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EFFECT OF DIFFERENT TYPES OF FERTILIZERS ON THE GROWTH AND PRODUCTIVITY OF OLIVE TREES (*Olea europaea* L.) CV. ARBEQUINA

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ABSTRACT

The study was done in the 2022 growing season on 16-year-old Arbequina olive trees cultivated at 6×6 m apart in clay sandy loam soil under drip irrigation system in a private orchard located at Zakho region, Duhok governorate, Kurdistan region, Iraq, to study the influence of different types of fertilizers on the growth and productivity of olive trees (*Olea europaea* L.) cv. Arbequina. The experiment consists of twenty-seven treatments (three levels of soil application of chicken manure 0,5, 10 kg tree^{-1}, foliar application of three conc. of seaweed extract (Sea force) 0,10,20 ml L^{-1} and soil application of three levels of mineral fertilizer Blaukorn NPK (12:12:16) at level (0, 150, and 200g tree^{-1}), mineral fertilizer was applied three times per season: First: at vegetative growth stage. Second: at full bloom. Third: after setting of fruits. Results indicate that soil application of chicken manure, especially at 10 kg tree^{-1}, and foliar spraying of Sea force at 20 ml L^{-1} significantly increased all studied characters (average leaf area, total chlorophyll content, number of flowers/inflorescences, fruit set %, fruit length, fruit width, fruit weight, total yield per tree, fruit total soluble solids (TSS%), Percentage of oil). Soil application of Blaukorn, especially at 200 g tree-1, significantly increased (average leaf area, fruits length, width and weight, and TSS). The binary and triple interactions of the study treatments on all the traits under investigation also showed a significant increase, particularly for the high levels of the study factors.

INTRODUCTION

The olive tree, *Olea europaea* L., is an evergreen fruit that is a member of the Oleaceae family and dates back approximately 8000 years, making it one of the earliest trees ever to be cultivated (Hegazy *et al.*, 2007). Olive trees are the most common fruit species in the Mediterranean basin due to their abundance of cultivated varieties and their significance to the environment, economy, and society (Langgut *et al.*, 2019). In 2020, the estimated number of olive fruitful trees grew in Iraq, including nearly 1329191 trees, which produced up to 33912 tons. While the acreage of olives in the world reached about 10578246 hectares, with production of 19464495 tons (FAO, 2021).

Fertilization is suspected one of the most important and critical factors for rapid plant growth. Fertilization is necessary for olive trees to maintain their optimal nutritional status and avoid reducing their growth or production. (Erel *et al.*, 2008). For olive trees, fertilization is essential; however, excessive fertilization may have a detrimental impact on olive yield and quality. (Haberman *et al.*, 2019). Chicken manure is the organic fertilizer made from the feces of chickens; it contains the highest amounts of (nitrogen, phosphorus, and potassium) of any animal manure and is especially useful for soil that is low in nitrogen. (Telkamp, 2015). In addition to fertilizing crops, manures also supply other essential plant nutrients and act as a soil amendment by adding organic matter, which helps improve the soil's moisture and nutrient retention (Michael *et al.,* 2017). El-Alakmy *et al.*, (2018) investigated the impact of organic fertilizers (chicken manure 7.8 Kg/tree/Year) on Kalamata olive trees, which enhanced fruit production with a high yield and desirable fruit quality. Arji *et al.*, (2021) examined how the Zard olive cultivar's growth and fruit qualities were affected by the addition of organic-manure, either with or without chemical-fertilizers. The highest growth rates and maximum weight of fruit were noted when treating with chicken-manure and chicken-manure plus chemical fertilizers. Al-Atrushy and Ibrahim (2023) study the effect of chicken manure at three levels (0, 3 and 6 kg.vine^{-1}) on grapevine cv. Zaitouni. The results showed that clusters number and weight, total yield and TSS were increased significantly by chicken manure especially at 6kg.vin^{-1}.

Seaweed extract is beneficial in sustainable agriculture because it is organic and biodegradable. Seaweed products have become increasingly popular in organic farming (Shaji *et al.*, 2021). Its extract has growth-promoting hormones such as (auxins; gibberellins; cytokinins; ethylene and polyamines), vitamins; amino acids; antibiotics; micronutrients and trace minerals. The foliar application of seaweed is a typical method to increase yield in many commercial crops (Khan *et al.*, 2012). Nearly all of the vitamins, amino acids, and trace minerals needed for plant survival are found in Sea force, also it is a major source of iodine (Berlyn & Russo, 1990). Rozbiany & Muhammad, (2022) study the influences of Sea force at four levels (0,2ml L^{-1},4ml L^{-1} and 6ml L^{-1}) on olive trees growth (Sorani cv.), 6ml L^{-1} recorded a significant increase in chlorophyll, leaf area, oil content, TSS, fruit diameter, fruit weight. Al-Saif *et al.*, (2023) study the impact of the foliar spray of Seaweed extract at (1000, 2000 and 3000 mg L^{-1}) on olive trees cv. Kalamata. It was discovered that the general (growth and development) of olive trees was positively impacted by the application of seaweed extract. Spraying seaweed extract significantly increased fruit set percentages, flower number, total soluble solid (TSS) Percentage, leaf chlorophyll content, and fruit yields, especially at concentrations of 3000 mg L^{-1}. Dawood *et al.*, (2013) study the effect of foliar spray of three concentration of Seaweed extract (0, 1 and 2 ml.L) and three concentrations of Urea (0, 0.25 and 0.50%) fertilizer on vegetative growth of *Pistacia khinjuk*. Results indicated that all the treatments led to improve vegetative growth (leaf area and chlorophyll content.

When additional organic resources are added to mineral fertilizer, the fertilizer's efficiency increases. It is clear that using organic inputs has many advantages. They are beneficial because they improve the soil's ability to hold moisture, enhance crop response to mineral fertilizers, control soil chemical and physical properties that impact root development and nutrient availability, add nutrients not found in mineral fertilizers, improve rooting conditions, increase phosphorus availability for plant uptake, reduce issues like soil acidity, and replenish soil organic matter. Therefore, to maximize crop yield, integrated nutrient management is helpful (Fairhurst, 2012). Bravo *et al.,* (2012) state that substituting chemical fertilizers with organic fertilizers alone is insufficient to sustain the productivity of high yielding crops. Conversely, (Lu *et al.*, 2014) found that crops' nutrient needs were satisfied and the effectiveness of macronutrients was preserved when inorganic fertilizers were partially substituted with organic ones. This implies that applying both organic and mineral fertilizers together may be more effective than applying each one alone. The growth of olive plants is significantly influenced by nitrogen (Fernandez-Escobar *et al.*, 2004), reduces biennial bearing (alternate bearing) and increases the percent of perfect flowers and yield (Therios, 2009). Phosphorus is a constituent of nucleic acids and phospholipids of the bio membranes and very important in photosynthesis (Pandey, 2015). Some recent studies have shown improved (flowering and fruit set levels) with increased P uptake (Erel *et al.*, 2008). Due to the annual removal of significant amounts of K during harvest, olive fruits have a high potassium (K) requirement. Because of this, K deficiency has extremely detrimental effects on production (Therios, 2009). Has been noted that Potassium is an important nutrient in olive. Regarding this, potassium fertilized olive trees showed increased growth and yields. Malek & Mustapha, (2013) showed an improvement of flowers, fruit weight, oil content and yield of Arbequina olive tree with NPK fertilizer. Al-A'areji, et al., (2013) study the effect of structure acta agro compound fertilizer (N 7%, P 21%, K 1%) at two levels (2 and 4 ml. L^{-1}) on Tangarin transplants. Results showed that soil application of the fertilizer at the level of 2 ml. L^{-1} gave the highest leaf area and 4 ml. L^{-1} gave the highest chlorophyll content. Al-Imam and Al-Qady (2018) study the effect of three levels of nitrogen fertilization (0,100 and 200 mgN.l^{-1}) on olive (*Olea europaea* L.) cv. Bashika. Fertilization with 200 mg N.l^{-1} resulted in an increase in leaves area.

The objective of this study is to improve vegetative growth, flowering, yield, fruit quantity and quality of Arbequina olive trees by using different types of fertilizer.

MATERIALS AND METHODS

This study was conducted in a private olive tree orchard in the Zakho region of the Dohuk governorate in the Kurdistan region of Iraq during the 2022 growing season. The orchard is 582 meters above sea level and is located between latitude 37° 06´ N and longitude 42° 39´ E. A drip irrigation system was used to select 16-year-old olive trees that were healthy and nearly uniform. The trees were spaced 6 x 6 meters apart, with 81. The regular agricultural and horticultural practices typically applied in a commercial orchard were applied to every tree included in this study. Clay sandy loam is the type of soil that olive trees grow in. Three replications of random soil samples (0–75 cm depth) were taken from various orchard locations. As stated by (Page *et al.*, 1982). Table 1 displays certain physical and chemical characteristics of the soil.

The experiment was arranged in a factorial design in RCBD, the trial included twenty-seven treatments (3 levels of applying chicken manure to the soil, 3 concentrations of applying seaweed extract foliarly, and 3 levels of applying mineral fertilizer to the soil), each experiment unit is represented by a single tree and three replications. As a result, the total number of trees in the study was 81. The SAS program was used to analyze the data, and Duncan's multiple range tests (DMRT) were used to compare the means at the 5% significance level (Al-Rawi & Khalafalla, 2000).

Table (1): Some chemical and physical properties of the orchard soil.

Characteristics of soil	Units	Test
(Sand)	%	24.7
(Silt)	%	21.5
(Clay)	%	53.8
(Texture of soil)	---	(clay sandy loam)
(Total N)	%	1.764
(Available phosphorus)	%	0.752
(Available potassium)	%	0.1322
(Organic matter)	%	2.14
(pH)	1:01	6.62
(Ec conductivity)	$^{1-}$ds m	1.054

The analysis was carried out at (Soil and Water Department Laboratory), College of Agricultural Engineering Sciences, Duhok University.

Experimental treatments include three-levels of soil application of chicken manure (0, 5, and 10 kg tree^{-1}) was used; in January 2022, it was applied as a soil fertilizer once per season by digging holes around the tree and then mixing it with the soil. Foliar application of three levels of seaweed (Sea force) at concentration (0-, 10- and 20-ml L^{-1}) and Three levels of soil application of mineral fertilizer (Blaukorn NPK 12:12:16) (0, 150, and 200g tree^{-1}). Mineral fertilizer was applied three times per season: The first: at vegetative growth stage. Second: at flowering (full bloom). Third: after setting of fruits. While the control trees were sprayed with distilled-water mixed with (Tween 20), Seaweed was sprayed on the trees in the morning until runoff occurred, and Tween 20 was added at a rate of 0.1 ml L^{-1} to reduce the water molecules' surface tension. Blooming started on April 20, 2022. Four flowering shoots were selected randomly with four directions of each tree, and given the following parameters: Average leaf area (cm^2): the average leaf area was estimated by (ImageJ 1.52a) software as in (Schneider et al., 2012). Total chlorophyll content (SPAD): The total chlorophyll content was determined using the chlorophyll measurement device (chlorophyll meter, SPAD-502, Konica Minolta). number of flowers/inflorescences, fruit set %, fruit length (mm), fruit width (mm), fruit weight (g), total yield per tree (kg tree^{-1}), fruit total soluble solids TSS% (Ranganna, 1977) and Percentage of oil by using Soxhlet method as mentioned in (A.O.A.C., 1975).

RESULTS AND DISCUSSION

Average leaf area (cm^2)

Table (2) showed that there were significant differences between the treatments. Increasing the levels of chicken manure, sea force, and Blaukorn significantly increased average leaf area, the highest value of average leaf area is found in the olive trees fertilized with 10 kg tree^{-1} chicken manure, 20 ml L^{-1} Sea force and 200 g tree^{-1} Blaukorn, that are (3.48, 3.31 and 3.25 cm^2) respectively. Regarding the interactions, data in table (2) suggests that the interaction between chicken manure + Sea force, chicken manure + Blaukorn and Sea force + Blaukorn were significantly differed, the maximum value of average leaf area (3.74, 3.59 and 3.46 cm^2) were obtained by the interaction of 10kg tree^{-1} chicken manure + 20 ml L^{-}

^{1} Sea force, 10kg tree^{-1} chicken manure + 200 g tree^{-1} Blaukorn and 20 ml L^{-1} Sea force+ 200 g tree^{-1} Blaukorn compared with the control's lowest value. It was evident from the same table that the three factors under investigation had a favorable effect on average leaf area with a node to their interaction, the greatest value (4.00cm^{2}) was resulted from the interaction of 10 kg tree^{-1} chicken manure + 20 ml L^{-1} Sea force + 200 g tree^{-1} Blaukorn in contrast to the trees that were not treated, which produced the lowest value of average leaf area.

Table (2): Effect of different types of fertilizers on the average leaf area (cm^{2}) of olive tree (*Olea europaea* L.) cv. Arbequina.

Chicken manure (kg tree^{-1})	Sea force ml L^{-1}	Blaukorn g tree^{-1}			Chicken manure * Sea force	Mean effect of Chicken manure
		0	150	200		
0	0	2.80 jk	2.97 f-k	2.87 h-k	2.88 e	2.93 c
	10	2.77 k	3.10 e-k	3.20 c-i	3.02 de	
	20	2.83 i-k	2.83 i-k	2.97 f-k	2.88 e	
5	0	2.97 f-k	3.03 e-k	2.93 g-k	2.98 de	3.13 b
	10	2.97 f-k	3.17 c-j	3.13 d-k	3.09 cd	
	20	3.20 c-i	3.33 c-f	3.40 b-e	3.31 b	
10	0	3.23 c-h	3.33 c-f	3.23 c-h	3.27 bc	3.48 a
	10	3.27 c-g	3.50 b-d	3.53 bc	3.43 b	
	20	3.50 b-d	3.73 ab	4.00 a	3.74 a	
Chicken manure * Blaukorn	0	2.80 e	2.97 de	3.01 cd	Mean effect of Sea force	
	5	3.04 cd	3.18 bc	3.16 b-d		
	10	3.33 b	3.52 a	3.59 a		
Sea force* Blaukorn	0	3.00 c	3.11 bc	3.01 bc	3.04 c	
	10	3.00 c	3.26 b	3.29 ab	3.18 b	
	20	3.18 bc	3.30 ab	3.46 a	3.31 a	
Mean effect of Blaukorn		3.06 b	3.22 a	3.25 a		

The Duncan multiple range test at the probability of 0.05 level indicates that there is no significant difference between the mean within a column, row, and their interaction following with the same latter.

Total Chlorophyll Content (SPAD)

According to table (3)'s results, it was found that the soil application of chicken manure at the level 10kg tree^{-1} significantly increased total chlorophyll content which gave (79.97 SPAD), foliar application of Sea force at 20 ml L^{-1} resulted in the significant influence in total chlorophyll content and given the maximum value (77.76 SPAD), as compared to other treatment., whereas soil application of Blaukorn at 200 g tree^{-1} recorded the highest total chlorophyll content which gave (76.87 SPAD), no significant differences between control and 200 g tree^{-1} Blaukorn . In respect with the interaction between chicken manure + Sea force, chicken manure + Blaukorn and Sea force + Blaukorn showed that there was a significant interaction influence of total chlorophyll content and the maximum value (82.87, 80.96 and 78.54 SPAD) were acquired from the combination of treatments 10 Kg tree^{-1} chicken manure + 20 ml L^{-1} Sea force, 10kg tree^{-1} chicken manure + 200 g tree^{-1} Blaukorn and 20 ml L^{-1} Sea force + 200 g tree^{-1} Blaukorn. Results of chicken manure, Sea force and Blaukorn interaction demonstrated that there was a significant impact on total chlorophyll content and demonstrated that the interaction among 10 kg tree^{-1} chicken manure + 20 ml L^{-1} Sea force + 200 g tree^{-1} Blaukorn was the most significant and successful treatment because it provided the highest total chlorophyll content 85.20 SPAD, Conversely, the control treatment received the lowest result.

Table (3): Effect of different types of fertilizers on the total chlorophyll content (SPAD) of olive tree (*Olea europaea* L.) cv. Arbequina.

Chicken manure (kg tree^{-1})	Sea force ml L^{-1}	Blaukorn g tree^{-1} 0	Blaukorn g tree^{-1} 150	Blaukorn g tree^{-1} 200	Chicken manure * Sea force	Mean effect of Chicken manure
0	0	71.07 k	72.27 jk	73.70 i-k	72.34 e	73.57 c
	10	74.93 g-j	72.47 jk	74.77 h-j	74.06 d	
	20	74.30 ij	74.03 ij	74.57 h-j	74.30 d	
5	0	75.17 g-j	72.50 jk	73.77 i-k	73.81 de	75.29 b
	10	75.93 e-i	75.57 f-i	76.33 e-i	75.94 c	
	20	76.07 g-j	76.40 e-i	75.87 ei	76.11 c	
10	0	78.40 c-f	77.87 d-g	77.47 d-h	77.91 b	79.97 a
	10	78.50 c-f	78.70 c-e	80.20 b-d	79.13 b	
	20	80.87 bc	82.53 b	85.20 a	82.87 a	
Chicken manure * Blaukorn	0	73.43 de	72.92 e	74.34 c-e	Mean effect of Sea force	
	5	75.72 c	74.82 cd	75.32 c		
	10	79.26 b	79.70 ab	80.96 a		
Sea force* Blaukorn	0	74.88 de	74.21 e	74.98 de	74.69 c	
	10	76.46 b-d	75.58 c-e	77.10 a-c	76.38 b	
	20	77.08 a-c	77.66 ab	78.54 a	77.76 a	
Mean effect of Blaukorn		76.14 ab	75.81 b	76.87 a		

The Duncan multiple range test at the probability of 0.05 level indicates that there is no significant difference between the mean within a column, row, and their interaction following with the same latter.

Number of flowers per inflorescence

The results in Table (4) indicates that the soil application of chicken manure at both levels (5, 10kg tree^{-1}) and foliar application of sea force at both concentrations (10,20 ml L^{-1}) significantly increased the no. of flowers per inflorescence, highest number of flowers per inflorescence was with high level of chicken manure (10 kg tree^{-1}) which gave (15.33) and the concentration of Sea force at (10ml L^{-1}) gave the greatest value (14.80) of number of flowers per inflorescence. Soil application of Blaukorn at 200 g tree^{-1} recorded the highest value (14.77), no significant differences between control and the two levels of blaukorn treatments. Regarding to the interaction between chicken manure + Sea force, chicken manure + Blaukorn and Sea force + Blaukorn, was a significant effect of no. of flowers/inflorescence and the biggest value (16.46, 15.96, and 15.72), respectively were obtained from the treatment combination of 10 kg tree^{-1} chicken manure + 20 ml L^{-1} Sea force, 10 kg tre^{-1} chicken manure + 0 g tree^{-1} Blaukorn and 10 ml L^{-1} Sea force + 200 g tree^{-1} Blaukorn. Chicken manure, Sea force and Blaukorn interaction outcomes suggested that there was a significant impact on number of flowers per inflorescence and demonstrated that the interaction between 10 kg tree^{-1} chicken manure + 20 ml L^{-1}

Sea force + 200 g tree^{-1} Blaukorn was the most important and effective treatment because it provided the highest number of flowers per inflorescence (16.62), Conversely, the control treatment gave the lowest number of flowers per inflorescence.

Table (4): Effect of different types of fertilizers on the Number of flowers per inflorescence of olive tree (*Olea europaea* L.) cv. Arbequina.

Chicken manure (kg tree^{-1})	Sea force ml L^{-1}	Blaukorn g tree^{-1}			Chicken manure * Sea force	Mean effect of Chicken manure
		0	150	200		
0	0	10.36 i	12.06 f-i	11.03 hi	11.15 d	12.68 b
	10	13.64 a-h	11.21 g-i	15.88 a-d	13.58 c	
	20	13.22 c-i	12.55 e-i	14.15 a-h	13.31 c	
5	0	13.31 b-i	13.56 a-h	14.82 a-f	13.90 c	14.80a
	10	15.69 a-e	15.44 a-e	16.51 ab	15.88 ab	
	20	14.30 a-g	13.56 a-h	16.00 a-d	14.62 bc	
10	0	16.47 a-c	14.19 a-h	13.12 d-i	14.59 bc	15.33 a
	10	14.83 a-f	15.25 a-f	14.78 a-f	14.95 a-c	
	20	16.59 a	16.16 a-d	16.62 a	16.46 a	
Chicken manure * Blaukorn	0	12.41 de	11.94 e	13.69 cd	Mean effect of Sea force	
	5	14.44 a-c	14.19 bc	15.78 ab		
	10	15.96 a	15.20 a-c	14.84 a-c		
Sea force* Blaukorn	0	13.38 c	13.27 c	12.99 c	13.21 b	
	10	14.72 a-c	13.96 bc	15.72 a	14.80 a	
	20	14.71 a-c	14.09 a-c	15.59 ab	14.79 a	
Mean effect of Blaukorn		14.27 ab	13.78 b	14.77 a		

The Duncan multiple range test at the probability of 0.05 level indicates that there is no significant difference between the mean within a column, row, and their interaction following with the same latter.

Fruit set %

According to the table (5) soil application of chicken manure at both levels (5, 10 kg tree^{-1}) significantly increased fruit set percentage, highest value was with high level of chicken manure (10 kg tree^{-1}) which gave (3.75%), and foliar spray of Sea force at concentrations (20 ml L^{-1}) given the biggest significant value (3.67%) of fruit setting. Soil application of Blaukorn at 200 g tree^{-1} recorded the highest value (3.54 %), but without a significant difference from the control treatment. Concerning to the effect of interaction between chicken manure + Sea force, chicken manure + Blaukorn and Sea force + Blaukorn, fruit set % was significantly impacted; the highest value (4.14, 3.78, and 3.82 %, respectively) was attained when olive trees were treated with 10 kg tree^{-1} chicken manure + 20 ml l^{-1} Sea force, 10 kg tree^{-1} chicken manure + 150 g tree^{-1} Blaukorn and 20 ml L^{-1} Sea force + 150 g tree^{-1} Blaukorn. Results of chicken manure, Sea force and Blaukorn interaction, indicated that the interaction among 10 kg tree^{-1} chicken manure + 20 ml L^{-1} Sea force + 150 g tree^{-1} Blaukorn produced the highest Percentage of fruit setting (4.49%), it was the most successful treatment, whereas the control treatment got the lowest percent.

Table (5): Effect of different types of fertilizers on fruit set % of olive tree (*Olea europaea* L.) cv. Arbequina.

Chicken manure (kg tree^{-1})	Sea force ml L^{-1}	Blaukorn g tree^{-1} 0	150	200	Chicken manure * Sea force	Mean effect of Chicken manure
0	0	1.93 h	2.23 h	2.21 h	2.12 d	2.85 b
	10	3.43 d-f	2.39 gh	3.92 a-e	3.25 bc	
	20	3.16 e-g	2.63 f-h	3.70 a-e	3.17 c	
5	0	3.29 d-f	3.43 d-f	3.62 b-e	3.45 bc	3.56 a
	10	3.48 c-f	3.18 e-g	3.97 a-e	3.54 bc	
	20	3.50 c-f	4.33 a-c	3.27 ef	3.70 b	
10	0	4.17 a-d	3.42 d-f	3.34 d-f	3.64 b	3.75 a
	10	3.62 b-e	3.45 d-f	3.35 d-f	3.47 bc	
	20	3.48 c-f	4.49 a	4.46 ab	4.14 a	
Chicken manure * Blaukorn	0	2.84 c	2.42 d	3.28 b	Mean effect of Sea force	
	5	3.43 ab	3.64 ab	3.62 ab		
	10	3.76 a	3.78 a	3.71 ab		
Sea force* Blaukorn	0	3.13 bc	3.03 c	3.06 c	3.07 c	
	10	3.51 ab	3.01 c	3.75 a	3.42 b	
	20	3.38 a-c	3.82 a	3.81 a	3.67 a	
Mean effect of Blaukorn		3.34 ab	3.28 b	3.54 a		

The Duncan multiple range test at the probability of 0.05 level indicates that there is no significant difference between the mean within a column, row, and their interaction following with the same latter.

Fruit length (mm)

Table (6) illustrates that increasing levels of chicken manure, Sea force and Blaukorn significantly increased fruit length. The highest value (20.85, 20.07 and 19.36 mm) was obtained in the tree receiving 10 kg tree^{-1} chicken manure, 20 ml L^{-1} Sea force and 200 g tree^{-1} Blaukorn, in contrast to the control. Regarding the interaction of chicken manure + Sea force, chicken manure + Blaukorn and Sea force + Blaukorn, data in table (6) shows that the interaction of 10 kg tree^{-1} chicken manure + 20 ml L^{-1} Sea force, 10 kg tree^{-1} chicken manure + 200 g tree^{-1} Blaukorn and 20 ml L^{-1} Sea force + 150 g tree^{-1} Blaukorn give the maximum value of fruit length (21.67, 21.13 and 20.44mm) respectively, compared to the smallest value from control. Regarding the interactions of the three factors studied (chicken manure, Sea force and Blaukorn), the same table, illustrates that the interaction of 10 kg tree^{-1} chicken manure + 20 ml L^{-1} Sea force + 200 g tree^{-1} Blaukorn gave the highest value (22.20 mm) which differed significantly from previous treatments, The control treatment yielded the lowest recorded value.

Table (6): Effect of different types of fertilizers on fruit length (mm) of olive tree (*Olea europaea* L.) cv. Arbequina.

		Blaukorn g tree^{-1}		

Chicken manure (kg tree^{-1})	Sea force ml L^{-1}	0	150	200	Chicken manure * Sea force	Mean effect of Chicken manure
0	0	14.70 m	15.67 l	16.50 kl	15.62 f	17.36 c
	10	16.80 k	16.57 kl	18.37 j	17.24 e	
	20	19.07 g-j	19.93 d-g	18.63 ij	19.21 cd	
5	0	18.40 j	18.77 h-j	18.87 h-j	18.68 d	19.04 b
	10	19.63 e-i	18.70 h-j	18.97 g-j	19.10 cd	
	20	18.83 h-j	19.70 e-h	19.50 f-i	19.34 c	
10	0	20.10 c-f	19.97 d-g	20.57 c-e	20.21 b	20.85 a
	10	20.87 b-d	20.53 c-e	20.63 c-e	20.68 b	
	20	21.10 bc	21.70 ab	22.20 a	21.67 a	
Chicken manure * Blaukorn	0	16.86 d	17.39 c	17.83 c	Mean effect of Sea force	
	5	18.96 b	19.06 b	19.11 b		
	10	20.69 a	20.73 a	21.13 a		
Sea force* Blaukorn	0	17.73 g	18.13 fg	18.64 ef	18.17 c	
	10	19.10 de	18.60 ef	19.32 cd	19.01 b	
	20	19.67bc	20.44 a	20.11 ab	20.07 a	
Mean effect of Blaukorn		18.83 b	19.06 b	19.36 a		

The Duncan multiple range test at the probability of 0.05 level indicates that there is no significant difference between the mean within a column, row, and their interaction following with the same latter.

Fruit width (mm)

Table (7) clearly demonstrates that the fruit width varied significantly. Soil application of chicken manure at 10 kg tree^{-1}, foliar spray of Sea force at 20ml L^{-1} gave the highest significant value (15.65 and 14.93mm), respectively. While soil application of Blaukorn at 150 g tree^{-1} and 200 g tree^{-1} provided a significant value compared to the control treatment, the greatest value came from 200 g tree^{-1} which gave (14.45mm). The interaction between chicken manure + Sea force, chicken manure + Blaukorn and Sea force + Blaukorn showed that there was a significant influence on fruit width. Additionally, the maximum value (16.86, 16.12 and 15.18 mm) was obtained at 10 kg tree^{-1} chicken manure + 20 ml L^{-1} Sea force, 10 kg tree^{-1} chicken manure + 200 g tree^{-1} Blaukorn and 20 ml L^{-1} Sea force + 150 g tree^{-1} Blaukorn respectively. Regarding the effect of interaction of chicken manure, Sea force and Blaukorn, the maximum fruit width (17.57mm) was showed when the olive trees treated with 10 kg tree^{-1} chicken manure + 20 ml L^{-1} Sea force + 200 g tree^{-1} Blaukorn was significantly higher in comparison to other interaction. Additionally, the smallest fruit width was found at the control treatment.

Table (7): Effect of different types of fertilizers on Fruit width (mm) of olive tree (*Olea europaea* L.) cv. Arbequina.

		Blaukorn g tree^{-1}		

Chicken manure (kg $tree^{-1}$)	Sea force ml L^{-1}	0	150	200	Chicken manure * Sea force	Mean effect of Chicken manure
0	0	10.63 m	11.43 lm	12.37 j-l	11.48 f	12.57 c
	10	12.43 j-l	12.23 kl	13.10 i-k	12.59 e	
	20	13.37 h-j	14.17 e-i	13.43 g-j	13.66 d	
5	0	14.00 f-i	14.23 e-i	14.33 e-h	14.19 cd	14.22 b
	10	14.20 e-i	14.23 e-i	14.17 e-i	14.20 cd	
	20	13.97 f-i	14.60 d-g	14.27 e-i	14.28 cd	
10	0	14.27 e-i	14.83 d-f	15.17 c-f	14.76 c	15.65 a
	10	15.23 c-e	15.17 c-f	15.63 cd	15.34 b	
	20	16.23 bc	16.77 ab	17.57 a	16.86 a	
Chicken manure * Blaukorn	0	12.14 e	12.61 de	12.97 d	Mean effect of Sea force	
	5	14.06 c	14.36 c	14.26 c		
	10	15.24 b	15.59 ab	16.12 a		
Sea force* Blaukorn	0	12.97 e	13.50 de	13.96 cd	13.47 c	
	10	13.96 cd	13.88 cd	14.30 c	14.04 b	
	20	14.52 bc	15.18 a	15.09 ab	14.93 a	
Mean effect of Blaukorn		13.81 b	14.19 a	14.45 a		

The Duncan multiple range test at the probability of 0.05 level indicates that there is no significant difference between the mean within a column, row, and their interaction following with the same latter.

Fruit Weight (g)

Data presented in Table (8) demonstrates that the application of chicken manure at 10 kg $tree^{-1}$ and foliar application with Sea force at 20 ml.L^{-1} and Blaukorn at 200 g. $tree^{-1}$ discovered the greaest significant value of fruit weight (3.10, 2.67 and 2.54 g) respectively, as compared, with other treatment. Concerning the impact of the interaction between chicken manure + Sea force, chicken manure + Blaukorn and Sea force + Blaukorn, there was a significant influence on fruit weight, the highest value (3.37, 3.09 and 2.77 g) respectively, was achieved by treating olive trees with 10 kg $tree^{-1}$ chicken manure + 20 ml L^{-1} Sea force, 10 kg $tree^{-1}$ chicken manure + 150 g $tree^{-1}$ Blaukorn and 20 ml L^{-1} Sea force + 200 mg L^{-1} Blaukorn, while the interaction of the control treatment resulted in the lowest fruit weight.. Results of chicken manure, Sea force and Blaukorn interaction, showed that the interaction among 10 kg $tree^{-1}$ chicken manure + 20 ml L^{-1} Sea force + 200 g $tree^{-1}$ Blaukorn was the most effective treatment since it produces the highest fruit weight (3.47g), but the control treatment was the lowest.

Table (8): Effect of different types of fertilizers on Fruit weight (g) of olive tree (*Olea europaea* L.) cv. Arbequina.

		Blaukorn g $tree^{-1}$		

Chicken manure (kg $tree^{-1}$)	Sea force ml L^{-1}	0	150	200	Chicken manure * Sea force	Mean effect of Chicken manure
0	0	1.27 m	1.50 lm	1.70 kl	1.49 g	1.80 c
	10	1.80 j-l	1.80 j-l	2.07 i-k	1.89 f	
	20	2.00 i-k	2.03 i-k	2.07 i-k	2.03 f	
5	0	2.10 h-j	1.93 i-k	2.20 g-i	2.08 f	2.32 b
	10	1.90 i-k	2.47 fg	2.43 f-h	2.27 e	
	20	2.63 f	2.43 f-h	2.77 d-f	2.61 d	
10	0	2.70 ef	2.73 ef	3.00 c-e	2.81 c	3.10 a
	10	3.10b-d	3.17a-c	3.13a-c	3.13 b	
	20	3.27 a-c	3.37 ab	3.47 a	3.37 a	
Chicken manure * Blaukorn	0	1.69 e	1.78 de	1.94 d	Mean effect of Sea force	
	5	2.21 c	2.28 c	2.47 b		
	10	3.02 a	3.09 a	3.20 bc		
Sea force* Blaukorn	0	2.02 e	2.06 e	2.30 d	2.13 c	
	10	2.27 d	2.48 bc	2.54 b	2.43 b	
	20	2.63 ab	2.61 ab	2.77 a	2.67 a	
Mean effect of Blaukorn		2.31b	2.38 b	2.54a		

The Duncan multiple range test at the probability of 0.05 level indicates that there is no significant difference between the mean within a column, row, and their interaction following with the same latter.

Total yield per tree (kg $tree^{-1}$)

Table (9) indicate that the soil application of chicken manure at 5 kg $tree^{-1}$ and 10 kg $tree^{-1}$ gave the significant results when compared with control treatment, and the biggest yield was obtained, from 10 kg $tree^{-1}$ chicken manure, which gave (22.70 kg $tree^{-1}$). Foliar spray of Sea force at both concentration (10, 20 ml L^{-1}) significantly increased total yield per tree, highest yield was with high concentrate of Sea force (20 ml L^{-1}) which gave (22.45 kg $tree^{-1}$), Conversely, there are no significant differences among all Blaukorn soil application treatments. In respect with the interaction between chicken manure + Sea force, chicken manure + Blaukorn and Sea force + Blaukorn indicated that the effect of interaction was a significant effect of total yield per tree and the highest value (23.45, 22.94 and 22.93 kg $tree^{-1}$) were obtained from the treatment combination of 10 kg $tree^{-1}$ chicken manure + 20 ml L^{-1} Sea force, 10 kg $tree^{-1}$ chicken manure + 0 g $tree^{-1}$ Blaukorn and 20 ml L^{-1}Sea force + 200 g $tree^{-1}$ Blaukorn. Results of chicken manure, Sea force and Blaukorn interaction observed that there was a significant impact on total yield per tree and illustrated that the interaction among 10 kg $tree^{-1}$ chicken manure + 20 ml L^{-1} Sea force + 200 g $tree^{-1}$ Blaukorn was the most important and successful treatment because it provided the highest total yield per tree (24.15kg $tree^{-1}$). While, the control treatment gave the smallest value (1.27kg $tree^{-1}$).

Table (9): Effect of different types of fertilizers on Total yield per tree (kg $tree^{-1}$) of olive tree (*Olea europaea* L.) cv. Arbequina.

Chicken manure (kg tree^{-1})	Sea force ml L^{-1}	Blaukorn g tree^{-1}			Chicken manure * Sea force	Mean effect of Chicken manure
		0	150	200		
0	0	17.72 d	20.16 cd	20.23 cd	19.37 c	20.79 b
	10	22.02 a-c	20.28 cd	22.97 a-c	21.76 b	
	20	20.95 bc	20.23 cd	22.51 a-c	21.23 b	
5	0	22.10 a-c	22.61 a-c	22.25 a-c	22.32 ab	22.39 a
	10	21.48 a-c	21.53 a-c	23.56 ab	22.19 ab	
	20	21.97 a-c	23.88 ab	22.15 a-c	22.66 ab	
10	0	23.79 ab	21.85 a-c	22.54 a-c	22.72 ab	22.70 a
	10	22.34 a-c	21.71 a-c	21.75a-c	21.93 ab	
	20	22.68 a-b	23.52 ab	24.15 a	23.45 a	
Chicken manure * Blaukorn	0	20.23 b	20.22 b	21.90 a	Mean effect of Sea force	
	5	21.85 a	22.67 a	22.65 a		
	10	22.94 a	22.36 a	22.81 a		
Sea force* Blaukorn	0	21.20 b	21.54 ab	21.67 ab	21.47 b	
	10	21.95 ab	21.17 b	22.76 ab	21.96 ab	
	20	21.86 ab	22.54 ab	22.93 a	22.45 a	
Mean effect of Blaukorn		21.67 a	21.75 a	22.46 a		

The Duncan multiple range test at the probability of 0.05 level indicates that there is no significant difference between the mean within a column, row, and their interaction following with the same latter.

Fruit Total Soluble Solids (TSS%)

According to the table (10) soil application of chicken manure at 10 kg tree^{-1}, foliar application of Sea force at 20ml L^{-1} and soil application of Blaukorn at 200 g tree^{-1} recorded the fruit total soluble solids highest value (15.48, 15.74 and 15.30 %) respectively as compared with other treatment. Regarding the impact of the interaction between chicken manure + Sea force, chicken manure + Blaukorn and Sea force + Blaukorn, there was a significantly affected on fruit total soluble solids, the highest values (16.84, 15.76 and 16.00%) respectively, were achieved by treating olive trees with 10k g tree^{-1} chicken manure + 20 ml L^{-1} Sea force, 10k g tree^{-1} chicken manure + 150 g tree^{-1} Blaukorn and 20 ml L^{-1} Sea force + 150g tree^{-1} Blaukorn. Outcomes of chicken manure, Sea force and Blaukorn interaction, indicated that the interaction among 10 kg tree^{-1} chicken manure + 20 ml L^{-1} Sea force + 200 g tree^{-1} Blaukorn and the interaction among 5 kg tree^{-1} chicken manure + 0 ml L^{-1} Sea force + 200 g tree^{-1} Blaukorn produced the highest fruit total soluble solids (17.60%), whereas the interaction among 5 kg tree^{-1} chicken manure + 10 ml L^{-1} Sea force + 0 g tree^{-1} Blaukorn produced the lowest fruit TSS (12.43%).

Table (10): Effect of different types of fertilizers on fruit total soluble solids (TSS%) of olive tree (*Olea europaea* L.) cv. Arbequina.

		Blaukorn g tree^{-1}		

Chicken manure (kg tree^{-1})	Sea force ml L^{-1}	0	150	200	Chicken manure * Sea force	Mean effect of Chicken manure
0	0	12.79 kl	13.90 h-k	14.97 d-i	13.88 cd	15.15 a
	10	15.60 c-f	14.67 d-j	15.15 d-i	15.14 b	
	20	16.49a-c	17.59 a	15.22 c-h	16.43 a	
5	0	15.81 b-d	17.00 ab	17.60 a	16.80 a	14.67 b
	10	12.43 l	13.43 j-l	13.85 h-k	13.24 d	
	20	14.05 g-k	13.42 j-l	14.40 f-j	13.95 c	
10	0	15.09 d-i	15.41 c-g	13.79 i-k	14.76 b	15.48 a
	10	14.48 e-j	14.88 d-i	15.14 d-i	14.83 b	
	20	15.93 b-d	17.00 ab	17.60 a	16.84 a	
Chicken manure * Blaukorn	0	14.96 bc	15.38 ab	15.12 a-c	Mean effect of Sea force	
	5	14.10 d	14.62 cd	15.28 a-c		
	10	15.17 a-c	15.76 a	15.51 ab		
Sea force* Blaukorn	0	14.56 b	15.43 a	15.45 a	15.15 b	
	10	14.17 b	14.33 b	14.71 b	14.40 c	
	20	15.49 a	16.00 a	15.74 a	15.74 a	
Mean effect of Blaukorn		14.74 b	15.25 a	15.30 a		

The Duncan multiple range test at the probability of 0.05 level indicates that there is no significant difference between the mean within a column, row, and their interaction following with the same latter.

Percentage of Oil (%)

According to table (11)'s results, soil application of chicken manure at 10 kg tree^{-1} gave the highest significant value (41.06%) and foliar spray of Sea force at 20ml L^{-1} gave the maximum value (40.70 %) and did not differ with the control treatment. Conversely, no significant differences in the Percentage of oil when Blaukorn treatments applied to the soil. Regarding to the interaction between chicken manure + Sea force and Sea force + Blaukorn, was a significant impact of Percentage of oil and the maximum value (41.64, 41.40 %) respectively, were obtained from the treatment combination of 10 kg tree^{-1} chicken manure + 20ml L^{-1} Sea force and 20 ml L^{-1} Sea force + 200g tree^{-1} Blaukorn, no significant differences between the interaction of chicken manure + Blaukorn in oil%. The results of the interaction among chicken manure, Sea force, and Blaukorn showed that there was not significant impact on the Percentage of oil and that the interaction among 10 kg tree^{-1} chicken manure + 0ml L^{-1} Sea force + 0 mg L^{-1} Blaukorn gave the highest Percentage of oil (43.11 %), while the interaction among 5 kg tree^{-1} chicken manure + 10ml L^{-1} Sea force + 150 mg L^{-1} Blaukorn gave the lowest value (35.92%).

Table (11): Effect of different types of fertilizers on Percentage of oil (%) of olive tree (*Olea europaea* L.) cv. Arbequina.

		Blaukorn g tree^{-1}				

Chicken manure (kg tree^{-1})	Sea force ml L^{-1}	0	150	200	Chicken manure * Sea force	Mean effect of Chicken manure
0	0	37.87a-c	38.65a-c	37.70a-c	38.08 bc	38.92b
	10	38.24a-c	40.21a-c	38.21a-c	38.88 a-c	
	20	39.71a-c	38.66a-c	41.07a-c	39.81 a-c	
5	0	38.71a-c	40.98a-c	40.22a-c	39.97 ab	39.06b
	10	37.75a-c	35.91c	36.08bc	36.58 c	
	20	42.24a-c	38.20a-c	41.48a-c	40.64 ab	
10	0	42.10a	39.71a-c	41.96a-c	41.26 ab	41.05a
	10	40.47a-c	40.84a-c	39.46a-c	40.26 ab	
	20	40.91a-c	42.36ab	41.63a-c	41.62 a	
Chicken manure * Blaukorn	0	38.60a	39.18a	39.01a	Mean effect of Sea force	
	5	39.57a	38.36a	39.26a		
	10	41.82a	40.64a	40.71a		
Sea force* Blaukorn	0	40.23ab	39.11ab	39.96ab	39.77ab	
	10	38.82ab	39.32ab	37.58b	38.57b	
	20	40.93ab	39.73ab	41.40a	40.71a	
Mean effect of Blaukorn		40.02a	39.41a	39.64a		

The Duncan multiple range test at the probability of 0.05 level indicates that there is no significant difference between the mean within a column, row, and their interaction following with the same latter.

The data shown in the preceding tables indicate evident that applying chicken manure to the soil significantly improved all studied characters in this investigation, as the best (average leaf area, total chlorophyll, number of flowers per inflorescence, fruit set %, fruit length, fruit width, fruit weight, total yield per tree, TSS and oil %) were produced with soil application of 10 kg tree^{-1} chicken manure. The components of chicken manure may be responsible because they give the plant good nutrition, and it is well known that nutrition plays a significant influence in a plant's ability to grow and develop. (Kassem & Marzouk, 2002). The stimulatory effect of the nutrients absorbed on the photosynthesis process may be responsible for the improvement in flowering, as this process undoubtedly had a positive impact on the flowering characteristics (Bhangoo *et al.*, 1988). The positive influence of soil application of chicken manure on the total yield, fruit quantity and quality characters could be attributed to the beneficial effect of the organic manure on enhancing fruit set percent (Abd El-Migeed *et al.*, 2007), and may also be related to feeding trees the different nutrients they need over an extended period of time (Birjely & Al-Atrushy, 2017). The total yield/tree increase with an increase of chicken manure rate, these may be corelated to the role of organic manure on fruit length, width (table 6, 7) and fruit weight (table 8), which positively affected by application of chicken manure (Abd El-Migeed *et al.*, 2007). The role of the chicken manure's essential nutrients may improve the bio synthesis and translocation, of carbohydrates from leaves to the fruits, which may have improved the chemical quality of the fruits (TSS and oil percentage) (Masoud, 2012). The breakdown of chicken manure and its abundance concentration of macro and micro elements may have contributed to the highest TSS% that was observed after applying chicken manure to the soil as an organic fertilizer. (Abbas *et al.*, 2007).

increasing average leaf area and total chlorophyll content after applying seaweed extract (Sea force) as foliar spray, could be due the main components of Sea force (magnesium, boron, and sulphur) that stimulate growth characteristics. The increase of the average leaf area because boron (B) activates auxin, which promotes cell division and development, and because boron helps transfer sugars from the cellular membrane to form proteins and carbohydrates that aid in optimal vegetative growth. (Galet, 1983). The reason behind increasing total chlorophyll % may be due to the role of these elements in the synthesis of the chlorophyll and the increase of the photosynthetic process (Al-Atrushy, 2009). The main components of Sea Force (Boron, Mg, SO_3, Mo, and S) that increase fruit setting as well as the physiological functions of these elements and how they affect the build-up of carbohydrates in fruit (Galet, 1983). The foliar application of Sea force had a significant influence on the improving the fruit (length & width), fruit weight and total yield per tree (tables 6,7,8,9). Fruit length and width were increased by applying seaweed extract (Sea force), which may have been caused by the presence of growth regulators that affect cell division and elongation in the early phases of fruit growth. (Khan *et al.*, 2012). The increase in average fruit weight may be explained by the presence of plant growth regulators in seaweed extract, such as auxins, gibberellins, and cytokinins (Pawar & Rana, 2019). Increased fruit weight may also be caused by photosynthesis and chlorophyll production, which raise the concentration of photo-assimilates. (Khan *et al.*, 2012). The effect of Sea force on increasing the yield may be attributed to the fruit weight (table 8) due to the main contents of Sea force and its effect on activating the photosynthesis process and plays significant impact as activators of many enzymes, it is also involved in the metabolism of carbohydrate (Mohammed & Abdul-Qader, 2007). The reason behind the positive effect of sea force on the quantity characteristics of fruit (TSS and oil %) may be attributed, to the role of macro and microelements and their positive effects on increasing the photosynthetic processes and activating the carbohydrate formulation and accumulation and transporting the organic products from the leaves to the fruit (Al-Atrushy, 2009).

As for the effect of mineral fertilizer (Blaukorn NPK 12:12:16), it’s clear from the data in tables (2,6,7,8,10) that it improved some of the vegetative growth and fruit quantity and quality characters of the Arbequina olive cultivar. The reason behind increasing these parameters (average leaf area, fruit length, fruit width, fruit weight and TSS) may be due to the role of the elements NPK (the main contents of Blaukorn) in vegetative and fruiting growth. The primary component in mineral fertilizers for fruit trees is nitrogen, which has a greater impact on vegetative growth, fruit quantity, and fruit quality. (Srivastava, 2012). It also is a basic component of chlorophyll, which is essential for photosynthesis and important for vegetative and development (Wagner, 2011). Phosphorus is essential for numerous biological processes, including the transfer of energy within plants, the synthesis and breakdown of carbohydrates, and photosynthesis (Srivastava, 2012). Potassium is important for basic physiological process such as cell division and growth, translocation of sugars, synthesis of proteins. It promotes fruit growth and improves the fruit's size, flavor, and color. (Srivastava, 2012).

CONCLUSIONS

The most important conclusions obtained in this experiment that each of chicken manure, seaweed extract (Sea force) and mineral fertilizer (Blaukorn NPK 12:12:16) at high levels improved the studied characteristics of vegetative growth, yield, fruit quantity and quality of olive cv. Arbequina. also, binary and triple interactions among high levels significantly increased most study parameters.

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CONFLICT OF INTEREST

There are no conflicts of interest with the publication of this work.

تاثير انواع مختلفة من الاسمدة في النمو والانتاجية لاشجار الزيتون صنف اربيكونيا Olea europaea L

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الخلاصة

أجريت هذه الدراسة خلال موسم النمو 2022 على أشجار زيتون صنف أربيكينا بعمر 16 سنة المزروعة بمسافة 6×6 م في تربة طينية رملية مزيجية تحت نظام الري بالتنقيط في بستان خاص يقع في منطقة زاخو بمحافظة دهوك، إقليم كردستان العراق لدراسة تأثير أنواع مختلفة من الأسمدة على نمو وإنتاجية أشجار الزيتون(*Olea europaea* L.) صنف أربيكوينا. تتضمن التجربة سبعة وعشرون معاملة (ثلاثة مستويات من مخلفات الدواجن المضافة الى التربة بنسب 5,0، 10 كغم شجرة$^{-1}$، الرش الورقي بثلاثة مستويات من مستخلص الطحالب البحرية(Sea force) 0، 20,10 مل. لتر$^{-1}$ وثلاثة مستويات من التسميد المعدني Blaukorn NPK (12:12:16) (0، 150، 200 غم. شجرة$^{-1}$). تم إضافة السماد المعدني ثلاث مرات في الموسم: أولاً: عند مرحلة النمو الخضري. ثانياً: عند الإزهار الكامل. ثالثاً: بعد عقد الثمار. أشارت النتائج إلى أن مخلفات الدواجن المضافة الي التربة وخاصة عند 10 كغم شجرة$^{-1}$ والرش الورقي بمستخلص الطحالب البحرية (Sea force)بتركيز 20 مل. لتر$^{-1}$ أدى إلى زيادة معنوية في جميع الصفات المدروسة (متوسط مساحة الورقة، محتوى الكلوروفيل الكلي، عدد الأزهار في النورة، نسبة عقد الثمار، طول الثمرة, عرض الثمرة, وزن الثمرة، إجمالي إنتاجية الشجرة، إجمالي المواد الصلبة الذائبة في الثمار(TSS%) ، نسبة الزيت في الثمار. اضافة السماد المعدني Blaukorn لا سيما عند 200 جرام الشجرة$^{-1}$ أدت إلى زيادة معنوية في متوسط مساحة الورقة،

طول وقطر ووزن الثمرة ونسبة المواد الصلبة الذائبة الكلية (TSS%). كما لوحظ ارتفاع معنوي في التداخلات الثنائية والثلاثية لمعاملات الدراسة على جميع الصفات المدروسة ولا سيما المستويات العالية لعوامل الدراسة.

الكلمات المفتاحية: مخلفات الدواجن, طحالب بحرية, السماد المعدني, زيتون.

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