and 41.887%), while the lowest fruit set percentages were from interaction between intensive plant distant with control (25.307 and 27.383 %) or with glutamic (26.363 and 28.453%) during both studied seasons. The other interactions gave medium values of fruit set percentages in the two seasons.

Table (11) Effect of cultivated distances and some stimulative substances on number of set fruitlets / inflorescence, sex ratio and fruit set percentage of olive trees in saline soil (2021 and 2022 seasons)

Cultivated distances / Stimulative substances	No. set fruitlets / inflorescence		mean	Sex ratio %		mean	Fruit set%		mean
	5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m	
	First season 2021								
Control(water spray)	4.24 g	3.58 h	3.91 D	90.78bcde	88.54 f	89.66 C	28.227ef	25.307f	26.767 D
Porolin at 150 ppm	9.16 a	5.58 e	7.37 A	89.27def	89.64cdef	89.45 C	45.263a	31.707 d	38.485 A
Fulvic acid at 50 ppm	6.66 c	4.83 f	5.75C	90.90bcd	89.23 ef	90.06 C	38.737b	30.687 de	34.712 B
Glutamic at 500 ppm	6.91 c	5.08 f	6.00C	91.66 ab	91.06 bc	91.36 B	31.980d	26.363f	29.172 C
Nano-chitosan at 50 ppm	7.66 b	5.58 e	6.62B	92.45ab	91.51 ab	91.98AB	35.750c	29.953 de	32.852 B
Potassium silicate at 1000 ppm	9.24 a	6.08 d	7.66 A	92.37 ab	93.01 a	92.69 A	39.423b	29.657 de	34.540 B
Mean	7.32 A	5.12 B		91.24 A	90.50 B		36.563 A	28.946 B	
	Second season 2022								
Control(water spray)	4.91 e	3.58 f	4.25 D	90.33 cd	92.02abc	91.18 B	33.930cd	27.383f	30.657 C
Porolin at 150 ppm	7.91a	5.83d	6.87 A	89.83 d	93.02 ab	91.42AB	41.887a	34.490 c	38.188 A
Fulvic acid at 50 ppm	6.08cd	4.83e	5.46C	93.95 a	89.15 d	91.55AB	35.570bc	34.827 c	35.198 B
Glutamic at 500 ppm	6.58bc	4.91e	5.75C	92.88 ab	90.76bcd	91.82AB	30.890de	28.453 ef	29.672 C
Nano-chitosan at 50 ppm	6.91 b	5.58d	6.25B	93.40 a	92.51abc	92.95 A	34.153cd	33.557 cd	33.855 B
Potassium silicate at 1000 ppm	8.41 a	6.08cd	7.25 A	92.21abc	90.70bcd	91.45AB	38.767ab	32.817 cd	35.792 AB
Mean	6.80 A	5.14 B		92.10 A	91.36 B		35.866 A	31.921 B	

Means with the same letters are not significantly different at P <0.05.

3.4. Total yield per tree (kg) and per feddan (ton)

System of normal plant density at 5 x 6 m recorded uppermost total yield/tree (78.06 and 66.39 kg/tree) and productivity/feddan (10.93 and 9.29 ton/fed) in the first and second seasons, respectively (Table,12).

Concerning the effect of stimulative substances, the highest total yield/tree and productivity per feddan were obtained from olive trees treated by proline (63.67 &55.67 kg / tree and 11.64 &10.27 ton / fed) and Nano- chitosan (65.50 & 58.67 kg / tree and 11.48 &10.36 ton / fed) in the two seasons respectively. Otherwise, control treatment recorded the lowermost values of total yield/tree (39.33 and 32.17 kg / tree) and productivity/ feddan (6.91 and 5.78 ton / fed) in both seasons, respectively.

The interaction between normal distant at 5 x 6 m and nano-chitosan recorded uppermost values of total yield / tree (98.00 and 86.67 kg / tree) and productivity/feddan (13.72 and 12.13 ton / fed) in the both seasons, respectively. The lowermost total yield / tree (20.00 and 18.33 kg / tree) and productivity/feddan (5.60 and 5.13 ton / fed) were from interaction between intensive plant density and control in the two seasons, respectively. The other interactions between plant density and stimulative substance gave intermediate values of total yield/tree in the both seasons.

Table (12). Effect of cultivated distances and some stimulative substances on total yield/tree and productivity/feddan of olive trees in saline soil (2021 and 2022 seasons)

Cultivated distances / Stimulative substances	Yield/tree (kg)		mean	Productivity/ Fed. (ton		mean
	5 x 6 m	3 x 5 m		5 x 6 m	3 x 5 m	
	First season 2021					
Control(water spray)	58.67 f	20.00 j	39.33 E	8.21 g	5.60 i	6.91 E
Porolin at 150 ppm	88.33 b	39.00 g	63.67 A	12.37 b	10.92 d	11.64 A
Fulvic acid at 50 ppm	67.67 e	24.00 j	45.83 D	9.47 f	6.72 h	8.10 D
Glutamic at 500 ppm	73.67 d	30.00 i	51.83 C	10.31 e	8.40 g	9.36 C
Nano-chitosan at 50 ppm	98.00 a	33.00 hi	65.50 A	13.72 a	9.24 f	11.48 A
Potassium silicate at 1000 ppm	82.00 c	35.67 gh	58.83 B	11.48 c	9.99 e	10.73 B
Mean	78.06 A	30.28 B		10.93 A	8.48 B	
	Second season 2022					
Control(water spray)	46.00 e	18.33 h	32.17 E	6.44 g	5.13 h	5.78 D
Porolin at 150 ppm	76.00 b	35.33 f	55.67A B	10.64b	9.89 bc	10.27A
Fulvic acid at 50 ppm	55.67 d	21.67 h	38.67 D	7.79ef	6.07 gh	6.93 C
Glutamic at 500 ppm	63.00 c	27.33 g	45.17 C	8.82de	7.65 f	8.24 B
Nano-chitosan at 50 ppm	86.67 a	30.67 Fg	58.67 A	12.13a	8.59 def	10.36 A
Potassium silicate at 1000 ppm	71.00 b	34.00 f	52.50 B	9.94bc	9.52 cd	9.73 A
Mean	66.39 A	27.89 B		9.29 A	7.81 B	

Means with the same letters are not significantly different at $P < 0.05$.

4. Discussion

This study declared the influence of cultivated distances and some simulative substances on olive trees (Toffahi cv.), which used for table purposes. The obtained results showed that the normal plant density had a significant effect on growth, flowering and total yield of olive trees, this positive effect is agreeing with those stated by **Leon *et al*. (2007); Larbi *et al*. (2012); Emam *et al*. (2016); Rajbhar *et al*. (2016) and Gomez-del-Campo *et al*. (2017).** This effect may be due to an increase in the rates of photosynthesis in trees grown under normal density as a result of good lighting which leads to an increase in the amount of carbohydrates stored in the fruits. Also, paucity of the competition between trees at normal plant densities for nutrients helps in increasing carbohydrate formation rates and improving growth and yield characteristics (Lauzike et al., 2020 and Haque and Sakimin, 2022). Density had a linear negative influence on fruit yield/tree **(Leon *et al*., 2007 and Larbi *et al*., 2012).** The olive trees at super high-density had low vigor and limited development in height and width, as well as a high leaf/wood ratio, but good lighting in the canopy **(Proietti *et al*., 2015).** The widest space (4X4m) of olive seedlings recorded highest increment rate of plant height, stem thickness, number of branches per plant, number of leaves per branch, also largest leaf area, beside the leaf potassium percentage and chlorophyll (b) content **(Emam *et al*., 2016).** The stem girth of mango trees under normal system was noted as 55.7cm whereas, it was slightly reduced to 50.7cm under high density of planting **(Rajbhar *et al*., 2016).**

Fulvic acid increases the photosynthetic rate and reduces the opening of stomata and the transpiration rate to regulate plant growth **(Anjum *et al*., 2011 and Huang *et al*., 2020).** It also enhances mineral element absorption **(Yang *et al*., 2013; Justi *et al*., 2019 and Wang *et al*., 2019).** Besides, it improves the transfer of minerals directly inside the plant cells, both fresh and dry weights **(Chen et al., 2004).**

Glutamic acid is one of these important amino acids, which have many roles within the plant cell, as it contributes to the construction of carbohydrates and protein and contributes to improving the physiological characteristics of plants **(Saburi *et al*., 2014).** It affects pollination and fruit set and induces the production of secondary metabolites **(Michard *et al*., 2011 and El-Shiekh & Umaharan, 2014).** The application of Glutamic acid improved sprouting of vegetative and reproductive buds, shoot diameter, leaf chlorophyll, leaf area, and productivity and also increased the leaf nutritional content from NPK, in contrast to the control **(Mazher *et al*., 2011; Serna-Rodriguez *et al*., 2011 and Al-Saif *et al*., 2024) .**

The application of chitosan on olive trees enhanced all growth characters (shoot length, number of leaves/shoot and leaf area), total chlorophyll, nutrients namely N, P and K, Mg and Ca in the leaves, flowering % and fruit setting aspects namely length of inflorescence (cm.), number of flowers/ inflorescence, perfect flowers %, yield as compared with the check treatment **(Kasem and Fawzy, 2020; Alshallash *et al*., 2023).**

The results showed a significant effect in almost data of potassium silicate, followed by nano-chitosan, compared to the rest of the treatments. A lot of studies showed that potassium silicate plays a major role in increasing growth and the productivity **[Ismail *et al*. (2014) ; Al- Hussein *et al*. (2019) ; Aly *et al*. (2019) and Okba *et al.* (2021)].** Leaf mineral content (N, P, K and Ca) was improved by spraying potassium silicate **(Ismail *et al*., 2014 and Lalithya *et al*., 2014).**

The beneficial effect of silicon in plants is due to its enhancement of enzymatic activity and photosynthesis, improvement of K+/Na+ ratio which help leaves to avoid Na+ toxicity and maintained higher chlorophyll retention **(Abd El-Hameed, 2014; Meena *et al*., 2014 and Meng *et al.*, 2020).** Moreover, silicon increased soluble substances in plant tissues, and promotion of the antioxidant defense mechanism of plants **(Sahebi *et al*., 2015). A**lso, potassium helps plants to adapt water shortages by controlling the opening and closing of stomata therefore it helps in controlling the process of photosynthesis and the formation of carbohydrates **(Hasanuzzaman *et al.*, 2018).** Moreover, **Kumari *et al.* (2021)** mentioned that potassium reduces salinity damage in plants by alleviating osmotic stress, strengthening the activity of antioxidant enzymes, and improving nitrogen utilization efficiency in plants which helps maintain crop yields during stress conditions.

References

A.O.A.C (2012). Official Methods of Analysis, International, 19 th Ed. Association of Official Analytical Chemists, Gaithersburg, Maryland, USA.

Abd El-Hady, A.M.; Aly M. A. and El-Mogy M. M. (2003). Effect of some soil conditioners on counteracting the adverse effects of salinity on growth and fruiting of Flame Seedless vines. Minia J. Agric. Res. and Develop., 23: 699-726 .

Abd El-Hameed, M.; Ali, A.; Esis, A.; and Ahmed, R. (2014). Reducing mineral N fertilizer partially in Thompson seedless vineyards by using fulvic acid and effective microorganisms. World Rural Observations, 6(4): 36- 42.

Ahmed, F.F. and Morsy M.H. (1999). A new method for measuring leaf area in different fruit species. Minia J. of Agric. & Develop., 19 : 97-105.

Ahmed, A. H. H.; Nesiem M. R. A.; Allam H. A. and El-Wakil A. F. (2016). Effect of pre-harvest chitosan foliar application on growth, yield and chemical composition of Washington navel orange trees grown in two different regions. African Journal of Biochemistry Research , 10(7), 59-69.

Ahmed, A.M. and Abd El-Hameed H.M. (2003). Growth, uptake of some nutrients and productivity of Red Roomy vines as affected by spraying of some amino acids, magnesium and boron. Minia J. Agric. Res. and Devlop., 23: 649-666.

Al- Hussein, O. A. K., Hamad S. A. and Oraby, Mona M.M. (2019). Effect of spraying potassium silicate on productivity and nutritional status of Sadek and Zebda mango cvs grown under newly reclaimed soil in Aswan, Egypt. New York Sci. J., 12 (1):1-11.

Al-Saif, A. M., Sas-Paszt, L., Saad, R. M., and Mosa, W. F. A. (2024). “Amino acids as safe biostimulants to improve the vegetative Growth, yield, and fruit quality of peach,” BioResources 19(3), 5978-5993.

Alshallash, K. S., Elnaggarb I. A., Abd El-wahedb A. N., Fahmyc A., Tawfeeqd A. M., Hammade E. M., Almashade A. A., Elmezienf A. I., Hamdyb A. E. and Tahag I. M. (2023). Using chitosan nanoparticles and N-acetyl thiazolidine 4-carboxylic acid for olive trees efficiency raising, improving fruits properties and oil quality. Brazilian Journal of Biology, 83: 1-11.

Aly, M. A.; Harhash M. M.; Mahmoud R. E. S. and Kabel S. A. (2019). Effect of foliar application of potassium silicate and amino acids on growth, yield and fruit quality of 'keitte' mango trees. J. Adv. Agric. Res. 24 (2): 238-250.

Anjum, S.A., Wang L., Farooq M., Xue L. and Ali S. (2011). Fulvic acid application improves the maize performance under well-watered and drought conditions. J. Agron. Crop Sci. 197: 409-417.

Black, C. A.; Evans D. D.; Evsminger L. E.; White J. L. and Clark F. E. (1975). Methods of soil analysis. Amer. Soc. Agron., Inc., Publ. Madison, Wisconsin, USAP 1162 – 1168.

Brandifeld, E. G. and Spincer, D. (1965). Determination of magnesium, calcium, zinc, iron and copper by atomic adsorption spectroscopy. J. Food.Agric. Sci; 16:33-38.

Carolina, F. de V. A and Helena G. C. L. (2020). Biostimulants and their role in improving plant growth under abiotic stresses. Biostimulants in Plant Science. Intech Open. DOI: 10.5772/intechopen.88829.

Chapman, H. D. and Pratt P. F. (1975). Methods of analysis for soils, plants and water. Univ.of California. Divison Agric. Sci., 172-173.

Chartzoulakis, K. (2005). Salinity and olive: Growth, salt tolerance, photosynthesis and yield. Agricultural Water Management 78:108-121 .

Chen, X., Grzegorczyk T.M., Wu B.I., Jr, J. Pacheco and Kong J.A. (2004). Robust method to retrieve the constitutive effective parameters of metamaterials. Phys. Rev. E 70, 016608.

Chibu, H., Shibayama H. and Arima S. (2002). Effects of chitosan application on the shoot growth of rice and soybean. Jap J Crop Sci 71: 206-211.

Cillidag, S. I. (2013). Table Olive processing technologies. J. Food quality,17:335-346.

Cottenie, A., Verloo M., Kiekens L., Velgle G. and amerlynuck R. (1982). Chemical Analysis of Plant and Soil, 43- 51. Laboratory of Analytical and Agroch. State Univ. of Belgium, Gent.

Diez, C. M.; Moral J.; Cabello D.; Morello P.; Rallo L. and Barranco D. (2016). Cultivar and tree density as key factors in the long-term performance of super high-density olive orchards. Front. Plant Sci. 7. DOI=10.3389/fpls.2016.01226.

Duncan, D. B. (1958). Multiple range and multiple F test. Biometrics, 11: 1-42.

El-Shiekh, A. and Umharan P. (2014). Effect of gibberellic acid, glutamic acid and pollen grains extract on yield, quality and marketability of 'Khalas' date palm fruits. Acta Horticulturae, 1047:93-97 .

Emam, H. E., Abd El-Moniem E. A.A. and Saleh M.M.S. (2016). The suitable planting distance for Koroneiki and Chemlali olives under Al-Nubaria district conditions. Interna. J. of Pharm Tech Res., 9(10): 145-152.

Forde, B.G. and Lee P.J. (2007). Glutamate in plants: metabolism. J. Experimental Bot., 58 Issue 9: 2339–2358.

Fouad, M. M., Kilany O. A. and El-said M. E. (1992). Comparative studies on flowering, fruit set and yield of some olive cultivars under Giza conditions. Egypt. J. Appl. Sci., 7: 630 – 644.

Gomez-del-Campo, M., Connor D.J. and Trentacoste E.R. (2017). Long-term effect of intra-row spacing on growth and productivity of super-high density hedgerow olive orchards (cv. Arbequina). Front. Plant Sci. 8:1790.

Greenwood, N. N. and Earnshaw A. (1997). Chemistry of the Elements (Second Edition)- 9- silicon. Butterworth-Heinemann .9:328-366.

Hasanuzzaman, M.; Bhuyan M. H. M. B.; Nahar K.; Hossain M. S.; Mahmud J. A.; Hossen M. S.; Masud A. A.; Moumita C. and Fujita M. (2018). Potassium: A vital regulator of plant responses and tolerance to abiotic stresses. Agronomy, 8, 31.

Huang, C., Wang Y., Li X., Ren L., Zhao J., Hu Y., Zhang L., Fan G., Xu J., Gu X. and Cheng Z. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 395: 497-506.

Ismail, E. A., Hussien S. M. and Grah F. I. A. (2014). Studies on improving fruit yield and quality of peach CV." Early sweeling. Egyptian Journal of Horticulture, 41(1):83-95.

Justi, M., Morais E.G. and Silva C.A. (2019). Fulvic acid in foliar spray is more effective than humic acid via soil in improving coffee seedlings growth. Arch. Agron. Soil Sci. 65: 1969-1983.

Kasem, M.S.M. and Heba S.I.M. Fawzy (2020). Effect of spraying chitosan on productivity of Picual olive trees. Egypt. J. Appl. Sci., 35 (12): 1-15.

Khalil, H. A. and Badr eldin R. M. (2021). Chitosan improves morphological and physiological attributes of grapevines under deficit irrigation conditions. Journal of Horticultural Research. 29(1): 9–22.

Khan, A. S.; Ahmad B.; Jaskani M. J.; Ahmad R. and Malik A. U. (2012). Foliar application of mixture of amino acids and seaweed (Ascophylumnodosum) extract improve growth and physico-chemical properties of grapes. Int. J. Agric. Biol., 14: 383-388.

Kumari, S.; Chhillar H.; Chopra P.; Khanna R. R. and Khan M. I. R. (2021). Potassium: A track to develop salinity tolerant plants Plant Physiology and Biochemistry .167: 1011-1023.

Lalithya, K.A., Bhagya H.P. and Choudhary R. (2014). Response of silicon and micro nutrients on fruit character and nutrient content in leaf of sapota. Biolife, 2(2):593-598.

Larbi, A.; Ayadi M.; Ben Dhiab A.; Msallem M. and Caballero J. M. (2012). Planting density affects vigour and production of 'Arbequina' olive. Spanish Journal of Agricultural Research .10: 1081-1089.

Leon, L., de la Rosa R., Rallo L., Guerrero N. and Barranco D. (2007). Influence of spacing on the initial production of hedgerow 'Arbequina' olive orchards. Span J. Agric. Res., 5(4): 554-558.

Liepman, A.H. and Olsen L.J. (2004). Genomic analysis of aminotransferases in Arabidopsis thaliana, Critical Reviews in Plant Sciences, 2004, vol. 23: 73-89.

Mazher, A.A.M., Zaghloul S.M., Mahmoud S.A., Siam H.S. (2011). Stimulatory effect of kinetin, ascorbic acid and glutamic acid on growth and chemical constituents of *Codiaeum variegatum* L. Plants. Am.-Eurasian J. Agric. Environ. Sci., 6:318–323.

Meena, V. D.; Dotaniya M. L.; Coumar V.; Rajendiran S.; Kundu S. A. and Subba Rao A. (2014). A Case for silicon fertilization to improve crop yields in tropical soils. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences .84: 505-518.

Meng, Y., Yin Q., Yan Z., Wang Y., Niu J., Zhang J. and Fan K. (2020). Exogenous Silicon Enhanced Salt Resistance by Maintaining K+/Na+ Homeostasis and Antioxidant Performance in Alfalfa Leaves. Frontiers in Plant Science 11.

Michard, E., Lima P.T., Borges F., Silva A.C., Portes M.T., Carvalho J.E., Gilliham M., Liu L.-H., Obermeyer G. and Feijo J.A. (2011). Glutamate receptor-like genes form Ca2+ channels in pollen tubes and are regulated by Pistil D-Serine. Science, 332: 434–437.

Mir, R. A.; Bhat B. A.; Yousuf H.; Islam S. T.; Raza A.; Rizvi M. A.; Charagh S.; Albaqami M.; Sofi P. A. and Zargar S. M. (2022). Multidimensional role of silicon to activate resilient plant growth and to mitigate abiotic stress. Frontiers in Plant Science. 13: 1-26.

Mitic, V., Jovanovic V.S., Dimitrijevic M., Cvetkovic J. and Stojanovic, G. (2013). Effect of Food Preparation Technique on Antioxidant Activity and Plant Pigment Content in Some Vegetables Species. Journal of Food and Nutrition Research. 1(6): 121-127.

Mondal, M. M. A.; Malek M. A.; Puteh A. B. and Ismail M. R. (2013). Foliar application of chitosan on growth and yield attributes of mung bean (*Vigna radiata* (L.) Wilczek). Bangladesh J. Bot., 42(1): 179-183

Okba S. K.; Mazrou Y.; Mikhael G. B.; Farag M. E. H. and Alam-Eldein S. M. (2022) Magnetized water and proline to boost the growth, productivity and fruit quality of 'Taifi' pomegranate subjected to deficit irrigation in saline clay soils of semi-arid Egypt. Horticulturae, 8(7):564.

Page, A. L.; Miller R. H. and Keeney D. R. (1982). Methods of Soil Analysis, part 2. Chemical and Microbiological Properties Amer. Soc. Of Agron, Madison, Wisconsin, USA.

Pettit, R. E. (2004). Organic matter, humus, humate, humic acid, fulvic acid and humin: Their importance in soil fertility and plant health. CTI Research, 10, 1–7.

Piper, C. (1950). Soil and plant analysis. international public inc., new york.

Plummer, D. T. (1971). An Introduction to Practical Biochem. Published by McGraw Hill Book Company (U.K.) Limited, pp. 64-69.

Proietti, P., Nasini L., Reale L., Caruso T., Ferranti F. (2015). Productive and vegetative behavior of olive cultivars in super high-density olive grove. Sci. Agric. 72 (1): 20 - 27.

Rajbhar, Y. P., Singh S.D., Lal M., Singh G. and Rawat P.L. (2016). Performance of high-density planting of mango (*Mangifera indica* L.) under mid-western plain zone of Uttar Pradesh. Internat. J. agric. Sci., 12 (2): 298-301.

Rallo, L., Barranco D., Castro-Gacía S., Connor D. J., Gómez del Campo M. and Rallo P. (2013). High-density olive plantations. Hortic. Rev. (Am. Soc. Hortic. Sci). 41, 303–382.

Regni, L.; Del Pino A. M.; Mousavi S.; Palmerini C. A.; Baldoni L.; Mariotti R.; Mairech H.; Gardi T.; D'Amato R. and Proietti P. (2019). Behavior of four olive cultivars during salt stress. Front Plant Sci. 10: 1-9.

Rinaudo, M. (2006). Chitin and chitosan: Properties and application. ProgPolymSci 31: 603-632.

Saburi, M., Mohammad R., Sayed H., Mohammad S. and Taghi, D . (2014). Effect of amino acids and nitrogen fixing bacteria on quantitative yield and essential oil content of basil Ocimum basilicum. Agric. sci. dev, 3(8), 265-268.

Saburi, M., Mohammad R., Sayed H., Mohammad S. and Taghi, D. (2014). Effect of amino acids and nitrogen fixing bacteria on quantitative yield and essential oil content of basil Ocimum basilicum. Agric. sci. dev, 3(8), 265-268.

Sahebi, M.; Hanafi M. M.; Siti Nor Akmar A.; Y. Rafii M.; Azizi P.; Tengoua F. F.; Azwa J. N. M. and M. Shabanimofrad (2015). Importance of silicon and mechanisms of biosilica formation in plants.25: 1-16.

Sajid, M.; Basit A.; Ullah Z.; Shah S. T.; Ullah I.; Mohamed H. I. and Ullah I. (2020). Chitosan-based foliar application modulated the yield and biochemical attributes of peach (*Prunus persica* L.) cv. Early Grand. Bull Natl Res Cent 44, 150.

Serna-Rodríguez, J.R., Castro-Brindis R., Colinas-León M.T., Sahagún-Castellanos J., Rodríguez-Perez J.E. (2011). Foliar application of glutamic acid to tomato plants (Lycopersicon esculentum Mill.) Rev. Chapingo Ser. Hortic., 17:9–13.

Sommer, M.; Kaczorek D.; Kuzyakov Y. and Breuer T. (2006). Silicon pools and fluxes in soils and landscapes: a review. J. Plant Nutr. Soil. Sci., 169: 310–329.

Wang, Y., Yang R., Zheng J., Shen Z. and Xu X. (2019). Exogenous foliar application of fulvic acid alleviate cadmium toxicity in lettuce (*Lactuca sativa* L.). Ecotoxicol. Environ. Saf.167: 10-19.

Wettestein, D. (1957). Chlorophyll Lethal und Submik roskopische fromivechsel der Plastiden Exptl. Cell Res., 12: 427-433.

Xu, R.; Huang J.; Guo H.; Wang C. and Zhan H. (2023). Functions of silicon and phytolith in higher plants. Plant Signal Behav. 18:2198848.

Yang, S., Zhang Z., Cong L., Wang X. and Shi S. (2013). Effect of fulvic acid on the phosphorus availability in acid soil. Journal of soil science and plant nutrition, 13(3): 526-533.

Zhang Q.; Han M.; Song C.; Song X.; Zhao C.; Liu H.; Hirst P. M. and Zhang D. (2015). Optimizing planting density for production of high-quality apple nursery stock in China, New Zealand Journal of Crop and Horticultural Science, 43 (1): 7-17. DOI:10.1080/01140671.2014.900093.

تأثير مسافات الزراعة وبعض المواد المحفزة على التزهير والمحصول الكلى لأشجار الزيتون صنف التفاحي في التربة الملحية

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الملخص

أجريت هذه الدراسة في موسمين ٢٠٢١ و٢٠٢٢ لدراسة تأثير نوعين من مسافات الزراعة (٥×٦ م و ٣×٥ م) وبعض المواد الكيميائية (البرولين بتركيز ١٥٠ جزء في المليون، حمض الفولفيك بتركيز ٥٠ جزء في المليون، حمض الجلوتاميك بتركيز ٥٠٠ جزء في المليون، نانو شيتوزان بتركيز ٥٠ جزء في المليون، سيليكات البوتاسيوم بتركيز ١٠٠٠ جزء في المليون) وتفاعلاتها على النمو والإزهار والمحصول الكلي لأشجار زيتون تفاحي عمر ٢١ سنة مزروعة في تربة رملية ملحية والرى بنظام التنقيط في بستان خاص في مدينة فايد بالإسماعيلية بمصر. أظهرت النتائج أن رش الأشجار بالنانو شيتوزان أو البرولين سجل أعلى إنتاجية في كلا الموسمين. أما بالنسبة لتأثير مسافة الزراعة، فمن الواضح تفوق الكثافة النباتية الطبيعية ٥× ٦م والتي كان لها تفوق أعلى في النمو الخضري، وصبغات التمثيل الضوئي للأوراق، ومحتوى العناصر والكربوهيدرات الكلية في الأوراق والخصائص الزهرية مقارنة بالأشجار المزروعة بكثافة على ٣× ٥م. أعطت الأشجار المرشوشة بسيليكات البوتاسيوم أعلى عدد من نموات البراعم / الفرع، بينما سجلت أشجار الزيتون المرشوشة بالجلوتاميك أو النانو شيتوزان أكبر مساحة أوراق. اكتسب رش النانو شيتوزان أو البورولين أكبر وزن طازج للأوراق. أعطى الرش الورقي بالبورولين أعلى نسبة نيتروجين، بينما أعطى النانو شيتوزان وسيليكات البوتاسيوم أعلى نسبة بوتاسيوم وفوسفور في الموسمين. وسجل التفاعل بين الكثافة النباتية الطبيعية ٥× ٦م مع حمض الجلوتاميك أعلى عدد للنورات/الفرع والنسبة الجنسية، كما أعطى التفاعل بين الكثافة النباتية الطبيعية٥× ٦م مع سيليكات البوتاسيوم أعلى عدد من الأزهار/النورة، بينما كان أعلى عدد من الأزهار/النورة أو عدد الثمار العاقدة/النورة للتفاعل بين المسافة الطبيعية عند ٥× ٦م مع سيليكات البوتاسيوم أو مع البورولين، وأعطت الأشجار المرشوشة بالبورولين أعلى نسبة معنوية لعقد الثمار وكذلك تفاعلها مع المسافة بين النباتات عند ٥× ٦م.