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# Response the vegetative characters of three cultivars of olives (Olea europaea L.) to application methods of Nano-Iron and seaweed extract

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## ABSTRACT

This study was conducted during the 2019 growing season in the olive grove of the college of Agriculture - Tikrit University / Salah al-Din, to study Response the vegetative characters of three cultivars of olives ( Olea europaea L.) to application methods of Nano-Iron and seaweed extract.

The study included three factors were as follows: The first factor (cultivars): Nabali variety (V1) , Ashrasi variety (V2), Khudhari variety (V3). and the second factor (application methods) : Foliar application (A1) , Trunk injection (A2) . and the third factor (application fertilizers) : It was added with three dates 15/2 , 1/3 and 15/3 It included : Fertilizers added by Foliar application: Control treatment (water only) (T0) and Nano-Iron ($Fe_3O_4$ Nanoparticles) with a concentration of 150 mg. $L^{-1}$ (T1), 300 mg. $L^{-1}$ (T2) and seaweed extract (Tecamin Algae) at a concentration of 2 ml. $L^{-1}$ (T3) , 4 ml. $L^{-1}$ (T4) . And fertilizers added by trunk injection : Control treatment (water only) (T0) and Nano-Iron ($Fe_3O_4$ Nanoparticles) with a concentration of 75 mg. $L^{-1}$ (T1), 150 mg. $L^{-1}$ (T2) and seaweed extract (Tecamin Algae) at a concentration of 1 ml. $L^{-1}$ (T3) , 2 ml. $L^{-1}$ (T4).

The experiment was conducted as a factors experiment according to the Split Split Plot Design in (RCBD) with three varieties and two addition methods and five treatments, and two seedling to each experimental unit and three replicates (3 x 2 x 5 x 2 x 3 = 180 seedlings) , The results showed a significant increase in both the total leaf area and the average of growth length, seedling height, main stem diameter and relative content of both chlorophyll and total carotenoids in the treatment of T2 nanoparticles (0.64 m2, 5.72 cm, 20.60 cm, 1.59 cm, 5.57 mg.gm-1, 0.209 mg.100gm-1) in succession, whereas treatment of seaweed extract T4 was significant increase in branches length only (15.02 cm), as shown by Dual and triple interference factors research significant differences for all the studied characters.

**Key Words :** Olive , Foliar application , Trunk injection , Nanoparticle, Seaweed extract

## Introduction

The scientific name of olives is Olea europaea L. which belong to family Oleaceae includes 30 Genus and 600 Species (Giorgio and Raffaella ، 2002) .

The olive tree is evergreen, of medium to high length, and it carries leather leaves that have a greenish-gray color, and the leaves are single with elongated blade and have a short neck (Al-hamadany et al، 2020). in Iraq, olive trees are cultivated in northern Baghdad to the western regions. The number of fruitful trees is 485585 trees and the average productivity is about 12292 tons, while the average yield of one tree is about 25.31 kg .Tree-1 (CSO/Iraq,2018). The method of foliar fertilization is safe and successful in vegetative plant nutrition, in addition to the homogeneous preparation of the plant with nutrients (Brayan, 1999), because the fertilization of trees by trunk injection has clear advantages such as no environmental pollution, more robust and less costly, no limits on tree height and fertilizers can be spread quickly (Sucheng et al, 2014) and find Frank et al (1982) Injection the 1% of FeSO4 solution to peach trees Prunus persica L. stem, led to a significant increase in all the characteristics of vegetative growth, such as the leafy area, the leaf content of chlorophyll and the length of the branches respectively .

Get it Fernandez et al (1993) significant differences in chlorophyll content and increased vegetative growth when trunk injecting into olive trees Olea europaea L .Verity Manzanillo and Peaches Prunus persica L. verity Maycrest by Fe Sulfate in two concentrations 0.5 % and 1 % .

Nanotechnology or nanoscience is a science that is concerned with the study of material processing at the atomic scale 10-9 Per meter, because nanomaterials exhibit properties that are different from materials when they are in more than their traditional dimensions 100 Nanometer (Saleh, 2015) .

Nanoparticle fertilizers have unique advantages due to their small size and large surface area that increase the sorption surface (Singh and Gupta, 2016) and get it Abou El-Nasr et al (2015) that there were significant differences when treating pear seedlings Pyrus Serotina L. verity Le- conte with nano iron oxide Fe3O4 by concentrations 25, 125 and 250 mg. L-1 where the concentration exceeded 250 mg .L-1 significant in both seedlings height, stem diameter and leafy area . Get it Sohrab et al (2016) indicated significant differences when treating pomegranate trees Punica Granatum L. verity Ardestani With nano zinc - boron and with different concentrations 0,60 and 120 mg .L-1 , achieving a concentration of 120 mg. L-1 has the highest chlorophyll content and leafy area . Iron contributes to the biological processes in the plant by being a active of enzymes for the respiration process and the transfer of electrons as it enters in the synthesis of chloroplast and many enzymes (Barker and Stratton, 2015).

Algae extracts are considered from the organic sources used in agricultural production as they active the growth and organization of plants, which leads to improving the physical and chemical characters of plants because they contain large and small elements, plant growth regulators like Uxins, cytokines, vitamins, amino and organic acids and multiple sugars as well as regulating osmosis in concentrations Higher tolerance and increased plant tolerance to salinity, drought and harsh environmental conditions (Jensen, 2004). reached Haggag et al (2014) the addition of seaweed extract liquid in a concentration of 4 ml.L-1 on the olive variety Aggizi it gave the best results with regard to the number of side branches, stem diameter and plant height. Alrawy et al (2016) found that the treatment of peach trees Prunus domestica L. With seaweed extract Sea Force At a concentration of 4 ml.L-1 it gave significant differences in both total leafy area and leaf content of chlorophyll.

Materials and Methods

This study was conducted during the 2019 growing season in the olive grove of the College of Agriculture - Tikrit University / Salah al-Din, to study Response the vegetative characters of three cultivars of olives ( Olea europaea L.) to application methods of Nano-Iron and seaweed extract .

Fertilizers were added in two ways, the first is sprayed on the vegetative system, the second is by injection into the trunk, and for two types of fertilizers, the first nano -iron Fe3O4 Nanoparticles 98% American made and second seaweed extract Tecamin Algae Spanish made and knowing their effect on the vegetative characters of three variety of olives, Nepali, Ashrasi and Khatheri .Where the study factors were as follows :

The first factor (varieties): Nabali variety(V1), Ashrasi variety(V2) and Khudari variety(V3) .

The second factor (addition methods): Foliar application (A1) and Trunk injection (A2) .

The third factor (application fertilizers) :It was added in three dates 15/2 , 1/3 and 15/3 It included :
Fertilizers added by foliar application :
(T0) Control treatment .
(T1) 150 mg.L-1 Fe3O4 Nanoparticles .
(T2) 300 mg.L-1 Fe3O4 Nanoparticles .
(T3) 2 ml.L-1 Tecamin Algae .
(T4) 4 ml.L-1 Tecamin Algae .
Fertilizers added by trunk injection :
(T0) Control treatment .
(T1) 75 mg.L-1 Fe3O4 Nanoparticles .
(T2) 150 mg.L-1 Fe3O4 Nanoparticles .
(T3) 1 ml.L-1 Tecamin Algae .
(T4) 2 ml.L-1 Tecamin Algae .

**Table (1) some physical and chemical properties of the soil used in the study**

| Adjective | | Amount | Unit |
|---|---|---|---|
| Chemical quality | | | |
| Degree of soil reaction  pH | | 7.82 | |
| Electrical conductivity  EC | | 0.22 | dS.m-1 |
| Organic matter  OM | | 2.61 | % |
| Available elements | | | |
| Available nitrogen  N | | 3.4 | mg.kg-1 |
| Available phosphorous  P | | 0.136 | mg.kg-1 |
| Available potassium  K | | 4.3 | mg.kg-1 |
| Calcium Ca+2 | | 47 | mg.kg-1 |
| Sodium Na+ | | 5 | mg.kg-1 |
| Magnesium Mg+2 | | 4.6 | mg.kg-1 |
| Carbonate | | 0 | mg.kg-1 |
| Bicarbonate | | 62 | mg.kg-1 |
| Sulfate | | 3.51 | mg.kg-1 |
| Chlorides | | 71.3 | mg.kg-1 |
| Physical quality | | | |
| Particle size distribution | Clay | 27 | % |
| | Silt | 15 | % |
| | Sand | 58 | % |
| Soil texture | | Sandy clay | |
| Iron | | 1.08 | mg.kg-1 |
| Zinc | | 0.935 | mg.kg-1 |

 *Soil analyzed in the Laboratory of Soil Science and Water Resources Department of the College of Agriculture, Tikrit University.

**Table (2) the chemical composition of Nano-Iron Fe3O4 Nanoparticles**

| Fe3O4 | 98%> |
|---|---|
| Ca | 0.02% |
| Cl | 0.02% |
| Cr | 0.02% |
| Mg | 0.01% |
| Mn | 0.115% |
| Na | 0.01% |
| Ni | 0.01% |
| Pb | 0.005% |
| SiO2 | 0.2% |
| SO42 | 0.1% |

**Table (3) the chemical composition of seaweed extract (Tecamin Algae)**

| Algae extract | 16 % |
|---|---|
| Organic matter | 13 % |
| Total nitrogen ( N ) | 1.00 % |
| Total phosphorus ( P2O5 ) | 0.50 % |
| Total potassium ( K2O) | 2.00 % |
| Free amino acids | 1.50 % |

The experiment carried as an experiment effect by Split Split Plot Design to the design of ( RCBD) With three verities, two addition methods, five treatments and by depends each two seedling as a Experimental unit and with three replicates ($3\times2\times5\times2\times3$=180 seedlings), after collecting data for the studied Characters, they were statistically analyzed according to the design used by the computer within a program Gen Stat the averages were compared according to the L.S.D Polynomial test below the 0.05 probability level (Al-Muhammadi and Al-Muhammadi ، 2012) .

Studied Characters :

1- Total leaf area (m2.Seedling-1) : The total leaf area of the seedling was estimated as follows :

Total leaf area of seedlings = area of one leaf × number of leaves per seedling

2- Average increase in length of the main branches (cm): The lengths of the main branches were measured using a tape measure for all seedlings from each treatment at the beginning of the experiment (February) and at the end of the experiment (August), then the average increase in the length of the branches was estimated.

3- Average increase in length of the secondary branches (cm) : The lengths of the secondary branches were measured using the tape measure for all seedlings from each treatment at the beginning of the experiment (February) and at the end of the experiment (August), then the average increase in the length of the branches was estimated.

4- Average increase in seedlings height (cm): The height of the seedlings was measured using a tape measure and for all seedlings from each treatment starting from the soil surface to the top of the seedlings at the beginning of the experiment (February) and at the end of the experiment (August), then the average increase in height was estimated the seedling.

5- Average increase in main stem diameter (cm) : The stem diameter of seedlings was measured at a height of 5 cm from the soil surface by (Vernier Caliper Digital) For all seedlings of each treatment at the beginning of the experiment (February) and at the end of the experiment (August), then the average increase in main stem diameter was estimated the seedling.

6- Relative content of total chlorophyll (mg . g -1 mushy weight) : The leaf content of the total chlorophyll was estimated according to the method (Goodwin, 1976 ) by Spectrophotometer to the following :

Total Chlorophyll (mg . g -1 )= [20.2D (645) + 8.02D (663) × V] / W × 1000

As :

D (663) = Light intensity of chlorophyll ( a) at wavelength (663 nm) .

D (645) = Light intensity of chlorophyll (b) at wavelength (645 nm) .

V =Volume of acetone solution (ml) .

W =Weight of the sample (g) .

7- Relative content of total carotenoids (mg. 100 g-1 mushy weight) :

The leaf content of total carotenoids was estimated according to the method (Goodwin,1976 ) by Spectrophotometer according to the following :

Total Carotenoid Content (mg. g -1tissue) = ( A × 250 ml ) \ (2300 × 100)

As :

A = Light intensity at wavelength (480 nm) .

## Results and discussion

Total leaf area (m2.Seedling-1)

The results of Table 4 showed that there were significant differences for the effect of the variety, as it gave the variety Khudari V3 The largest total leaf area was 0.68 m2, while the variety Nabali V1 was given lowest area to 0.37 m2, and it is showed from the results of the table itself to the not having of significant differences for the effect of the addition methods, and also shows from the results of Table 4 the significant differences of the two factors T2 and T4 in the total leaf area, as each of them obtained 0.64 m2 while giving the control treatment T0 The lowest total leaf area is 0.26 m2 .

As for the effect of Combination between the varieties and the addition methods V×A The results of Table 4 indicate that there were significant differences for the Khudari variety in the trunk injection method V3A2 It gave the largest total leaf area of 0.76 m2 compared to the Nabali variety and in both ways V1A1 and V1A2 Which gave the lowest area of 0.37 m2 . As for the Combination between the varieties and treatments V×T The results of the table itself indicate the superiority of the Khudari variety in the treatment of seaweed extract V3T4 significant in the total leaf area, as it reached 1.01 m2 while gave the two varieties Nabali and Ashrasi in control treatment V1T0 and V2T0 Less area amounted to 0.21m2. From the results of Table 4 also there are significant differences between the addition and treatments of the Combination A×T as it gave the way to trunk injection in the treatment of nanoparticles A2T2 The highest total leaf area reached 0.74 m2 while the foliar application method gave the control treatment A1 T0 Less area amounted to 0.25 m2 .

As for the three Combination between varieties, addition methods and treatments V×A×T The results of Table 4 indicate the presence of significant differences, as it gave the Khudari variety in the method of trunk injection in the treatment of nanoparticles V3A2T2 The largest total leaf area was 1.22 m2. hile the Ashrasi variety was given in trunk injection into the control treatment V2A2T0 Less area leaf amounted to 0.17 m2 .

**Table (4) Effect of variety, addition methods, treatments and Combination between them on the total leaf area (m2 . Seedling -1)**

| Varieties | Addition methods | Treatments | | | | | V×A |
|---|---|---|---|---|---|---|---|
| | | T0 | T1 | T2 | T3 | T4 | |
| Nabali V1 | A1 | 0.22 | 0.44 | 0.39 | 0.21 | 0.59 | 0.37 |
| | A2 | 0.20 | 0.32 | 0.48 | 0.50 | 0.34 | 0.37 |
| Ashrasi V2 | A1 | 0.24 | 0.50 | 0.61 | 0.34 | 0.35 | 0.41 |
| | A2 | 0.17 | 0.49 | 0.51 | 0.43 | 0.52 | 0.42 |
| Khudari V3 | A1 | 0.29 | 0.54 | 0.64 | 0.38 | 1.09 | 0.59 |
| | A2 | 0.43 | 0.56 | 1.22 | 0.66 | 0.93 | 0.76 |
| | | | | | | | Variety effect |
| V×T | V1 | 0.21 | 0.38 | 0.43 | 0.36 | 0.46 | 0.37 |
| | V2 | 0.21 | 0.49 | 0.56 | 0.38 | 0.43 | 0.42 |
| | V3 | 0.36 | 0.55 | 0.93 | 0.52 | 1.01 | 0.68 |
| | | | | | | | Addition effect |
| A×T | A1 | 0.25 | 0.50 | 0.55 | 0.31 | 0.67 | 0.46 |
| | A2 | 0.27 | 0.46 | 0.74 | 0.53 | 0.60 | 0.52 |
| Treatments effect | | 0.26 | 0.48 | 0.64 | 0.42 | 0.64 | |
| LSD | V | A | T | V×A | V×T | A×T | V×A×T |
| 0.05 | 0.06 | NS | 0.08 | 0.09 | 0.13 | 0.11 | 0.18 |

**Average increase in length of the main branches (cm)**

The results of Table 5 showed that there was a significant difference for the effect of the variety, as the variety V3 was given the highest average increase in length of the main branches was 11.64 cm, while the variety V1 gave the lowest average was 9.65 cm ، and it is showed from the results of the table itself to the having of significant differences for the effect of the addition methods was achieved A2 the highest average increase was 11.03 cm, while the method A1 was achieved the lowest average was 10.52cm, and the results of Table 5 also showed superiority of treatment T4 Significantly, in the Average increase in length of the main branches, as it gave 15.02 cm, followed by a significant difference in treatment T2 an average increase of 13.44 cm ، while giving control treatment T0 the lowest average is 5.31 cm.

As for the effect of Combination between V×A From the results of Table 5 a significant effect of interference was observed V3A1 It gave the highest average increase in length of the main branches of 12.12 cm compared to the Combination V1A1 Which gave the lowest average was 8.27 cm. As for the Combination between V×T The results of the same table indicate the superiority of the Combination V3T2 Significantly, the mean increase in the length of the branches reached 15.74 cm while the interference was given V1T0 The lowest average is 4.44 cm . Through the results of Table 5 we showed that there were significant differences for between A×T It gave the Combination A1T4 The highest average increase in the length of the branches was 15.06 cm while the Combination was given A1T0 The lowest average is 5.09 cm.

As for the triangular interference between V×A×T From the results of Table 5 it is showed that there are significant differences if the interference is given V3A1T2 The highest average increase in length of the main branches was 16.17 cm, while Combination gave V1A1T0 The lowest average increase was 3.98 cm.

**Table (5) Effect of variety, addition methods, treatments and Combination between them on the average increase in length of the main branches (cm) .**

| Varieties | Addition methods | Treatments | | | | | V×A |
|---|---|---|---|---|---|---|---|
| | | T0 | T1 | T2 | T3 | T4 | |
| Nabali V1 | A1 | 3.98 | 8.92 | 5.73 | 8.00 | 14.73 | 8.27 |
| | A2 | 4.90 | 10.22 | 15.12 | 9.83 | 15.05 | 11.02 |
| Ashrasi V2 | A1 | 5.25 | 10.38 | 15.27 | 10.07 | 14.78 | 11.15 |
| | A2 | 5.72 | 11.17 | 13.05 | 9.82 | 14.68 | 10.89 |
| Khudari V3 | A1 | 6.05 | 11.33 | 16.17 | 11.40 | 15.67 | 12.12 |
| | A2 | 5.98 | 10.65 | 15.32 | 8.68 | 15.20 | 11.17 |
| | | | | | | | Variety effect |
| V×T | V1 | 4.44 | 9.57 | 10.43 | 8.92 | 14.89 | 9.65 |
| | V2 | 5.48 | 10.78 | 14.16 | 9.94 | 14.73 | 11.02 |
| | V3 | 6.02 | 10.99 | 15.74 | 10.04 | 15.43 | 11.64 |
| | | | | | | | Addition effect |
| A×T | A1 | 5.09 | 10.21 | 12.39 | 9.82 | 15.06 | 10.52 |
| | A2 | 5.53 | 10.68 | 14.49 | 9.44 | 14.98 | 11.03 |
| Treatments effect | | 5.31 | 10.44 | 13.44 | 9.63 | 15.02 | |
| LSD | V | A | T | V×A | V×T | A×T | V×A×T |
| 0.05 | 0.76 | 0.47 | 0.64 | 0.82 | 1.14 | 0.90 | 1.58 |

**Average increase in length of the secondary branches (cm)**

The results of Table 6 indicate that there were no significant differences for the effect of both the verity and the addition methods, while the results of the itself table show the superiority of the treatment T2 Significantly, in the length of the secondary branches, as it gave 5.72 cm, followed by a significant difference as well T4 an average increase of 5.22 cm، while giving control treatment T0 The lowest average is 2.13 cm.

Table 6 results also showed that the effect of Combination between V×A It achieved a significant superiority of Combination V1A1 It gave the highest average increase in the length of the forest was 4.36 cm compared to Combination between V2A2 Which gave the lowest average was 3.89 cm . What about the Combination between V×T The results of the table itself indicate that there is Combination between V1T2 Significantly, in the mean increase in the length of the branches, as it reached 6.04 cm, while the Combination was given V1T0 The lowest average was 2.07 cm . The results of Table 6 to significant differences of between A×T It gave the Combination A1T2 The highest mean increase in branch length was 5.94 cm while the Combination was given A1 T0 The lowest average was 2.08 cm.

As for the triangular Combination between V×A×T Table of results is observed 6 significant differences was gave the Combination between V1A1T2 The highest Average increase in length of the secondary branches was 6.18 cm, while an Combination was given V2A1T0 The lowest average increase was 1.92 cm.

**Table (6) Effect of variety, addition methods, treatments and Combination between them on the average increase in length of the secondary branches (cm) .**

| Varieties | Addition methods | Treatments | | | | | V×A |
|---|---|---|---|---|---|---|---|
| | | T0 | T1 | T2 | T3 | T4 | |
| Nabali V1 | A1 | 2.08 | 3.92 | 6.18 | 3.93 | 5.68 | 4.36 |
| | A2 | 2.05 | 4.07 | 5.90 | 4.07 | 5.02 | 4.22 |
| Ashrasi V2 | A1 | 1.92 | 3.77 | 6.08 | 3.92 | 5.68 | 4.27 |
| | A2 | 2.37 | 3.98 | 5.37 | 4.15 | 3.58 | 3.89 |
| Khudari V3 | A1 | 2.23 | 3.88 | 5.57 | 3.98 | 5.63 | 4.26 |
| | A2 | 2.12 | 3.82 | 5.23 | 4.05 | 5.72 | 4.19 |
| | | | | | | | Variety effect |
| V×T | V1 | 2.07 | 3.99 | 6.04 | 4.00 | 5.35 | 4.29 |
| | V2 | 2.14 | 3.87 | 5.72 | 4.03 | 4.63 | 4.08 |
| | V3 | 2.17 | 3.85 | 5.40 | 4.02 | 5.67 | 4.22 |
| | | | | | | | Addition effect |
| A×T | A1 | 2.08 | 3.86 | 5.94 | 3.94 | 5.67 | 4.30 |
| | A2 | 2.18 | 3.96 | 5.50 | 4.09 | 4.77 | 4.10 |
| Transaction effect | | 2.13 | 3.91 | 5.72 | 4.02 | 5.22 | |
| LSD 0.05 | V | A | T | V×A | V×T | A×T | V×A×T |
| | NS | NS | 0.44 | 0.44 | 0.72 | 0.61 | 1.04 |

**Average increase in seedling height (cm)**

The results of Table 7 showed that there were no significant differences for the effect of both the variety and the addition methods in the average increase in seedlings height. Also, results from Table 7 show the superiority of the treatment T2 Significantly, the average increase in seedlings height was 20.60 cm, followed by treatment T4 and a significant difference as it reached 20.35 cm, while giving control treatment T0 The lowest average is 11.63 cm.

As for the effect of Combination between V×A Indicate the results of Table 7 to the significant differences as give the Combination V3A2 The highest average increase in the height of the seedling was 17.32 cm compared to the Combination V2A1 Which gave the lowest average was 16.12 cm. As for the Combination between V×T The results of the itself table indicate the superiority of the Combination V3T2 Significantly, in the average increase in seedlings height, it reached 22.18 cm, while Combination was given V3 T0 The lowest average increase was 10.30 cm. Also, from the results of Table 7 there are significant differences between the two Combination A×T It gave the Combination A2T2 The highest average increase in seedlings height was 21.27 cm, while Combination was given A2T0 The lowest average was 10.49 cm.

As for the three-way Combination between V×A×T Table 7 results indicate that there were significant differences, as it gave Combination V3A2T2 The highest average increase in the height of the seedling was 23.90 cm, while giving V3A1T0 The lowest average increase was 10.08 cm.

**Table (7) Effect of variety, addition methods, treatments and Combination between them on the average increase in seedlings height (cm)**

| Varieties | Addition methods | Treatments | | | | | V×A |
|---|---|---|---|---|---|---|---|
| | | T0 | T1 | T2 | T3 | T4 | |
| Nabali V1 | A1 | 17.53 | 14.22 | 19.90 | 14.35 | 19.98 | 17.20 |
| | A2 | 10.12 | 15.52 | 19.93 | 15.17 | 20.65 | 16.28 |
| Ashrasi V2 | A1 | 10.67 | 15.88 | 19.42 | 14.48 | 20.13 | 16.12 |
| | A2 | 10.85 | 16.93 | 19.98 | 15.95 | 19.93 | 16.73 |
| Khudari V3 | A1 | 10.08 | 15.40 | 20.45 | 15.18 | 20.97 | 16.42 |
| | A2 | 10.52 | 16.00 | 23.90 | 15.75 | 20.43 | 17.32 |
| | | | | | | | Variety effect |
| V×T | V1 | 13.83 | 14.87 | 19.92 | 14.76 | 20.32 | 16.74 |
| | V2 | 10.76 | 16.41 | 19.70 | 15.22 | 20.03 | 16.42 |
| | V3 | 10.30 | 15.70 | 22.18 | 15.47 | 20.70 | 16.87 |
| | | | | | | | Addition effect |
| A×T | A1 | 12.76 | 15.17 | 19.92 | 14.67 | 20.36 | 16.58 |
| | A2 | 10.49 | 16.15 | 21.27 | 15.62 | 20.34 | 16.78 |
| Transaction effect | | 11.63 | 15.66 | 20.60 | 15.15 | 20.35 | |
| LSD 0.05 | V | A | T | V×A | V×T | A×T | V×A×T |
| | NS | NS | 1.74 | 1.91 | 2.93 | 2.44 | 4.17 |

**Average increase in main stem diameter (cm)**

It is noted from the results of Table 8 that there were no significant differences for the effect of both the variety and the addition methods in the average increase in the diameter of the main stem, and also notes from the results of Table 8 the superiority of treatment T2 Significantly in Average increase in main stem diameter reached 1.59 cm, followed by treatment T4 and a significant difference as well, reaching 1.37 cm, while giving control treatment T0 The lowest average is 0.66 cm.

As for the effect of Combination between V×A Indicate the results of Table 8 to the existence of significant differences as give Combination V3A2 The highest average increase in stem diameter was 1.39 cm compared to Combination V2A2 Which gave the lowest average was 1.02 cm .As for the Combination between V×T The results of the itself table indicate superiority V3T2 Significantly in average increase in main stem diameter reached 1.74 cm, while the Combination was given V2T0 The lowest average increase was 0.52 cm .As can be seen from the results of Table 8 also showed significant differences for between A×T Give as A1T2 The highest average increase in main stem diameter was 1.74 cm, while the Combination was given A1T0 The lowest average is 0.64 cm.

As for the triangular Combination between V×A×T It is observed from the results of Table 8 that there are significant differences if they give Combination V1A1T2 The highest average increase in stem diameter reached 1.95 cm, while giving V2A2T0 The lowest average increase was 0.47 cm.

**Table (8) Effect of variety, addition methods, treatments and Combination between them on the average increase in main stem diameter (cm)**

| Varieties | Addition methods | Treatments | | | | | V×A |
|---|---|---|---|---|---|---|---|
| | | T0 | T1 | T2 | T3 | T4 | |
| Nabali V1 | A1 | 0.75 | 0.92 | 1.95 | 0.93 | 1.28 | 1.17 |
| | A2 | 0.78 | 1.02 | 1.18 | 1.17 | 1.30 | 1.09 |
| Ashrasi V2 | A1 | 0.58 | 1.33 | 1.50 | 1.25 | 1.25 | 1.18 |
| | A2 | 0.47 | 0.85 | 1.42 | 1.18 | 1.17 | 1.02 |
| Khudari V3 | A1 | 0.58 | 1.10 | 1.78 | 0.93 | 1.72 | 1.22 |
| | A2 | 0.77 | 1.40 | 1.70 | 1.60 | 1.50 | 1.39 |
| | | | | | | | Variety effect |
| V×T | V1 | 0.77 | 0.97 | 1.57 | 1.05 | 1.29 | 1.13 |
| | V2 | 0.52 | 1.09 | 1.46 | 1.22 | 1.21 | 1.10 |
| | V3 | 0.67 | 1.25 | 1.74 | 1.27 | 1.61 | 1.31 |
| | | | | | | | Addition effect |
| A×T | A1 | 0.64 | 1.12 | 1.74 | 1.04 | 1.42 | 1.19 |
| | A2 | 0.67 | 1.09 | 1.43 | 1.32 | 1.32 | 1.17 |
| Transaction effect | | 0.66 | 1.10 | 1.59 | 1.18 | 1.37 | |
| LSD 0.05 | V | A | T | V×A | V× T | A× T | V×A×T |
| | NS | NS | 0.16 | 0.25 | 0.31 | 0.24 | 0.42 |

**Relative content of total chlorophyll (mg . g -1 mushy weight)**

It is noted from the results of Table 9 that there is a significant difference for the effect of the variety, as the variety V2 was given the highest relative content of total chlorophyll was 5.93 mg. g-1 , while gave the variety V1 the lowest relative content is 3.68 mg .g-1, as the results of the itself table indicate that there

were significant differences for the effect of the addition methods if the method was achieved A2 the highest relative content of total chlorophyll was 5.22 mg.g-1, while the method was achieved A1 the lowest relative content is 4.79 mg .g-1, it is also evident from the results of Table 9 superiority treatment T2 significant in the relative content of total chlorophyll as it gave 5.57 mg .g-1,followed by a significant difference as well T3 With a relative content of 5.56 mg .g-1, while control treatment T0 was given the lowest relative content is 3.38 mg .g-1 .

As for the effect of Combination between V×A From the results of Table 9 a significant difference of Combination V2A2 It gave the highest relative content of total chlorophyll of 6.57mg .g-1, compared to Combination V1A2 Which gave the lowest relative content of 3.58 mg .g-1 .

As for the Combination between V×T the results of the itself table indicate an Combination V2T2 significant in the relative content of total chlorophyll as it reached 7.41 mg .g-1, while the give V1T0 the lowest relative content is 2.47 mg .g-1 .

As evidenced by the results of table 9 there were significant differences for Combination between A×T give as A2T4 the highest relative content of total chlorophyll was 6.05 mg .g-1, while give A2T0 the lowest relative content is 3.28 mg .g-1.

As for the triangular Combination between V×A×T It is noted from the results of table 9 that there are significant differences as it gave the V2A2T2 the highest total chlorophyll content was 8.40 mg .g-1, while gave V1A1T0 the lowest relative content is 2.32 mg .g-1.

**Table (9) Effect of variety, addition methods, treatments and Combination between them on the relative content of total chlorophyll (mg . g -1 mushy weight)**

| Varieties | Addition methods | Treatments | | | | | V×A |
|---|---|---|---|---|---|---|---|
| | | T0 | T1 | T2 | T3 | T4 | |
| Nabali V1 | A1 | 2.32 | 4.38 | 3.20 | 4.86 | 4.15 | 3.78 |
| | A2 | 2.62 | 3.70 | 3.75 | 3.17 | 4.68 | 3.58 |
| Ashrasi V2 | A1 | 4.19 | 5.22 | 6.43 | 6.88 | 3.71 | 5.29 |
| | A2 | 3.52 | 7.01 | 8.40 | 6.83 | 7.10 | 6.57 |
| Khudari V3 | A1 | 3.97 | 4.96 | 5.78 | 5.70 | 6.04 | 5.29 |
| | A2 | 3.68 | 5.66 | 5.86 | 5.94 | 6.35 | 5.50 |
| | | | | | | | Variety effect |
| V×T | V1 | 2.47 | 4.04 | 3.48 | 4.01 | 4.42 | 3.68 |
| | V2 | 3.86 | 6.12 | 7.41 | 6.86 | 5.41 | 5.93 |
| | V3 | 3.83 | 5.31 | 5.82 | 5.82 | 6.19 | 5.39 |
| | | | | | | | Addition effect |
| A×T | A1 | 3.49 | 4.85 | 5.14 | 5.81 | 4.63 | 4.79 |
| | A2 | 3.28 | 5.46 | 6.00 | 5.31 | 6.05 | 5.22 |
| Transaction effect | | 3.38 | 5.15 | 5.57 | 5.56 | 5.34 | |
| LSD 0.05 | V | A | T | V×A | V×T | A×T | V×A×T |
| | 0.07 | 0.05 | 0.06 | 0.08 | 0.11 | 0.09 | 0.15 |

**Relative content of total carotenoids (mg. 100 g-1 mushy weight)**

The results of the table 10 there is a significant difference to the effect of verity gave as V3 the highest relative content of total carotenoids was 0.199 mg. 100g-1, while gave the verity V1 the lowest relative content is 0.174 mg . 100 g-1 , and the results of the itself table indicate that there were significant differences for the effect of the addition methods if the method was achieved A2 the highest relative content of total carotenoids was 0.190 mg. 100 g-1, while the method was achieved A1 the lowest relative content is 0.189 mg. 100 g-1, and also indicate the results of table 10 superiority the transaction T2 significantly, the relative content of total carotenoids was 0.209 mg. 100 g-1, followed by a significant difference as well T4 with a relative content of 0.197 mg. 100g-1, while comparison treatment T0 was given the lowest relative content is 0.167 mg. 100g-1.

As for the effect of Combination between V×A from the results of table 10 a significant effect of V3A1 It gave the highest relative content of total carotenoids

of 0.204mg 100g-1, compared to the Combination V1A1 which gave the lowest relative content of 0.170 mg . 100g-1 .

As for the Combination between V×T It is observed from the results of the itself table to the superiority of Combination V1T2 significant in the relative content of total carotenoids as it reached 0.214 mg. 100g-1, while comparison V1T0 the lowest relative content is 0.141 mg . 100 g-1.

It is also evident from the results of table 10 that there were significant differences for the Combination between A×T It achieved A2T2 the highest relative content of total carotenoids was 0.210 mg . 100 g-1 , while achieved A2T0 the lowest relative content is 0.146 mg . 100 g-1 .

As for the intra - triple between V×A×T from the results of Table 10 it is noticed that there are significant differences, if Combination is given V1A1T2 the highest total carotenoids content was 0.216mg. 100g-1, while give V1A1T3 the lowest relative content is 0.101 mg. 100 g-1.

**Table (10) Effect of variety, addition methods, treatments and Combination between them on the relative content of total carotenoids (mg. 100 g-1 mushy weight)**

| Varieties | Addition methods | Treatments | | | | | V×A |
|---|---|---|---|---|---|---|---|
| | | T0 | T1 | T2 | T3 | T4 | |
| Nabali V1 | A1 | 0.175 | 0.213 | 0.216 | 0.101 | 0.143 | 0.170 |
| | A2 | 0.107 | 0.169 | 0.213 | 0.192 | 0.210 | 0.178 |
| Ashrasi V2 | A1 | 0.193 | 0.177 | 0.198 | 0.202 | 0.198 | 0.194 |
| | A2 | 0.161 | 0.207 | 0.203 | 0.204 | 0.202 | 0.195 |
| Khudari V3 | A1 | 0.195 | 0.191 | 0.209 | 0.210 | 0.213 | 0.204 |
| | A2 | 0.171 | 0.166 | 0.213 | 0.210 | 0.214 | 0.195 |
| | | | | | | | Variety effect |
| V×T | V1 | 0.141 | 0.191 | 0.214 | 0.146 | 0.176 | 0.174 |
| | V2 | 0.177 | 0.192 | 0.200 | 0.203 | 0.200 | 0.194 |
| | V3 | 0.183 | 0.178 | 0.211 | 0.210 | 0.213 | 0.199 |
| | | | | | | | Addition effect |
| A×T | A1 | 0.188 | 0.194 | 0.208 | 0.171 | 0.185 | 0.189 |
| | A2 | 0.146 | 0.181 | 0.210 | 0.202 | 0.209 | 0.190 |
| Transaction effect | | 0.167 | 0.187 | 0.209 | 0.186 | 0.197 | |
| V×A×T | | A×T | V×T | V×A | T | A | V |
| 0.004 | | 0.002 | 0.003 | 0.002 | 0.002 | 0.001 | 0.002 |

The cause for the olive varieties differences of the vegetative characters (Tables 4, 5, 9 and 10 ) is due to genetic caused specific to the variety and controlling the vegetative growth of the plant (Robinson and Schwabe, 1986), This is consistent with what Al-Ishaqi (2002) mentioned when he studied seven varieties of olives.

The results (Tables 5, 8 and 10) also indicate that the trunk injection method is superior to the caused transfer of nutrients elements to the plant parts with the rising water, as the transport of nutrients within the vascular bundles is very easy and fast and does not necessarily have to be through diffusion what happens as a result of the transition from the high Concentration to the low Concentration only, but the transition may also occur through the mass transfer that occurs as a result of the water flow (Al-Sahaf , 1989), and these results are consistent with the findings of Al-Zubaidi (2018) and Jahanshah et al (2016) in their studies on date palm trees.

The increase in the characteristics of vegetative growth (Tables 4, 5, 6, 7, 8, 9, and 10) to the seedlings treated with nanoparticles due to the role of iron in regulating vital activities within the plant, because the increased concentration of iron in plant tissues increases the efficiency of photosynthesis activation of the enzymes involved in many physiological processes and the construction of amino and nucleic acids and energy compounds, which led to an increase in photosynthesis products and thus an increase in vegetative growth (Abu Dahi and Yunus, 1988) these results are consistent with Al-Aaraji (2003) found on seedlings of bitter orange and Kapota (2005) in their study of List seedlings. as for

the increase resulting from the treatment with seaweed extract (Tecamin Algae) It returns to the chemical content of these extracts are non-fertilizer materials that stimulate the growth of plants with a low concentrations and contain micro and macro nutrients and they have more than one set of growth-promoting materials such as cytokines, auxins, vitamins, amino and organic acids, compounds similar to auxins, and multi saccharides such as laminarin, fucoidan and alginate which have a wide range in their impact on the plant's biological activities . It also contains betaines which is a source of nitrogen in the low concentrations and a regulator of osmosis in high concentrations and the role of these extracts in increasing the resistance of plants to salinity, freezing, and drought may be attributed to this compound (Table 3) where nitrogen is one of the most important nutrients for the plant, as it is the main component of the amino acids that are protein building units, as it is included in the synthesis of enzymes, some growth regulators, vitamins, and chlorophyll. As for phosphorus, it is involved in the synthesis of a large number of organic compounds and energy production compounds and give the plant the power to grow (Al-Sahaf , 1989) , and potassium has an important role in plant growth, as it is the most important cation in the physiology of the plant for its physiological and biochemical functions such as cell division and encouraging the growth of Mystical tissue and carbohydrate formation It was in the leaves and moved to the growth and storage areas of the plant (Al-Naimi, 1999) these results are consistent with the findings of Al-Asadi (2016) on olive seedlings.

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## استجابة الصفات الخضرية لطرائق إضافة الحديد النانوي ومستخلص الطحالب البحرية لثلاثة أصناف من الزيتون Olea europaea L.

**ماجد حسن محمد الجبوري ، خالد عبدالله سهر الحمداني**

**الملخص**

نُفذت هذه الدراسة خلال موسم النمو 2019 في بستان الزيتون التابع لكلية الزراعة – جامعة تكريت / محافظة صلاح الدين، لدراسة استجابة الصفات الخضرية لطرائق إضافة الحديد النانوي ومستخلص الطحالب البحرية لثلاثة أصناف من الزيتون Olea europaea L. تضمنت الدراسة ثلاثة عوامل حيث كانت عوامل الدراسة كالاتي: العامل الأول (الأصناف): صنف نبالي (V1) ، صنف أشرسي (V2)، صنف خضيري (V3). و العامل الثاني (طرائق الإضافة): الرش الورقي (A1)، حقن الجذع (A2). والعامل الثالث (الأسمدة المضافة) : وقد اضيفت بثلاثة مواعيد 15/2 و 1/3 و 15/3 وتضمنت: الأسمدة المضافة عن طريق الرش الورقي: معاملة المقارنة (الماء فقط) (T0) والحديد النانوي Fe3O4 Nanoparticles بتركيز 150 ملغم.لتر−1 (T1) و300 ملغم.لتر−1 (T2) ومستخلص الطحالب البحرية Tecamin Algae بتركيز 2 مل.لتر−1 (T3) و 4 مل.لتر−1 (T4) والأسمدة المضافة عن طريق حقن الجذع: معاملة المقارنة (الماء فقط) (T0) والحديد النانوي Fe3O4 Nanoparticles بتركيز 75 ملغم.لتر−1 (T1) و 150 ملغم.لتر−1 (T2) ومستخلص الطحالب البحريةTecamin Algae بتركيز 1 مل.لتر−1 (T3) و 2 مل.لتر−1 (T4).

نفذت التجربة كتجربة عاملية حسب نظام الألواح المنشقة المنشقة Split Split Plot Design وفق تصميم القطاعات العشوائية الكاملة RCBD بثلاثة اصناف وطريقتين اضافة وخمسة معاملات وباعتماد كل شتلتين وحدة تجريبية وبثلاثة مكررات (3 × 2 × 5 × 2 × 3 = 180 شتلة)، أظهرت النتائج تفوق معاملة الحديد النانوي T2 معنوياً في كُل من المساحة الورقية الكلية ومتوسط الزيادة في طول التفرعات وارتفاع الشتلة وقطر الساق الرئيس والمحتوى النسبي لكلاً من الكلوروفيل والكاروتينات الكلية (0.64 م2 ، 5.72 سم ، 20.60 سم ، 1.59 سم ، 5.57 ملغم.غم−1 ، 0.209 ملغم.100غم−1 ) على التوالي، في حين تفوقت معاملة مستخلص الطحالب البحرية T4 في متوسط الزيادة في طول الأفرع فقط (15.02 سم) ، كما أظهرت التداخلات الثنائية والثلاثية لعوامل البحث فروقات معنوية ولكافة الصفات المدروسة.